



Self-Directed Learning

Curriculum implementation, praxis
and scholarship in context

Edited by

Charlene du Toit-Brits, Jean Henry Blignaut & Elize Vos

NWU Self-Directed Learning Series
Volume 14

Self-Directed Learning

**Curriculum implementation,
praxis and scholarship in context**



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Peer-review declaration

The publisher (AOSIS) endorses the South African 'National Scholarly Book Publishers Forum Best Practice for Peer-Review of Scholarly Books'. The book proposal form was evaluated by our Social Sciences, Humanities, Education and Business Management editorial board. The manuscript underwent an evaluation to compare the level of originality with other published works and was subjected to rigorous two-step peer review before publication by two technical expert reviewers who did not include the volume editor and were independent of the volume editor, with the identities of the reviewers not revealed to the editor(s) or author(s). The reviewers were independent of the publisher, editor(s) and author(s). The publisher shared feedback on the similarity report and the reviewers' inputs with the manuscript's editor(s) or author(s) to improve the manuscript. Where the reviewers recommended revision and improvements, the editor(s) or author(s) responded adequately to such recommendations. The reviewers commented positively on the scholarly merits of the manuscript and recommended that the book be published.

Research justification

This book is centred on an in-depth analysis of original research about applying self-directed learning (SDL) within the context of curriculum, praxis, and scholarship. Several authors conducted the research. This collaborative effort brings together diverse perspectives and methodologies to enrich the understanding of SDL. The primary focus of this book is on incorporating SDL into the process of curriculum development, as well as the significance of scholarly research in the design and implementation of curricula. In addition, the book discusses the relevance of incorporating technology into the learning process. This research focuses on modifying instructional strategies to accommodate the shifting requirements of higher education (HE) and school environments. The curriculum that focuses on catering to students' needs and interests, taking inspiration from constructivism, socio-constructivism and context-based learning theories, will be a topic of discussion in this book. Moreover, this book explores practical strategies for educators to implement these theories effectively in diverse educational settings. As mentioned earlier, the declaration emphasises the significance of educational communities, the coherence and integration of curricular content, various pedagogical approaches and SDL.

This book provides an in-depth analysis of various subject areas connected to SDL as an alternative method of instructing students. The chapters cover research on concepts and reviews, research on empirical investigations and research on practical applications. The following are some of the topics that will be discussed: the implications of artificial intelligence; strategies for reducing procrastination; fostering SDL in homeschooling; enhancing SDL attributes; preparing teachers to support self-direction; facilitating curriculum transformation; implementing cooperative learning-embedded assessment; incorporating indigenous knowledge; teaching education about climate change; and integrating educational robotics. In general, this book is an extremely helpful resource for teachers who are interested in incorporating SDL into their instructional strategies. The fundamental purpose of this book is to provide academics working on the concept of SDL with empirical study findings that might act as a source of motivation for their own research and scholarly work. Specifically, the book focuses on active learning strategies that can be applied in various educational environments, including those found in schools and HE institutions. Learners and students may benefit from these approaches, which have the potential to improve their abilities for the 21st century and better prepare them for the problems that the Fourth Industrial Revolution will bring.

The editors carried out a comprehensive screening process on each chapter, using the abstracts provided to determine whether the chapters were suitable for inclusion. After that, the editors did an all-encompassing review of each chapter to ensure there was no inconsistency and to guarantee that the standards of quality were high. After this preliminary examination, the chapters underwent an external, more in-depth and more stringent peer review process directed and coordinated by AOSIS. The editors of this collection believe the essays significantly contribute to the current academic work in the fields of SDL, curriculum implementation, and praxis. In addition, to adhere to the standards established by the Department of Higher Education and Training (DHET), this publication contains original research backed by academic citations that have been subjected to stringent scrutiny. The material presented in this book is original and has not been copied entirely from another source.

An initial review of the abstracts that were submitted was carried out by the scientific committee. Following their submission, the chapters were run via Turnitin,

a software program that detects plagiarism. The editors thoroughly examined each chapter. The following chapters are based on yet significantly revised from dissertations: 'Continuous professional development through SDL among lecturers in curriculum transformation' by Jackie Slabbert-Redpath, Charlene du Toit-Brits and Josef de Beer; 'Towards a student-centred curriculum: The case of cooperative learning-embedded assessment' by Anita Lubbe and Elsa Mentz; 'From classroom to home: Unleashing the power of self-directed learning in homeschooling' by Marguerite Scheepers, Jean Henry Blignaut and Charlene du Toit-Brits and 'Enhancing self-directed learning: Integrating the Rationality Index of Plant Use and scientific principles in pre-service chemistry teachers' training' by Judicial Sebatana, Eunice Pretorius, Washington Dudu and Josef de Beer.

The target audience is scholars in the field of SDL within education.

The editors are positive that the book will include a large scientific discussion and, as a result, can significantly contribute to the current body of knowledge on SDL. In addition, we firmly assert that there is no evidence whatsoever of any form of plagiarism contained within the content.

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Abbreviations and acronyms, figures and tables appearing in the text and notes

List of abbreviations and acronyms

ABC	Arena, Blended, Connected
AI	artificial intelligence
BBP	block-based programming
CAPS	Curriculum Assessment Policy Statements
CAQDAS	computer-assisted qualitative data analysis software
CBT	cognitive behavioural therapy
CHAT	cultural-historical activity theory
CHE	Council for Higher Education
CL	cooperative learning
CoP	communities of practice
CPD	continuous professional development
CT	computational thinking
CTL	Centre for Teaching and Learning
CV	consensus view
DBE	Department of Basic Education
DE	distance education
DHET	Department of Higher Education and Training
FET	Further Education and Training
GASE	general academic self-efficacy
GPT	generative pre-trained transformer
GSN	Global Student Network
HE	higher education
HEI	higher education institutions
HEQC	Higher Education Quality Committee
IBL	inquiry-based learning
ICT	information and communication technologies
IK	indigenous knowledge
IS	information systems
LIFE	Life Sciences

LMS	learning management system
LTSM	Learning and Teaching Support Material
ML	machine learning
MOOC	Massive Open Online Courses
NOIK	nature of indigenous knowledge
NOS	nature of science
NQF	National Qualifications Framework
NWU	North-West University
PAR	participatory action research
PBL	problem-based learning
PCK	Pedagogical Content Knowledge
PGCE	Postgraduate Certificate in Education
PLE	personal learning environment
Q&APP	Qualification and Academic Programme Planning
RGDC	Research Data Gatekeeper Committee
RIPU	Rationality Index of Plant Use
SAQA	South African Qualifications Authority
SDL	self-directed learning
SDLAS	Self-Directed Learning Aptitude Scale
SDLI	Self-Directed Learning Instrument
SDLRS	Self-Directed Learning Readiness Scale
SDLS	Self-Directed Learning Scale
SoCP	scholarship of curriculum practices
SoTL	scholarship of teaching and learning
SRL	self-regulated learning
SRSSDL	Self-Rating Scale of Self-Directed Learning
STEM	Science, Technology, Engineering and Mathematics
TIMSS	Trends in International Mathematics and Science Study
TLA	teaching, learning and assessment
UCDP	University Capacity Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VLE	virtual learning environment
VNOIK	Views of the Nature of Indigenous Knowledge
VNOS	Views of the Nature of Science
ZPD	Zone of Proximal Development

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Many researchers and practitioners believe that educational practices have not kept pace with the demands of the 21st century. Economies, societies and politics around the world are being reshaped by globalisation. Expanding populations and increasing standards of living are contributing to environmental degradation and diminishing availability of critical resources. Profound changes to the nature of modern work and life, stemming from rapid technological advances, will likely accelerate with recent developments in artificial intelligence. Yet, despite already being several decades into the ‘information age’, many commonly used educational practices date from the industrial age. In addressing these challenges, this scholarly book offers compelling evidence of how self-directed learning (SDL) can cultivate the knowledge and skills needed for success in the 21st century.

In this era of unprecedented change and information access, we must rethink our educational goals. Present-day knowledge, skills and tools are increasingly unlikely to be adequate for future work. Today’s students must be empowered to learn throughout their lives. The solutions to increasingly complex technological, environmental and societal problems require enhanced skills not sufficiently addressed by traditional knowledge-transfer curricula. These include problem-solving, creativity, critical thinking, curiosity, collaboration and communication skills, among others (e.g., Du Toit-Brits 2019). In an artificial intelligence (AI) world, questions of when and how to use technology, and what to do with its outputs, become crucial. Those decisions, at least for the time being, are best made by humans.

Self-directed learning, while not a new concept, gained increased relevance at the end of the 20th century with the approach of the information age. Crucially, unlike more traditional educational approaches, the focus of SDL is on learning rather than teaching. Originally defined by

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Knowles (1975) from studies of adult education, SDL is deeply rooted in constructivism and social constructivism. Self-directed learning cultivates learners who are agents of their own learning, self-regulating, responsible for their learning, intrinsically motivated and empowered to make choices about their learning. These are many of the same skills needed for life-long learning and for success in a world characterised by rapid change. Learning with SDL is also more relevant to the learner, so learners are more motivated and the learning is more meaningful.

This book, the 14th in the AOSIS Self-Directed Learning Series, presents comprehensive evidence that SDL can be effectively implemented across diverse educational settings. It offers practical examples, evidence and analysis of numerous aspects of SDL. Each of the chapters is co-authored by scholars affiliated with the Research Unit on Self-Directed Learning at North-West University, one of the largest research centres focused on this topic. The book begins with a chapter on artificial intelligence and its potential for individualised and flexible learning, to revolutionise online learning. Acknowledging the synergies between SDL and self-authorship, the authors of Chapter 2 propose a model for creating SDL environments that promote self-authorship. Chapter 3 explores how the SDL attributes of learners and educators function as catalysts in achieving curricular and pedagogical objectives. Chapter 4 turns our attention to how to best empower teachers in training with the competencies and methodologies to facilitate the development of SDL among their learners. Chapter 5 explores the crucial role of SDL interventions in addressing issues of academic procrastination. Chapter 6 returns our focus to the development of teachers and proposes that SDL empowers educators with greater autonomy over their professional development and facilitates their ability to continually modify their instructional approaches in response to the changing needs of their students and society. Chapter 7 offers a practical application of SDL that incorporates cooperative learning and embedded assessment in collaborative problem-solving and critical-thinking activities. Chapter 8 describes the development of SDL in pre-service teachers using block-based programming. Following the recent COVID-19 pandemic, Chapter 9 explores the importance and value of SDL in home-school environments. The final chapter discusses engaging students and pre-service teachers in chemistry through the use of indigenous knowledge in a problem-based learning setting.

In summary, globalisation and rapid technological advances have transformed nearly every aspect of modern life, necessitating new forms of learning both during formal education and throughout life. A self-directing

learner is especially well-equipped with the knowledge, skills and dispositions needed to adapt and thrive in a rapidly evolving world. Readers of this book will discover a wealth of examples, ideas and analyses that advocate for and support a transition to this powerful, learner-centred pedagogy. Together we can create a future where students, parents, educators, administrators, scholars and policymakers embrace the transformative potential of SDL.

Preface

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The primary emphasis of this book is to explore the concept of self-directed learning (SDL) and its integration into the curriculum. It examines the practical aspects of implementing SDL and situates it within the scholarly environment. Within the dynamic landscape of education, there exists a continuous advancement in our understanding of pedagogy and the implementation of curriculum to cater for the developing needs of students and learners successfully. The book *Self-Directed Learning: Curriculum Implementation, Praxis and Scholarship in Context* is a medium for bridging theoretical constructs with real-world implementations. This resource provides educators, administrators and researchers with substantial material regarding the design, implementation and evaluation of the SDL curriculum. This research investigates the academic discussion surrounding the technique mentioned above, offering a comprehensive guide for understanding the contextual factors that impact SDL. Given the growing importance of lifelong learning and SDL, this publication aims to fill a notable void by empowering educators to create dynamic and effective learning environments.

Chapter 1 provides an overview of the influence of artificial intelligence (AI) on online learning, which holds significant implications for SDL and curriculum implementation. Artificial intelligence has the potential to revolutionise education by offering personalised and adaptable learning experiences tailored to the specific requirements of each student. E-learning platforms can leverage AI to analyse extensive data sets, identifying individual students' strengths, weaknesses and learning

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preferences, thereby facilitating the provision of customised educational materials. Integrating SDL practices enhances student engagement and motivation, empowering them to assume responsibility for their education and forge personalised learning trajectories. Consequently, educators, curriculum developers and policymakers need to comprehend AI's consequences and potential advantages in online education to efficiently harness this technology and create meaningful educational opportunities in the digital age.

Du Toit-Brits, Blignaut and Wirth explore SDL's transformative potential as a pedagogical strategy to foster self-authorship in students in Chapter 2. The central theme is self-authorship, an empowering process enabling students to take control of their education and life narratives. Through SDL, students develop self-governance and self-determination, aligning their destinies with personal values and aspirations. The interplay between SDL and self-authorship is explored, highlighting their significant role in shaping a student's intellectual and personal identity. Thoughtfully designed SDL environments promote individual growth and enhance the overall educational experience. The chapter also examines the practical applications of SDL in curriculum implementation, teaching practices and academic scholarship. It argues that fostering self-authorship demands a fundamental re-evaluation of learning approaches, with SDL serving as an ideal vehicle for this purpose. Educators are encouraged to design learning environments to nurture self-authorship intentionally. Ultimately, ample opportunities for SDL are suggested to set the stage for developing a purposeful sense of direction in students' educational journeys.

Building on the importance of a fundamental shift in educational approaches and for educators to create environments that support students and learners in their pursuit of SDL, personal growth and self-authorship, Chapter 3 reports on the critical importance of establishing clear and precise learning goals and objectives as a foundational step in curriculum development. They highlight the need for a flexible curriculum that can adapt to evolving learner requirements and address diverse learning styles, abilities and interests. Furthermore, the chapter stresses the significance of enhancing educators' and learners' attributes to maximise the effectiveness of curriculum and pedagogical objectives. This chapter also proposes that SDL is essential for achieving educational aims and promotes a sense of agency among learners and educators, encouraging active participation in teaching and learning, leading to better information retention, application in various contexts and improved critical thinking skills.

Chapter 4 relates to the necessity of implementing SDL practices into higher education teacher training. The impetus for higher education teacher training is to provide novice teachers with the skills and methods they need

to foster SDL among their learners. Self-directed learning is an essential education component to address this issue as it empowers learners and educators by encouraging critical thinking, problem-solving and continual learning. Furthermore, the chapter emphasises how incorporating SDL into the curriculum and assisting new teachers in efficiently implementing it can increase student engagement and motivation. Doing so can foster a climate of SDL and initiative, leading to more meaningful educational experiences and higher academic accomplishment. This chapter clearly emphasises the importance of SDL in higher education and its potential to improve the teaching and learning processes.

Chapter 5 extends the importance of SDL in higher education by specifically interrogating the significance of cultivating SDL skills within the context of higher education as a means to address procrastination. Procrastination is a substantial obstacle to advancing academic pursuits and acquiring knowledge. Within this chapter, SDL skills, such as effective time management and a sense of personal responsibility, are regarded as a potential remedy for procrastination, resulting in more substantial and influential educational encounters. Learning these skills transcends the confines of the classroom and facilitates ongoing education. From this chapter, it is clear that higher education institutions are widely acknowledged for their capacity to improve student achievement and engagement through strategies aimed at mitigating procrastinating tendencies and fostering SDL, thus emphasising the crucial significance of SDL within higher education.

Chapter 6 highlights the importance of curriculum improvement through contextualisation, student-centred pedagogy, SDL and continuous professional development (CPD). The chapter emphasises the role of academics as curriculum planners and designers, stressing the need to contextualise the curriculum, promote SDL, integrate social justice and decolonise content. Self-directed learning is crucial in this transformation, empowering students to take control of their learning, which enhances engagement and develops essential skills for the 21st century. Continuous professional development programmes focused on SDL equip educators with the skills to implement student-centred pedagogies and hybrid teaching approaches, fostering autonomy, self-reflection among students and transformation. As change agents, educators benefit from expanded CPD opportunities to improve their qualifications and acquire micro-credentials in SDL and innovative teaching methods. Curricular training and orientation are vital for encouraging reflective practices among educators. Therefore, the authors propose a comprehensive CPD approach that emphasises SDL is essential for effective curriculum reform. Doing so prepares educators to create learning environments that support continuous improvement in teaching and learning experiences.

In Chapter 7, Lubbe and Mentz examine a curriculum that places the student at the centre, emphasising cooperative learning-embedded evaluation. Integrating cooperative learning and embedded assessment mechanisms into curriculum design and implementation can foster student engagement in collaborative problem-solving and critical-thinking endeavours. This methodology emphasises the engagement of individuals, enabling a more thorough understanding of the subject matter and promoting the development of essential skills such as teamwork. The pedagogical strategy that emphasises addressing students' individual needs aligns with the principles of SDL practice, which promotes the cultivation of autonomous learners capable of setting goals, monitoring their progress and making informed decisions on their educational path. The authors contextualise that cooperative learning-embedded assessment is a pedagogical approach grounded in social constructivism and draws upon the social interdependence theory. By adopting this approach, the organisation of social interdependence is prioritised over social independence or dependency, and this approach equips students with the essential skills and attitudes required to succeed in a dynamic and constantly evolving environment.

Chapter 8 focuses on higher education institutions that must adapt to the technological breakthroughs of the Fourth Industrial Revolution (4IR). The authors contextualise the benefits of educational robotics on higher-order cognitive skills, motivation and satisfaction. Pre-service teachers can benefit from educational robots in developing critical thinking, problem-solving and SDL skills. This chapter also presents block-based programming, digital microworld skills and self-efficacy to stimulate pre-service teachers' SDL. Data presented in this chapter revealed that pre-service education students had early academic hurdles. Students were taught critical thinking, problem-solving and coding skills like error detection and debugging. The data indicated a positive shift in students' self-efficacy perceptions, marked by increased motivation, confidence and persistence, concurrent with enhancements in self-management, accountability and other SDL skills.

Our social and personal responsibilities extend beyond formal education in this age of rapid change. Therefore, Chapter 9 discusses SDL and its impact on many aspects of education. Because of the COVID-19 outbreak, the international community has been forced to prioritise SDL. In this turbulent period, home-based education is vital. This chapter analyses SDL and its effects on individuals, focusing on homeschooling. The authors emphasise the potential for SDL to transform both children and parents who are educators and facilitators. This chapter also explains how SDL can help homeschoolers take charge of their education, develop critical thinking abilities and grasp the subject matter. According to the authors, SDL extends beyond conventional schooling, including extracurricular activities and lifetime learning.

The focus of the last chapter (Chapter 10) is the Rationality Index for Plant Use (RIPU) in chemistry education, which may enhance scientific comprehension through SDL, curriculum integration and contextualised research. The Rationale Index for Plant Use encourages students to question the rationale of traditional plant uses, linking scientific concepts to practical applications. Incorporating this indicator into the educational programme encourages students to assume responsibility for their learning and develop into proactive students. Individuals are interested in investigating, analysing and evaluating the scientific concepts underlying plant utilisation, allowing for SDL. This strategy facilitates the development of students' critical thinking, problem-solving and scientific knowledge. Combining traditional knowledge with scientific concepts gives students a comprehensive understanding of the topic's cultural and historical context. The strategy promotes a comprehensive and interdisciplinary understanding of chemistry, academic excellence, and additional research and enquiry. The Rationality Index for Plant Use enhances SDL, curriculum implementation and academic performance in chemistry by engaging students actively in the practical applications of scientific principles.

Collectively, the chapters (Chapters 1-10) in *Self-Directed Learning: Curriculum Implementation, Praxis and Scholarship in Context* demonstrate the value of this resource for educators, scholars and policymakers. This book examines the advantages of SDL in education, integration strategies and the effects on student autonomy and participation. It also contains information regarding the development of SDL educational programmes. In addition, case studies and suggestions for enhancing SDL comprehension are included. Detail is given to AI, procrastination, homeschooling and teacher education. This breadth of this coverage makes it valuable knowledge and helps readers comprehend SDL's potential to improve educational outcomes and equip students with critical skills for academic and professional success.

Self-directed learning praxis and poiesis in the age of artificial intelligence

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■ Abstract

The use of generative artificial intelligence (AI) in an online learning environment has the potential to impact self-directed learning (SDL) praxis and curriculum implementation. The potential of AI to revolutionise the education sector lies in its ability to provide tailored and flexible learning experiences that cater to each student's distinct needs and preferences. Through AI technologies, e-learning platforms can analyse extensive data to discern students' aptitudes, deficiencies and learning preferences, thereby facilitating the provision of tailored and pertinent educational materials. Furthermore, implementing SDL praxis amplifies students' engagement and motivation and fosters SDL by enabling individuals to assume responsibility for their education and pursue customised learning trajectories. This research involved using a diffractive methodology to consider the implications of AI for SDL praxis and poiesis in an online learning environment. The chapter concludes with some practical propositions for teaching and learning.

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■ Introduction

If self-directed learning (SDL) is understood as a way in which students assume an authoritative role in determining their own learning needs, goals, resources, strategies and evaluation (Knowles 1975), then praxis is paramount for the learning process. Praxis is considered a practice that 'involves engaging in learning with an active awareness of the developmental process as it occurs' (Ritchie 2023, p. 14). Praxis implies students taking charge of their learning and actively engaging in the learning process. Within a context where learning is regarded as social constructivism (Van der Walt 2016), praxis may not merely be limited to doing (*praxis*) but also creating (*poiesis*). Such an approach again emphasises the active role of the student in the classroom context and stands in opposition to an educator-centred approach.

This chapter engages with SDL regarding how this concept is considered a process (Brockett & Hiemstra 2019; Merriam & Bierema 2014) that builds on the social constructivist notion that active collaborative construction of knowledge is central to learning (Collis & Moonen 2009). Furthermore, SDL involves some manner of independence as well as an active enquiry on the part of the student (Van Deur 2017) that relates to an authentic context (Merriam & Bierema 2014). However, literature has shown how cooperation between students has the potential to support learning, especially as regards SDL and the use of technology (Curran et al. 2019). Self-directed learning does not imply learning in isolation but rather engagement with others (Brockett & Hiemstra 2019), and therefore, SDL praxis and poiesis would also reflect this.

Despite clear associations between SDL and andragogy (Knowles 1975), the relevance and scope of empirical research have extended beyond that of adult learning to all levels of education, including that of learners (Morris & Rohs 2023; Van Deur 2017). In this chapter and in this book, the term 'learner' is used for those studying at school level, whereas 'student' is used for post-school studies such as at university level. Unless, of course, the terms are from direct quotations. It is evident that there has been increased datafication of education (Pedró et al. 2019), as masses of data are generated within administrative and learning processes in learning institutions. However, the key would be to be able to draw effectively on such data in an ethical way to enhance learning and effectivity within such institutions. Within the context of the increasing presence of artificial intelligence (AI) in classrooms at all levels (Adiguzel, Kaya & Cansu 2023; Han, Park & Lee 2022; Ouyang, Zheng & Jiao 2022), it is evident that AI has and will significantly influence SDL praxis and poiesis. Artificial intelligence is very relevant to education; however, this phenomenon has recently seen many rapid developments (Şenocak, Koçdar & Bozkurt 2023). Despite AI being applied

in education for the past 40 years in different guises, generative AI is set to become more widespread and have far-reaching educational implications (UNESCO [United Nations Educational, Scientific and Cultural Organization] 2023). The most prominent development concerning generative AI has been language and the capacity to generate language that appears to be human-like (Giannini 2023).

This conceptual chapter, using a diffractive methodology (Barad 2007, 2014), is driven by the research question: *What are the implications of AI for SDL praxis and poiesis in an online learning environment?* To answer this research question, some theoretical concepts had to be considered for this chapter. Consequently, SDL for praxis, poiesis and noesis, and AI and online learning are discussed through pertinent literature on these topics.

■ Self-directed learning for praxis, poiesis and noesis

■ The concept of self-directed learning

In this chapter and in this book, Knowles's (1975) classic definition of SDL is adopted. He describes this concept as:

[...] a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing and implementing appropriate learning strategies and evaluating learning outcomes. (p. 18)

A narrower view of SDL would be that it 'is an intentional learning process that is created and evaluated by the learner' (International Society for Self-Directed Learning 2020). In both these definitions, the centrality of students is evident. However, the latter definition lacks detail on the praxis, while Knowles's definition covers several elements that are pertinent to praxis and, ultimately, also poiesis. Self-directedness can also be considered a student characteristic, even though these two definitions do not refer to this aspect. For Brockett and Hiemstra (2019, p. 52), SDL extends beyond being centred around 'an instructional process' only; it also relates to being a learning characteristic or 'personality construct' (Brockett & Hiemstra 2019, p. 54). For Garrison (1997), SDL involves:

[A]n approach where students are motivated to assume personal responsibility and collaborative control of the cognitive (self-monitoring) and contextual (self-management) processes in constructing and confirming meaningful and worthwhile learning outcomes. (p. 18)

These three constructs – self-management, self-monitoring and motivation – form Garrison's (1997) SDL model. Self-management emphasises the poiesis of SDL, as it relates to the act of constructing learning, while self-monitoring pertains to students' unique role in taking charge but also

working collaboratively. Personal responsibility is a central SDL tenet (Brockett & Hiemstra 2019).

Theoretically, the underlying paradigms of SDL are constructivism and specifically social constructivism. Mentz et al. (2018, pp. 171-172) note that 'through social construction of knowledge, meaning should thus emerge for active participants' in SDL. This view also supports the importance of learning as meaning-making and, by implication, collaborative and active poiesis. Furthermore, Merriam and Bierema (2014) acknowledge the relevance of social constructivism for SDL. According to them, 'aspects of constructivism, especially the social construction of knowledge, are central to self-directed learning, transformational learning, experiential learning, reflective practice, situated cognition, and communities of practice' (Merriam & Bierema 2014, p. 37). As is stated here and as is evident from other works in the field, SDL has the potential to shape transformational learning experiences (Charokar & Dulloo 2022). Such transformational learning experiences extend from praxis, poiesis and noesis.

■ Praxis, poiesis and noesis

Self-directed learning implies active participation by students within the learning space and, ultimately, some process of creating with others in a real-life context. In this chapter, the two processes of doing and making are regarded as related and, at times, intertwined. In addition, they are interpreted in the context of the Aristotelian concept of *praxis* or *action* as well as *poiesis* or *producing* to ultimately support *noesis* or, in other words, *understanding* (Aristotle 2014). Such an understanding of SDL as praxis-poiesis for noesis aligns with the theoretical underpinnings of SDL in social constructivism.

Within the context of SDL, the Aristotelian concept of praxis relates to an action done for the sake of the action itself and not to produce as is the case with poiesis. In this sense, it is all about active engagement on the side of the student. When it comes to poiesis, the constructivist and, more specifically, social constructivist nature of SDL is emphasised as it is all about making outcomes, resources, strategies, artefacts and ways of evaluating such processes.

Within the context of SDL, the Aristotelian conceptualisation of praxis should also be interpreted as having an aim at the end (*telos*) and involving some deliberate choice (*prohairesis*) (Aristotle 2014). Praxis is considered goal-directed, tends to imply some change and should originate from an agent itself (Bobzien 2014), and in this chapter, the agent would be the student. Within the realm of education, this statement suggests that students assume responsibility for their learning by actively participating in classroom activities. In this context, the student determines the goal,

and the change is also student-driven and may involve praxis and poesis. The engagement in such self-directed behaviour necessitates a favourable setting, together with the presence of encouraging peers and facilitators.

In this chapter, the case is made that there is a need to extend beyond actively engaging to creating or producing through deliberate choice. With praxis, the focus is on both form and matter; with poiesis, the emphasis is on producers applying form to what has been provided (Polansky 2014). Notably, extending AI beyond a support mechanism on the educator's part to a tool in the hands of students has significant implications for students, specifically for classroom praxis and poiesis. However, such an approach would require that online learning environments and the software used are supportive of student active engagement, production and choices.

In this chapter, the role of AI should be seen in the context of using digital technologies in the learning context. From the literature, it is evident that digital technologies have the potential to support students towards their self-directedness, especially with sufficient support through both SDL and technology (Morris & Rohs 2023). Using such technology implies a certain environment; hence, it is relevant to consider SDL within the context of online learning environments.

■ Self-directed learning and an online learning environment

The impact of the environment in which learning takes place is highly relevant for SDL. Whether this is a formal or informal learning environment, the environment itself may be conducive to supporting SDL (Beard & MacTavish 2022). Furthermore, online learning environments have the potential to provide more resources for use by students (Song & Bonk 2016) than would have been the case in face-to-face environments. More resources are available, but there needs to be structure, and the actual learning environment needs to be considered.

Different terms are used for platforms or environments where learning can occur online. Such platforms may involve an informal set of online tools and resources, or a structured, more formal collection of tools within a learning management system (LMS). A further relevant concept is that of the virtual learning environment (VLE). Mueller and Strohmeier (2011) define VLEs as:

[E]lectronic information systems (IS) for the full administrative and didactical support of learning processes in (higher) education(al) and vocational training settings by providing learners with adequate learning resources to develop intended qualifications systematically. (p. 2505)

This extensive definition combines both administrative and didactic functions. Furthermore, the environment's role in providing resources is clear; however, the student's role in resource curation is not clear, and apart

from the vague references to the development of qualifications, little is noted about the learning process itself. Regardless of the platform type, any AI implementation would require some interface between the student and the software. Hence, mainstreaming AI might imply incorporating generative AI technologies in existing platforms and systems.

In contrast with a more generic and group-oriented environment such as an LMS, the concept of a personal learning environment (PLE) has been proposed. As an approach, PLEs allow students to select tools such as social media towards a more self-regulated approach to learning (Serhan & Yahaya 2022) and can potentially support SDL (Conradie 2014). By implication, the emphasis on student choice and agency could support SDL and needs to be considered in any AI-driven intervention, as many such systems do not allow for the consultation of different resources, as discussed later in this chapter. A recent systematic review on PLEs (Serhan & Yahaya 2022) has shown that both self-regulated learning (SRL) and SDL are prominent theoretical perspectives that have been researched in terms of PLEs. In this context, SRL can be considered a goal-oriented process through which students consciously make decisions and specifically strive towards identified learning goals (Molenaar et al. 2022).

Within an environment supporting SDL, Beard and MacTavish (2022) have proposed a model that may be highly relevant for SDL and hence also for this discussion. The CLEAR model involves students having the opportunity to 'choose, lead, experience, apply, and reflect' (Beard & MacTavish 2022, p. 13) when using a particular environment. By implementing this model, Beard and MacTavish (2022) have observed students becoming independent and self-directed. The proposed activities are also well aligned with SDL principles set out in key literature on student-centred activities and reflection (Brockett & Hiemstra 2019) and may also be used in any AI-driven process. However, to move towards generative AI in SDL praxis and poiesis, it is necessary to consider the concept of AI in the online learning context.

■ Artificial intelligence and online learning

A further central concept in this chapter is that of AI for education. In this chapter, AI involves how machines can adapt to changing situations, solve problems and act in a way that shows some form of intelligence (Coppin 2004). The history of the modern conception of AI is traced back to the work of Alan Turing and the Turing test, and the term itself was coined by John McCarthy and colleagues in 1955 (Adiguzel et al. 2023; Şenocak et al. 2023). Hence, despite the recent interest in this concept, studying AI in different disciplines is not new.

The importance of AI for education is evident in integrating educational and learning theories in AI-enabled online learning and obtaining and

analysing data throughout the learning process (Ouyang et al. 2022). In a UNESCO working paper on AI, Pedró et al. (2019, p. 8) highlight four dimensions of AI: 'thinking humanly', 'thinking rationally', 'acting humanly' and 'acting rationally'. Furthermore, guidelines such as the Turing test can be used to determine the level of a system's ability to show intelligent behaviour. In this chapter, the emphasis is specifically on AI in education and not AI in general. Giannini (2023) notes how generative AI has been rolled out and made available for anyone and is faster than many previous technologies and faster than textbooks that get validated in educational contexts.

Three paradigms have been proposed for AI in education: 'Paradigm One: AI-directed, learner-as-recipient'; 'Paradigm Two: AI-supported, learner-as-collaborator'; and 'Paradigm Three: AI-empowered, learner-as-leader' (Ouyang & Jiao 2021, p. 3). The first paradigm draws on behaviourism, and the learning process is directed by the AI tool. In the second and third paradigms, the student drives the learning process. In the second paradigm, the student collaborates with the AI tool, reflecting a social constructivist process. As regards the third paradigm, the AI tool only supports what the student does and allows for greater personalisation and adaptive learning. The increased need for greater personalisation is supported by the 2024 EDUCAUSE Horizon Report (Pelletier et al. 2024). Adaptive learning implies customisation and personalisation of learning for students through an online system based on data and potentially using AI. Specifically, 'adaptive learning assesses where students are in the learning cycle and enables their achievement at the most effective pace' (Ice & Dziuban 2023).

A significant advancement in generative AI has been the development of ChatGPT (Şenocak et al. 2023), an AI-powered chatbot developed by OpenAI (2022). ChatGPT is built on large language models that employ natural language processing and generation (Adiguzel et al. 2023; Zheng et al. 2023). Using the generative pre-trained transformer (GPT) model, ChatGPT and other generative AI systems can 'analyze the complex patterns and structures of human language, and they are primarily trained to understand and generate human language' (Bozkurt 2023, p. 200). The question remains whether the analysis of language data and the production of understandable responses imply true intelligence. As the etymology of the term 'intelligence' suggests, this concept specifically relates to being able to comprehend or understand, not merely mimicking it.

The generative AI chatbot ChatGPT is considered a useful platform for learning. In this context, ChatGPT has already been used for learning and teaching purposes in different fields, including chemistry (Zheng et al. 2023), language (Hong 2023; Kohnke, Moorhouse & Zou 2023), mathematics (Wardat et al. 2023) and nursing (Sun & Hoelscher 2023), to name a few. Baskara (2023) explored its use as a VLE. According to Baskara (2023, p. 7), this chatbot is 'capable of fostering multidisciplinary

learning and promoting collaboration across various fields of study' and also simulates 'real-world scenarios and challenges'. This kind of integration of generative AI in pedagogically sound systems shows great promise. However, there has also been criticism about the accuracy of output from ChatGPT. Consequently, this has led to the development of additional tools to ensure correct information. An example of this is the *ChatGPT Chemistry Assistant* developed by Zheng et al. (2023).

Apart from the developments around ChatGPT, there has also been a trend in higher education institutions developing custom generative AI tools. One such example is the development of U-M GPT, U-M Maizey and U-M GPT Toolkit developed by the University of Michigan (2023), which is available to their staff and students. It is anticipated that more such integrations will be the way in which generative AI is made readily available to students and educators.

Research has already been conducted on using AI chatbots within the education context. In this regard, Han et al. (2022) explored an AI chatbot's effect on non-face-to-face nursing classes. They found that using an AI chatbot positively affected student interest and SDL. Firat (2023, p. 61) recommends SDL, as AI tools should '[e]ncourage the adoption of AI-supported learning environments that are personalized, adaptive, and responsive to individual students needs while promoting self-directed learning'. Such personalisation is essential for effective SDL praxis, poiesis and noesis.

The potential of AI from both an instructional perspective and a student perspective has been shown in the literature (Ouyang et al. 2022). The advantages of providing adaptive and individualised support for students through AI (Jokhan et al. 2022) may also be supportive of SDL, especially in informing the activities of facilitators and the online learning experience itself. In 1986, in terms of SDL, Hiemstra (2013) proposed the idea of learning individualisation – the so-called individualised teaching-learning process and, ultimately, individualised instruction.

In approaching AI, specifically generative AI, critical theory of technology can be useful. In this context, the critical theory of technology allows for an approach to technologies where users' interaction and use can be explored within a specific social and historical context where the technology is not regarded as being neutral or determinist (cf. Jin et al. 2015). Here, what Feenberg (2009, p. 33) calls instrumentalisation theory is relevant at two levels: firstly, 'we seek and find affordances that can be mobilized in devices and systems by decontextualizing the objects of experience and reducing them to their useful properties'; and secondly, 'we introduce designs that can be integrated with other already existing devices and systems and with various social constraints such as ethical and aesthetic principles'.

The ethics around the use of generative AI is complex and has implications at national and institutional levels. In this regard, UNESCO (2021) has already published the *Recommendation on the Ethics of Artificial Intelligence*, which provides clear guidance on responsible and ethical policy and practices around AI. The aim of this recommendation is ‘to provide a basis to make AI systems work for the good of humanity, individuals, societies and the environment and ecosystems, and to prevent harm’ (UNESCO 2021, p. 14). The document also has specific recommendations relating to education and research. In this context, AI literacy and AI ethics skills are mentioned especially within the context of digital divides and access. Within the context of teaching and learning, the following very important aspects are noted (UNESCO 2021):

Member States should also ensure that AI technologies empower students and teachers and enhance their experience, bearing in mind that relational and social aspects and the value of traditional forms of education are vital in teacher-student and student-student relationships and should be considered when discussing the adoption of AI technologies in education. AI systems used in learning should be subject to strict requirements when it comes to the monitoring, assessment of abilities, or prediction of the learners’ behaviours. AI should support the learning process without reducing cognitive abilities and without extracting sensitive information, in compliance with relevant personal data protection standards. (p. 34)

From this statement, the emphasis is on focusing on the benefits for teachers and students while also recognising the value of existing forms of education, especially the relationship between teachers and students and also student peers. Furthermore, the need for requirements when using AI technologies for analytical purposes is noteworthy. Importantly, apart from data protection for classroom AI practices, the implications for a potential impact on cognitive abilities warrant attention in the planning for any AI-related praxis and poiesis.

It is already clear from student perceptions of AI that this could be the cause of anxiety (Almaiah et al. 2022), which would have motivational implications for any SDL praxis and poiesis. The potential anxiety associated with students using AI systems is well articulated in a vignette written by Bozkurt (2022) in which a student’s engagement with a fictional AI proctoring system is relayed. This narrative presents the key to the disconnect between human and AI system and the potential issues that might arise from inherent data-related bias.

In the case of ChatGPT, unlike with the technology involved with search engines such as Google, options are not provided from sets of curated data; rather, this platform provides ‘authoritative-seeming responses using machine-produced content’ (Giannini 2023, p. 3). Such an approach has implications for SDL, as in this case, using generative AI limits the potential resource choice of users (in the context of this chapter, students).

The concepts of a learning platform or a specific AI-driven tool are mentioned throughout this chapter; however, if SDL is to be understood from the perspective of lifelong learning (Brockett & Hiemstra 2019; Charokar & Dulloo 2022), then AI-supported learning should also be considered independent from a single platform or through applications that can be used independently in various contexts.

Considering these theoretical concepts, a diffractive methodology was used to steer the interpretation and presentation of certain propositions in this chapter. The diffractive methodology is unpacked and then employed to facilitate a systematic diffractive analysis of critical sources related to SDL praxis, SDL poiesis and AI in education.

■ Methodology

A diffractive methodology was employed for this conceptual chapter to explore the implications of AI for SDL praxis and poiesis. *Diffraction* refers to how different intersecting concepts or waves are considered regarding their superposition and interferences (Barad 2007, 2014). So, in the same way different waves react when they engage with each other in nature, the concepts are considered and analysed in this chapter. Furthermore, this approach was used to consider SDL praxis and poiesis together with AI, not as it relates to their similarities, but rather their inherent differences and potential conflicts regarding knowledge-making (Bozalek & Zembylas 2018). To this end, the research involved a systematic diffractive analysis of critical sources related to SDL praxis, SDL poiesis and AI in education.

Towards considering the diffractive entanglements between SDL and AI in online environments, a selection of pertinent key sources was identified and approached through a process of *re-turning*. Barad (2014, p. 168) describes this process as turning to the texts over and over again and hence, 'iteratively intra-acting, re-diffracting, diffracting anew, in the making of new temporalities (spacetime-matterings), new diffraction patterns'. Owing to the nature of this process, interpretations, although rigorous, are subjective when it comes to source selection.

However, for the sake of the scientific integrity of this diffractive process, it was essential to ensure the trustworthiness of the analysis. In this regard, credibility, dependability, transferability, as well as confirmability (Denscombe 2021; Lincoln & Guba 1986) were considered in the data analysis. Such an analysis and method of ensuring trustworthiness is more fitting within a pragmatic research paradigm (Denscombe 2021).

This analysis implied critical engagement with different sources, cross-checking and thick descriptions of the data. The following discussion presents entanglements between SDL and AI in online environments

towards reaching some proposed propositions that could inform praxis within the curriculum. This process specifically involved a *re-turning* (Barad 2014) to Knowles's conceptualisation of SDL praxis and poiesis of AI in online environments.

■ **Diffractional entanglements between self-directed learning and artificial intelligence in online environments**

Before certain propositions could be established, inevitable diffractional entanglements were explored to assess AI's effects on SDL praxis and poiesis in an online learning environment. Consequently, the discussion of the research conducted for this chapter involves considering learning needs diagnosis, learning goals formulation, resource identification, learning strategy selection and implementation, and learning outcomes evaluation.

■ **Learning needs diagnosis**

Needs assessment is essential to SDL (Brockett & Hiemstra 2019). This step informs the *telos* or goal formulation and directly impacts the praxis and poiesis. Such a diagnosis is personal and individual to the student but is often realised socially within a classroom or learning environment with peers. The potential exists for effective learning needs diagnosis with AI-driven tools because, in essence, any diagnosis is data-driven. A concrete example of probing student needs through generative AI in support of SDL would be the generative AI chatbot application, called TeacherGAIA, which was developed by Ali et al. (2023). Here student needs are considered through prompts, and interactions are then structured based on responses apart from supporting SDL. This research also shows promise in terms of self-assessment.

It has been noted how AI-driven tools increase motivation as well as engagement (Adiguzel et al. 2023). Currently, a challenge of AI – and more specifically generative AI technology such as ChatGPT – is that it lacks contextual awareness and true understanding, as its comprehension is only based on language patterns and structures derived from the data used in its training (Bozkurt 2023; Giannini 2023; Sun & Hoelscher 2023). It is critical that learning needs diagnosis be considered as both an individual step towards praxis and poiesis and a contextualised one. Such an approach implies in-depth knowledge, in other words, data about the students and their immediate context. These data involve socio-cultural, geographical and other location-bound properties and contextual factors relevant to a specific learner. Contextualisation at a personal level could also address the unique requirements of learners with disabilities or diverse learning needs.

Importantly, AI-driven tools have the potential to differentiate and support students with different needs. From the literature, it is clear how such tools can positively affect students with learning disabilities and may even reduce anxiety among students (Adiguzel et al. 2023). This aspect emphasises the need for contextualisation, as individual student needs may vary significantly based on existing dispositions. From this process of identifying needs, certain goals for learning can be set. Based on students' reactions and inputs to prompts, generative AI could have a significant role to play in helping students diagnose their needs. For the educator and broadly for educational institutions, such data would provide valuable information on the common needs of a class or even an institution. The hope would be that online learning environments and AI systems would allow for easy and ethical access to such data. Similarly, such data may also contribute to the formulation of learning goals.

■ Learning goals formulation

As per the definition of SDL presented earlier in this chapter, students need to be able to set their own goals. As noted before, this concept relates to what Aristotle (2014) called the *telos* or goal at the end. This individualised, contextualised *telos* guides learning and is a way to assess whether understanding or noesis was reached. However, reaching such a goal could extend beyond understanding and imply praxis and poiesis.

Within highly structured learning environments, such as schools and higher education institutions (HEIs), learning goal formulation is often informed by external variables such as course and lesson outcomes and professional regulatory requirements. In a context where constructive alignment is prevalent, there are certain limitations regarding student choice outcomes. Biggs (2014, p. 5) defines constructive alignment as 'a design for teaching in which what it is intended students should learn, and how they should express their learning, is clearly stated before teaching takes place'. It is common in university contexts for broad outcomes to be determined in advance by the institution through the educator or even, in some cases, external regulatory bodies. The educator may also determine outcomes within the scope of a lesson, whether online or in person. With the inclusion of generative AI in the equation with the existing presence of constructive alignment practices at universities, the need for SDL and greater flexibility in the teaching space, the teaching negotiation process for educators becomes quite complex.

However, using ChatGPT, for example, generative AI can be used to generate goals, set goals and support SDL development (Lin 2023). Within this context, adaptive learning environments have the potential to support student goal setting through the recognition of problem-solving goals, as was

illustrated by Goslen et al. (2022), this was performed in game-based learning environments. As with the needs diagnosis, goal formulation could draw on historical data of students as well as provide data based on prompts. The level of educator intervention would of course depend on the nature of constructive alignment in the institution, the institution's commitment to SDL and especially within the context of AI systems, which do not currently allow for access to feedback in the backend necessarily, whether or not educator intervention is technically possible. A further example of using ChatGPT for goal formulation is the process suggested by Rakap (2023) which showed how ChatGPT could be used to support goal setting by novice teachers, specifically within the context of the development of individualised education programme goals for children with autism.

In any case, at the level of praxis and poiesis, this would imply some form of negotiation between the student and the external entity, even if this is not as overt and formalised. The challenge would be determining how AI-driven tools can support such a process. From goal formulation, the emphasis then shifts to resource identification.

■ Resource identification

Resource selection is an important step towards SDL, as the needs and goals of each learning process and each student are unique, so the resources should also be individually and contextually suited for the relevant learning praxis and poiesis. Regarding AI-driven tools, such resources extend to human and material resources, as was Knowles's (1975) original intention with SDL. Here, human resources may imply drawing on different expertise in language and technology, whereas in an online environment, material resources may be endless in scope. However, in this chapter, the focus is more on the latter iteration.

A key concern regarding SDL and introducing AI-based technologies in the learning space is that this might imply bringing in another 'content transmitter' (cf. Knowles 1975). Consequently, on the side of a facilitator or in the design of learning environments, opportunities for active critical engagement with the technology should be considered. However, the ability of AI-driven tools to analyse and interpret massive amounts of data shows promise in providing the most suitable resource that applies to the specific context, class, group and individual. An example of resource identification can be found in the research by ElSayary (2024) where case studies are discussed through which learning is personalised through adjustments in content delivery or even changes in the complexity of content.

Students could be supported towards becoming self-directed in resource identification through prompts and case-based facilitation

in LMSs. In this regard, Charokar and Dulloo (2022) suggest using case-based scenarios to guide students in using questions to lead them to answers through specific learning resources. Again, when developing such an approach, there might be inherent tension regarding what the educator's role would be in determining the relevant cases and their contents. Ideally, some form of curation should ensure contextualised and localised content.

There is also an opportunity for significant facilitator involvement in resource identification. While a facilitator may have a minor role in selecting materials, they play a more prominent role in guiding students through the process and helping them recognise reliable, relevant and high-quality resources. The importance of the teaching presence was noted in research on SDL and online environments. This aspect is especially significant when supporting students' self-monitoring, and teaching presence is related to students' cognitive presence (Zhu et al. 2023). A further aspect of importance is students' selection and implementation of specific learning strategies.

■ Learning strategy selection and implementation

Regarding the conceptualisation of praxis in this chapter, the strategy selection and implementation process both entail doing what Aristotle (2014) called praxis and poiesis, which involve production and creation. This view, in turn, aligns with SDL's roots in constructivism (Simons 2000). This aspect of SDL relates to what is performed for praxis and poiesis and how it occurs. In this context, AI-driven tools may be the focus but also the means to an end - this depends on the followed AI paradigm and the identified learning goals.

Individualisation of learning strategies through adaptive learning can be facilitated with an intelligent tutoring system that employs adaptive sequencing of selected learning activities (Shabana, Lakshminarayanan & Anil 2022). In this case, it is proposed that a multi-armed bandit algorithm and a change point detection algorithm are combined to allow for effective personalisation. It has been noted how, in AI-enabled environments, individualised assessments and guidance can be provided (Adiguzel et al. 2023).

The potential of AI for learning personalisation is evident through an AI-empowered student-as-leader paradigm (Ouyang & Jiao 2021) and the use of AI-based scaffolded learning environments (Umutlu & Gursoy 2022). Such individualisation shows the greatest potential promise in supporting SDL, as the environment can then be customised to the exact needs and goals determined by the student. In terms of a concrete example, research by Marquardson (2024) has shown how SDL can be fostered through the

active use of ChatGPT by students through student-driven topic and resource selection as well as execution of student-created learning plans.

Within this context, specific new literacies and skills are needed to effectively use AI tools for educators and students (Firat 2023; Sun & Hoelscher 2023). Any implementation for the sake of SDL requires applying skills within a specific context and developing a proper understanding of the pertinent principal skills (Ritchie 2023). As much as the scaffolding of strategies supporting SDL is necessary for SDL praxis and poiesis, support of language and technical skills is needed when using AI-driven tools. At the end of the learning process, there is also a need to evaluate whether the learning outcomes were reached.

■ Learning outcomes evaluation

The process of SDL involves not only planning and implementation but also the evaluation of learning (Brockett & Hiemstra 2019). In this regard, the student would consider the set goals and evaluate whether the outcomes were reached. This process can be considered the essence of the reflection and assessment process inherent in all learning.

The potential of generative AI for assessment is significant. On a surface level, Wang et al. (2022) found that large pre-trained language models could generate relevant quality questions that could not be distinguished from human-authored questions. However, AI-driven tools may have value at all levels of learning outcome evaluation in that they may not just contribute to determining how assessment can take place but also act as an assessment in curating the data generated by students throughout the learning process. For example, Mogavi et al. (2024) emphasise the need for considering learning outcomes in terms of gauging learning rather than artefacts, and this will also have implications for student outcome evaluation.

As regards assessment, AI-driven tools allow for differentiating assessments based on students' abilities, monitoring and collecting various multimodal data (Adiguzel et al. 2023; Cotton, Cotton & Shipway 2023) to inform any learning outcomes evaluation. Such systems also have the potential to predict student progress and engagement (Adiguzel et al. 2023; Firat 2023) and so allow for individualised intervention through the learning platform or by a facilitator. Consequently, AI-driven tools could support students and learning, act diagnostically, inform different aspects of formative and summative assessment, and contribute to identifying trends and determining future planning.

From these discussed diffractive entanglements, several propositions have been derived. These propositions may inform further SDL praxis and poiesis regarding AI in higher education and even other educational contexts.

■ Propositions: Towards self-directed learning praxis and poiesis with artificial intelligence

In the spirit of a diffractive methodology, this chapter does not make recommendations or prescribe any application. Instead, some propositions (cf. Murriss & Bozalek 2019) are presented from the diffractive *re-turning* to SDL praxis and poiesis of AI in online environments. In this chapter, there are at least two levels of entanglement by means of diffraction: SDL and praxis–poiesis and then SDL and AI. The first level of entanglement, which relates to SDL and specifically praxis, extends beyond this chapter and is also evident in subsequent chapters dealing with praxis in various contexts. As such, the interference of waves between SDL and praxis as concepts propagate throughout the book.

In this section, the focus is specifically on the entanglement between SDL and praxis–poiesis on the one side and specifically AI on the other. Regarding praxis and poiesis, the focus is on the student and their choices of resources and the learning process as a whole. In the SDL literature, the emphasis on the learning process of the individual is evident (Brockett & Hiemstra 2019). It is noted in the literature that self-directed students are competent, causal reasoners (Lapidow & Walker 2022). Hence, through a process of Aristotelian *prohairesis* or deliberate choice, students act or make and, by implication, learn. All of these happen within a specific process that others may or may not facilitate (Brockett & Hiemstra 2019). It is already clear that apart from the potential that systems such as ChatGPT hold, they limit choices, as feedback is provided in the form of a definitive answer (Giannini 2023) that may also be decontextualised. Mogavi et al. (2024, p. 18) highlight the potential of generative AI to possibly ‘limit critical thinking and creativity, impede a deep understanding of subject matter, and foster laziness and passivity’.

Diffraction implies some form of interference or influence, and as such in considering the dynamics between SDL and praxis–poiesis, SDL implies a student-centred process which in this case is focused on praxis and poiesis as active creation underlies the learning process. However, within the context of using generative AI, on the one hand, this may imply greater individualisation and resources, and on the other hand, the praxis and even poiesis may be transferred to an AI system where the ultimate goal is merely an artefact that is submitted rather than learning itself.

As such, it is imperative to ensure that AI-driven platforms allow for conditions with adequate balance ‘between the learner’s level of self-direction and the extent to which opportunity for self-directed learning is possible’ (Brockett & Hiemstra 2019, p. 63). It is necessary to determine

the role of AI-driven tools and human facilitators in the learning space regarding facilitation and as a resource. In research conducted by Lin (2023) regarding the possible role ChatGPT can play as a facilitator towards motivating SDL, it is noted that there is a need for ‘instructors’ that can guide students in generating appropriate prompts and that the level of engagement between platform and human facilitator must be carefully considered. There have also been attempts at creating applications using ChatGPT and embedding them in practices supporting SRL (Wu et al. 2024). Consequently, apart from the technology itself, the practices instituted by administrators, educators and, ultimately, the students themselves would determine the success of any AI-driven interventions.

As it is relevant to consider to what extent AI-driven platforms can fulfil educator roles, one can draw on the six facilitation roles identified by Hiemstra (2013) and reflect on the diffractive entanglement with generative AI:

- Content resource: Content in different formats chosen based on field content, student data and system-driven conversations.
- Resource locator: Locating and sharing of resources or even facilitated searches with system support.
- Interest stimulator: Engagement with students through prompts to activate interest.
- Positive attitude generator: Building confidence through verbal interaction and feedback based on student activities on the learning platform.
- Creativity and critical thinking stimulator: System-driven discussions and simulations.
- Evaluation stimulator: Prompting and feedback to students based on student targets set and activities on the learning platform.

Furthermore, from empirical research carried out on an online platform designed to let students engage with praxis towards supporting SDL, Ritchie (2023, p. 21) determined that to facilitate a practice of praxis, students should ‘actively reflect, acknowledging the self in learning and how they are mentally and physically impacted by, progress through, and interact with their surroundings and others’. The potential of drawing on data to create real-world scenarios and authentic contexts, as was found in activities using ChatGPT (Baskara 2023), also shows promise towards supporting SDL. However, it is important to avoid over-dependence on AI systems (Alier, García-Peñalvo & Camba 2024).

Before getting to praxis and poiesis, both the educator as facilitator and the student should be skilled sufficiently to use any generative AI tool or platform or have ‘AI fluency’ (Pelletier et al. 2024). Firat (2023, p. 61) recommends a ‘focus on integrating critical thinking, creativity,

problem-solving, and digital literacy skills as explicit learning outcomes and experiential competencies within course and curriculum design'. The need for educator training is also highlighted in the literature (Wardat et al. 2023). Such praxis and poiesis also require access, and within the context of increased AI use, the issue of the digital divide, where equitable access to technology is different between contexts, is still highly relevant as is evidenced in the 2024 EDUCAUSE Horizon Report (Pelletier et al. 2024). Capacity building of educators and students around plagiarism and the tools involved in generative AI is also essential (Cotton et al. 2023). Conversely, in the *Global Education Monitoring Report*, UNESCO (2023) makes the following significant remark in this regard:

[F]aced with new technology tools, the ideal response is unlikely to be further specialization in technology-related domains; rather, it is a balanced curriculum that maintains if not strengthens and improves the delivery of arts and humanities to reinforce learners' responsibility, empathy, moral compass, creativity and collaboration. (p. 13)

In this statement, the need for a balanced approach to curriculum is evident. The implication is that for praxis and poiesis, capacity should be built through skills related to technology, specifically a broader range of skills relevant to the AI context. Moreover, as Giannini (2023) recommends, generally, knowledge creation should not be delinked from human beings which in a diffractive reading may be the case with unsystematic and irresponsible AI integration.

A further issue when using generative AI tools or platforms is the accuracy of output (Adiguzel et al. 2023; Sun & Hoelscher 2023). As such tools rely on the accuracy of the data they build on, currently, caution should be taken. Inaccuracies in output and the need for checking by experts are evident (Wardat et al. 2023). Similarly, AI systems as sources of authority should be carefully considered (Giannini 2023).

Ethical issues in using AI are considered important in the literature on AI in education (Sun & Hoelscher 2023). Artificial intelligence tools rely not only on initial data but also on learning based on feedback and further inputs from users. This has specific implications for data security and privacy (Adiguzel et al. 2023). There is also the potential for abuse, deception and bias through such systems (Adiguzel et al. 2023; Sun & Hoelscher 2023). The prospect of using such tools to aid plagiarism has also been widely stated (Adiguzel et al. 2023; Cotton et al. 2023), and this may imply changes in how assessment should be carried out (Firat 2023). In the 2024 EDUCAUSE Horizon Report (Pelletier et al. 2024), the following recommendation is made:

If you find that an AI tool can easily accomplish an assignment without human involvement, consider revising the assignment to focus on the important human-learning objectives. (p. 22)

Considering the diffractive entanglements between SDL and AI in online environments in this chapter, it might be sensible to consider this role of technology with the same scepticism as Candy (2004). Evidently, educational AI tools do not sufficiently draw on general pedagogical or instructional approaches (Adiguzel et al. 2023). Hence, it might be necessary to wait until the emerging technologies are broadly accepted, all involved are sufficiently trained, and the motivation for the use of such technologies has gone beyond the novelty of the technology and instead is driven by pragmatism. The role students and educators will play in the mainstream use of AI is also an important consideration. In this regard, Giannini (2023, p. 4) states that ‘education systems need to return agency to learners and remind young people that we remain at the helm of technology’. This agency is critical not just for establishing a measured approach to AI but also for creating a conducive environment for SDL.

■ Conclusion

This analysis showed how considering the diverging concepts of SDL praxis and poiesis together with AI uncovers and causes certain conflicting and potentially disruptive consequences for the wider education context. The need for SDL praxis and poiesis is evident and notable in how learning and assessment activities could be considered on a continuum between praxis and poiesis towards a student-focused noesis. The chapter also provides a theoretical implementation framework for SDL praxis and poiesis in AI-enabled online learning. The chapter concludes with some practical propositions around the roles and activities of students and educators within an AI-enabled online learning context.

Within the context of the methodology employed for this chapter, the process of diffraction of considering SDL praxis and poiesis in terms of AI is incomplete and warrants dynamism. The concept of interrogating the self and others, as discussed by Barad (2014), involves moving beyond the individual learning process of SDL and transforming it into a collective and dynamic social act of disruption and learning. In online learning contexts, as the case will increasingly be with AI, a deconstruction would be ongoing regarding how learning, teaching, facilitating and even self-directedness could be understood. In conclusion, it is only through a repeated *re-turning* to the ideas presented here and in the following chapters that curriculum implementation, praxis and scholarship within the context of SDL could be comprehended.

In a vignette by Bozkurt (2022), the interactions between a student and an AI-powered online system during an examination are described. This extreme and alarming narrative shows the result of taking the educator as a facilitator out of the formal learning context. When student emotions

lead to potential misidentification or assessment is influenced by perceived aggression or critical thought being misconstrued as bias, the learning agency is shifted from student to system. As AI is introduced in more aspects of the learning sphere, so should the question be asked whether, as is performed by Alim in Bozkurt's (2022) vignette, we will merely accept the grade or try and defend what it means to be human when engaging with online systems for learning. In the next chapter, the implementation and praxis of the SDL curriculum are further explored as a path to self-authorship, continuing the proposed diffractive reading of SDL and praxis introduced in this chapter.

Cultivating self-authorship through self-directed learning environments

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■ Abstract

This chapter explored the potential of self-directed learning (SDL) as a transformative teaching and learning strategy for promoting self-authorship – a process that empowers students to take charge of both their education and life narratives. Through development as self-directing learners, students cultivated essential qualities such as self-governance, self-determination and the ability to author their destinies in alignment with their individual

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values and aspirations. Central to our discussion was the harmonious relationship between SDL and self-authorship. Through examination of their symbiotic goals, we highlighted the significance of these constructs in shaping a student's intellectual and personal identity. When SDL environments are thoughtfully designed and effectively executed, they not only foster individual growth but also strengthen the overall educational experience, making it more enduring and impactful. In this chapter, we explored the practical applications of SDL in curriculum design, teaching praxis and academic scholarship. We contend that fostering self-authorship requires a fundamental re-evaluation of our approach to learning. Furthermore, we argue that SDL serves as an ideal vehicle for self-authorship. Through a holistic understanding of these applications, educators will be better equipped to create learning environments that are intentionally designed to nurture self-authorship. Ultimately, we suggest that by providing students with ample opportunities for SDL, one also sets the stage for the development of a rich and purposeful sense of direction in their educational journeys.

■ Introduction

Following the exploration of the transformative potential of artificial intelligence (AI) for fostering self-directed learning (SDL) in online learning environments presented in Chapter 1, this chapter dives into the realm of SDL environments. While the previous chapter highlighted AI's capacity to customise educational experiences for SDL, the focus now shifts to cultivating SDL environments to enhance self-authorship. In learning to assume greater agency in the SDL environment, students also develop the knowledge, skills and habits of mind to take agency over their educational and life journeys. Together, these chapters paint a picture of how technology and pedagogical strategies can be harmoniously integrated and leveraged to empower learners in the digital age.

The educational domain comprises a rich tapestry of interwoven and diverse perspectives. Among these, SDL, experiential learning and transformational learning are prominent pedagogical approaches, each contributing distinctively to educational theory and practice. Our emphasis in this chapter was on SDL's role as a transformative approach in teaching and learning, particularly in its potential to foster curriculum implementation, praxis and the scholarship of self-authorship. By delving into how SDL cultivates self-governance and empowerment in students, we underscored its significance in allowing students to actively shape their educational destinies.

Recognised for its versatility and dynamism, SDL complements and challenges many other traditional educational practices. Self-directed

learning can uphold existing educational practices while significantly changing conventional teaching and learning approaches. In addition, SDL's inherent versatility situates it prominently within the diverse landscape of educational methodologies (cf. Guglielmino 2013; Knowles, Holton & Swanson 2015).

Central to our discussion was the concept of the *self* in education – an inherent source of learning that forms the basis for acquiring knowledge and individual development (Guglielmino 2008, 2013). Rather than a mere passive recipient of knowledge, the *self* is an engaged participant, actively constructing personal knowledge and understanding. This shift underpins the broader evolution of modern education, which seeks to mould students into autonomous learners who are capable of self-development, self-determination and self-regulation (Du Toit-Brits 2018b).

In creating SDL environments for nurturing self-authorship, we emphasised the importance of student agency and ownership. Such an environment fosters a profound sense of self-authorship; however, it nurtures a lifelong commitment to continuous SDL and equips students to navigate in a complex and rapidly changing world (cf. King & Siddiqui 2011).

Our ambitions for this chapter were twofold: to contribute meaningfully to the SDL discourse and to nurture the development of individuals who possess both a comprehensive understanding of academic content and a deep-rooted sense of self (cf. King & Siddiqui 2011). Such individuals can critically engage with the world and make informed educational and life decisions. Finally, we made recommendations for establishing educational environments that promote SDL and self-authorship. We aimed to illuminate pathways for reshaping education while also championing the emergence of more empowered and resilient individuals in the modern world.

■ Nurturing meaning-making and self-authorship through self-directed learning

In the current educational milieu, the primary objective is to foreground the facilitation of meaning-making through learning – a paradigm that has gained prominence in education (Ancess 2003; Du Toit-Brits 2018b). In teaching and learning that aims to promote understanding, students are encouraged to explore their own thoughts and ideas, which helps them develop their intellectual landscape and enhance their ability to learn independently. Moreover, the exigency of scholastic triumph for all students underscores the pedagogical panorama (Du Toit-Brits 2018b). Achieving this laudable goal necessitates educators to methodically craft and amalgamate pedagogical content and delivery, fostering an environment that empowers students to engage with learning on their terms and to

assume ownership of their academic trajectory (Ancess 2003; Baxter Magolda & King 2004; Kegan 1994).

The cultivation of meaning-making presupposes a dynamic comprehension of learning, challenging the passivity that characterises students as mere recipients of knowledge. The vitality of a learning community wherein knowledge is wielded as an instrument of empowerment is unmistakable (Baxter Magolda & King 2007; Du Toit-Brits 2018a; Ryan & Deci 2000). In this intricate tapestry, educators bear the mantle of nurturing a growth mindset, instilling cognitive agility, reflective thinking, problem-solving understanding and responsiveness. With support from various scholarly sources, a pedagogical approach towards meaning-making is presented as one centred on customised learning objectives, a strong awareness of students' developmental trajectories and a commitment to promoting their intellectual progress and identity development (cf. King & Siddiqui 2011). This holistic ambition transcends formal curriculum limitations and invites educators to weave a culture of meaning-making into the educational fabric (Baxter Magolda & King 2007; Blignaut 2021; Kegan 1994; Verster, Mentz & Du Toit-Brits 2018), a change attainable via the educational framework's hidden and unspoken aspects.

Kegan's theoretical underpinning of meaning-making elucidates the intricate process by which individuals forge an understanding of themselves, their capacities and their cognitive landscapes (Ancess 2003; Kegan 1994). Meaning-generation transpires within the crucible of the learning experience and is shaped by the individual's responses. Kegan's theoretical edifice further underscores the pivotal role of internal cognitive architecture in engendering meaning-making, thereby propelling the evolution of the *self* (Kegan 1994). This transformation unfolds gradually, informed by experiential encounters and temporal progression. The Keganian schema posits six comprehensive configurations of meaning-making, characterised as 'orders of consciousness' (Baxter Magolda & King 2007; Kegan 1994). As students navigate these cognitive realms, their meaning-making endures transformative shifts, entailing reconfigurations of self-perception and interpretative insights.

The Keganian schema is a profound and enlightening conceptual framework within human awareness and cognitive growth (Kegan 1982, 1994). These orders include psychological development phases and serve as gateways to comprehending the fundamental nature of our being and the transformative quest for self-consciousness (Kegan 2000). Central to Kegan's thesis is the notion that our cognitive understanding of the external environment, our construction of personal identity and our ability to navigate intricate concepts undergo developmental progression (Baxter Magolda 2008).

The first stage of awareness – the impulsive mind – serves as the point of origin for this expedition (Kegan 2000). In this context, the global perspective prioritises immediate gratification and the fundamental need for survival. In contemporary society, human behaviour is often driven by desires and necessities as individuals navigate a complex web of stimuli and responses. As we transition to the second level, the human mind distinguishes itself from these innate urges. The emergence of the socialised mind is characterised by its adherence to external rules and ideals, leading to a sense of compliance (Wertsch 1985). This phase signifies the emergence of self-consciousness, as people start scrutinising the societal norms and values they have absorbed. The third level of cognitive development – the self-authoring mind – assumes control over one’s autonomy and independence. In this context, people are emancipated from external sources of authority and establish their values and beliefs. Individuals craft their narratives, assuming the role of writers in shaping their life trajectories. Commencing one’s life story is essential at this juncture as it marks the transition to a phase of greater autonomy, empowerment and self-determination.

However, Kegan’s schema does not conclude at this point. The fourth order – the self-transforming mind – represents a significant advancement in consciousness, characterised by a quantum jump. The individual acknowledges the constraints of their viewpoint and welcomes the perpetual state of change in existence. In this context, the dissolution of the ego occurs when individuals negotiate intricate situations with a sense of modesty and receptiveness. The fifth and sixth orders – namely, the integral and the transpersonal minds – represent the pinnacle of human awareness. The individual transcends their ego and unites with the interwoven fabric of all reality. The integrative perspective acknowledges the interconnectedness of many elements within the human experience, aiming to cultivate a sense of harmony within this intricate fabric (Kegan 2000; Wertsch 1985). In the culmination of this exposition on the Keganian schema, we arrive at a significant point of intersection. This intersection is a reminder that self-discovery and personal development are continuous and dynamic (cf. King & Siddiqui 2011). Within this framework, this chapter aligns harmoniously with the contours of Kegan’s fourth order, establishing itself as a conceptual scaffold.

Broadening the vista to encompass the significance of meaning-making, a focused exploration of Kegan’s fourth order becomes imperative. In this cognitive terrain, individuals strive to nurture their constructs of meaning, a domain wherein self-authorship emerges as a pivotal facet (Baxter Magolda 2008; Kegan 1994). The ‘residents’ of this realm cultivate the faculty to discern and embrace personal standards, both autonomously and in synergy with others. This cognitive domain finds manifestation in

instances where individuals coalesce their insights, crafting their interpretations of knowledge or experiential episodes and subsequently embedding these self-forged constructs within their educational odyssey (Ignelzi 1994). This self-authored conceptual tapestry imbues the 'self' with a symbolic identity, accentuating the role of self-directedness, critical thinking, accountability, self-determination and problem-solving acumen.

This chapter postulates the indispensability of cultivating an SDL environment, encapsulating the attributes of maturity, autonomy, empowerment and a growth-oriented cognitive disposition. This educational orchestration beckons students to perceive themselves as co-creators within the pedagogical tapestry, operating firmly in the precincts of purpose and perseverance. This co-creative symbiosis, emblematic of educators and students collaboratively shaping curricular components and pedagogical paradigms, manifests pedagogical ingenuity (Bovill et al. 2016). However, implementing co-creation entails nuanced curriculum implications interwoven with the tapestry of teaching and learning. A group of scholars – including Baxter Magolda and King (2007), Kegan (1994), Khiat (2015), Knowles et al. (2015) and Verster et al. (2018) – endorses the premises elucidated herein.

Considering the preceding discourse, it becomes imperative to underline that the vitality of co-creating a pedagogical milieu is underscored by its potential to animate the curricular fabric. Thus, it is essential to emphasise that collaborating to create an educational environment is made even more significant by its ability to bring life and energy to the curriculum. This animate curriculum synthesises 'knowing', 'acting' and 'being', emblematic of a richly engaging pedagogical landscape (Barnett & Coate 2005; Verster et al. 2018). These integral constituents coalesce to carve a trajectory wherein students nurture their authentic selves. The juncture of 'knowing' is characterised by a student's assertion of personal epistemological claims unique to their cognitive journey (Barnett & Coate 2005) – thus, wherein students assume responsibility for their learning. This process engenders a heightened consciousness, where students synthesise experiential knowledge and appraise it critically. 'Being' underscores the transformation into heightened self-awareness, where students articulate cognisance through lived experiences while concurrently evaluating acquired knowledge through a critical lens. This confluence ultimately nurtures authenticity and compels students to engage earnestly, transcending the periphery of traditional educational roles (Barnett & Coate 2005).

The dialectic interplay of knowing, acting and becoming a tripartite symphony adorns the curricular landscape, infusing it with humane, personal and societal dimensions. These constituents, integral to contextual meaning-making, germinate practicality, confidence, self-reliance, self-understanding

and self-realisation – all indispensable constituents for SDL and self-authorship. Nevertheless, collaboratively constructing an educational environment that includes the curriculum is a complex undertaking with several intricate obstacles. The potency of the above-mentioned elements in teaching, learning, curriculum development and implementation is insufficient to navigate the complexities. The essence of student-centred curricula necessitates nurturing students' creativity, innovation and individual relevance (Bovill & Woolmer 2019; Verster et al. 2018). Therefore, co-creation assumes an inherently contingent character, intertwined with an educator's pedagogical ethos and the ensuing impact on the prospect of curricular coalescence (Bovill et al. 2016; Verster et al. 2018).

Within the realm of educational co-creation, these considerations present a variety of challenges, including: (1) overcoming resistance that is ingrained in traditional educational practices; (2) navigating institutional norms that can either facilitate or obstruct collaborative efforts; and (3) establishing an inclusive co-creative ethos (Bovill et al. 2016). The cognitive paradigms and instructional methodologies of educators are the primary sources of resistance. These factors can either inspire or discourage co-creation, depending on how they are implemented. This resistance is frequently rooted in deeply ingrained pedagogical norms, experiential legacies and student expectations. As a result, it is necessary to engage in thoughtful conversation and dialogue to alleviate concerns and cultivate an atmosphere that is conducive to collaborative endeavours (Bovill et al. 2016; Hughes & Barrie 2010).

Although institutions are designed with the best intentions, their architecture and practices can unwittingly hamper the process of co-creation. The implementation of collaborative partnerships that are characterised by student-driven outputs that harness their experience and understanding might, however, help to offset the potential negative effects of these problems. These types of methods not only address the structural constraints but also capitalise on the information and abilities that students already possess, giving them the ability to actively influence their educational experiences (Bovill et al. 2016). There is the potential to change conventional learning settings into dynamic spaces where co-creation thrives, which would be to the benefit of both educators and students (cf. Blignaut 2021). This might be accomplished by addressing these difficulties through strategic dialogues and institutional flexibility.

Conversely, a conducive atmosphere is fostered for collaborative invention, possibly dismantling the obstacles presented by entrenched perspectives and conventional frameworks. This argument, on the one hand, emphasises the importance of acknowledging and questioning prevailing educational viewpoints that may impede collaboration. On the

other hand, the argument highlights the potential of SDL and self-authorship to empower students and foster collaborative co-creation within education.

Furthermore, the co-creation imperative is not an unequivocal canvas where every facet of teaching, learning or curricula is a subject of discussion and transformation. Co-creation operates on a spectrum, aligning with diverse individuals at varying stages, all converging towards enhancing the students' learning experiences (Bovill et al. 2016). Indirect co-creation mechanisms, like pre-topic brainstorming or preparatory tasks, serve as pedagogical points of departure, reflecting students' collective yet individualised understanding (Bovill et al. 2016). A prudent educator embraces the potency of power dynamics and its influence on learning experiences, propelling pedagogical strategies that invite co-creation (Ryan & Tilbury 2013). Anchoring co-creation with well-defined goals, inclusive target groups and cogent rationales for inclusion or exclusion is paramount, substantiating a purposeful and rationale-driven co-creative landscape.

Therefore, the edifice of co-creating an educational culture is a testimony to the dynamic interplay between educators and students, encapsulating both the inherent challenges and transformative potential. The co-created curriculum begets an animate landscape, wherein 'knowing', 'acting' and 'being' coalesce, nurturing authenticity, empowerment and enriched learning experiences. Notwithstanding the challenges, the manifold benefits of co-creation radiate, fostering identity development, engagement, motivation and self-authorship (Cook-Sather, Bovill & Felten 2014; Lubicz-Nawrocka 2018). This co-creative tapestry – nestled within the broader schema of SDL and meaning-making – serves as an instrumental conduit for students' journey towards self-authorship.

■ Role of self-directed learning in fostering meaningful growth

Self-directed learning represents a significant paradigm shift in education, emphasising the empowerment of students to take charge of their educational journeys. The origins of SDL can be attributed to the groundbreaking research conducted by scholars such as Candy, Rogers, Knowles, Guglielmino, Long and Tough, who established the foundation for this revolutionary educational methodology. At the heart of SDL is the cultivation of an autonomous classroom environment that supports comfort, collaboration and partnership among students. Malcolm Knowles highlighted this in 1975, underlining the importance of creating an atmosphere where learners feel emotionally, intellectually and socially supported. This environment enables students to engage deeply with their learning, infusing it with personal relevance and meaning.

To effectively function as the ‘architects’ of their learning paths, the authors believe that students must be provided with a variety of supportive conditions and components. A flexible and supportive learning environment is essential, granting students the liberty to customise their educational experiences to align with their personal interests and goals. This setting is further enriched by access to a diverse array of resources, including libraries, digital platforms and expert guidance, which collectively offer a wide spectrum of knowledge and tools. Moreover, the presence of skilled mentors and facilitators is crucial. These individuals provide guidance, feedback and encouragement, which are essential for nurturing SDL skills. The curriculum itself should promote choice, adaptability and real-world application, encouraging learners to apply their knowledge in meaningful ways and fostering a culture that values creativity, critical thinking and experimentation.

In advancing SDL, it is also vital for educators to be proactive in fostering these skills within each student. According to scholars like Du Toit-Brits (2018a), Guglielmino (2008, 2013) and Knowles et al. (2015), there is a clear mandate for educators to confidently support the development of SDL skills and SDL attributes (in Chapter 3). Research endorsed by Aness (2003) further underscores the significance of infusing learning experiences with meaning, advocating for meaningful encounters within an SDL-based classroom setting. Thus, SDL revolutionises traditional learning methods not only by fostering autonomy but also by creating a transformative meaning-making learning environment that encourages self-exploration and personal growth. This meaning-making educational approach not only prepares students to be self-reliant students but also equips them with the skills necessary to navigate and adapt to the evolving demands of the modern world.

This journey towards meaningful transformation is intricately linked with the meaning-making process in SDL (Aness 2003; Baxter Magolda & King 2007; Du Toit-Brits 2018b). As Baxter Magolda and King (2007) and Du Toit-Brits (2018b) revealed, this concept underscores how students construct intentional understandings from the information they receive, fostering a dynamic interplay between learning and transformation. This interactive path of meaning-making, expounded upon by Du Toit-Brits (2015, 2018b), is pivotal to encouraging students to derive personal significance from the knowledge they acquire, thereby catalysing comprehensive human development (cf. King & Siddiqui 2011).

In this process, nurturing personal growth and empowerment assumes a central role, intertwining seamlessly with the journey of meaning-making transformation. Scholars contend that students’ sense of belonging, experience and practical application of knowledge must be cultivated to

facilitate substantial behavioural, attitudinal and practical changes (Dirkx & Mezirow 2006; Du Toit-Brits 2018b; Hoggan 2016; Wenger 1998; Yorks & Kasl 2006). This holistic development unfolds as individuals embark on a self-directed and progressive growth voyage, even facing challenges, as illuminated by Du Toit-Brits (2018b).

Consequently, this chapter proposes that at the heart of this potentially revolutionary process, SDL emerges as a potent instrument capable of catalysing development across intrapersonal, interpersonal and interconnected levels. Thus, equipping, guiding and supporting students through SDL in the classroom becomes paramount. This empowerment enables students to uncover their latent potential, possibly leading to transformative shifts in their identities, particularly when the learning experiences are infused with purpose (Dirkx & Mezirow 2006; Mezirow 1990; Newman 2012, 2015).

In essence, the transformation of learning prompts a shift in the student's cognitive perspective, resulting in a refined and nuanced comprehension of the learning process. Self-reflection and self-direction are integral to this change, aiding students in forging connections between new knowledge and their prior experiences. This fusion, therefore, ignites meaningful learning, necessitating the cultivation of self-awareness and setting the stage for an educational journey that enriches their lives (Du Toit-Brits 2018a; Henderson 2010; Taylor 2007).

The immense potential of these meaningful learning experiences, capable of fundamentally transforming students' lives, accentuates the importance of these ideas (Du Toit-Brits 2018b, 2022). This chapter also suggests that students harness education as a conduit by critically evaluating their learning objectives, enhancing their self-concept and redistributing the locus of control from educators to themselves. Armed with newfound skills and heightened confidence, they transition into active participants in the learning process, marked by increased accountability and self-efficacy. We believe that this deliberate educational voyage takes shape, characterised by awareness, appropriation and serving as a symbiotic catalyst for the holistic growth of each student.

■ Unveiling the transformative potential of self-directed learning

As observed in the previous section, SDL is an innovative and progressive approach to education that surpasses the conventional perception of passive knowledge acquisition. We posit that SDL facilitates self-authorship development and fosters personal growth. Providing agency to students is encouraged by the opportunity to assume responsibility for their

educational trajectory (cf. Wirth et al. 2021). Regarding the idea or model put forward by Du Toit-Brits (2018b), students are urged to engage actively in their learning pursuits and build their own interpretations and knowledge. This theoretical framework emphasises the significance of SDL as a cognitive process involved in constructing meaning and has several consequences for education and individual growth and development (cf. King & Siddiqui 2011).

The implementation of SDL enables students to assume a proactive role in their educational journey, fostering a sense of empowerment and ownership. Students can thus make informed choices about their studies' content, methodology and timing. The cultivation of agency fosters self-efficacy and the ability to actively guide one's own learning, hence encouraging self-reliance and autonomy in various aspects of life. To proficiently navigate the process of generating significance through SDL, students must engage in critical thinking and introspection. Students develop skills in evaluating information, analysing multiple perspectives and creating independent options. These skills and abilities enhance students' ability to engage in critical thought, decision-making and problem-solving processes grounded on trustworthy information. It is also true that SDL cultivates a 'growth mindset' (e.g. as described by Dweck 2016) among students, promoting a sustained desire for knowledge and understanding that extends beyond the scope of conventional schooling. Students who embrace the SDL concept have a higher propensity to actively pursue novel information, effectively navigate dynamic circumstances, actively participate in continuous personal and professional growth, and are more inclined to demonstrate inventiveness.

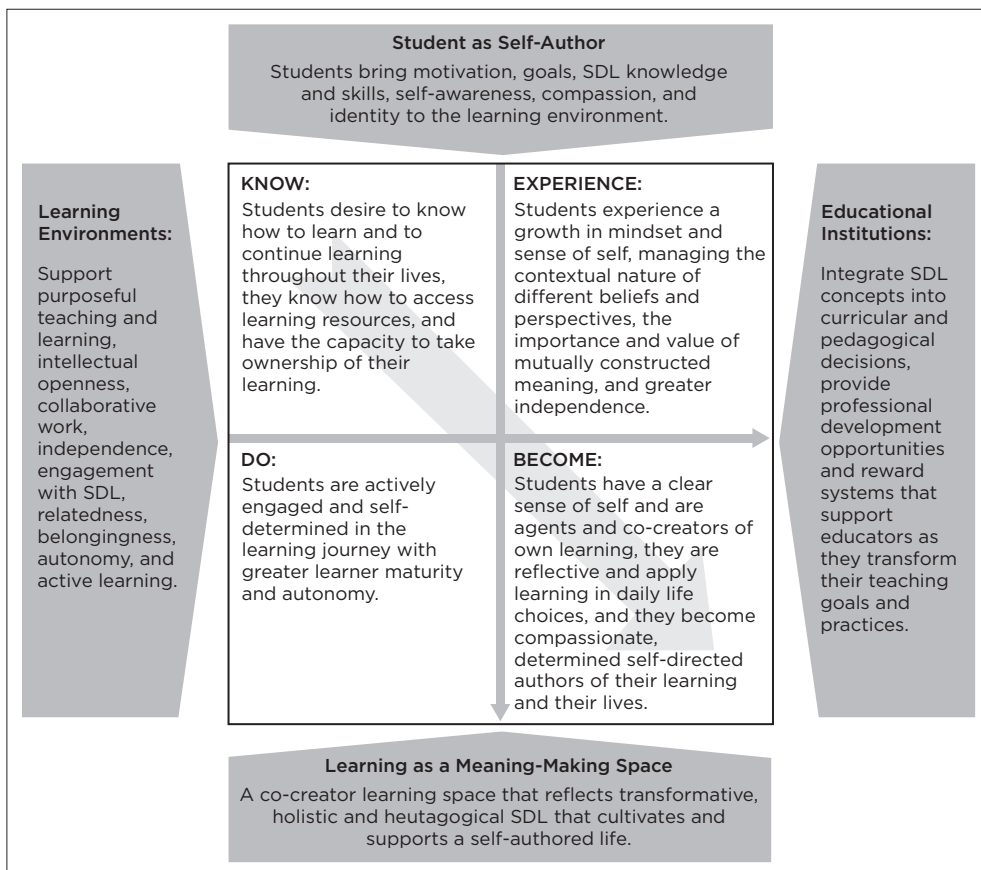
The theoretical framework proposed by Du Toit-Brits (2018b) emphasises the holistic aspect of SDL, which plays a significant role in a student's emotional, social and personal development (cf. King & Siddiqui 2011). Students acquire heightened self-awareness, develop emotional intelligence and cultivate resilience throughout their educational journey. She also believes that students must possess a heightened comprehension of their fundamental beliefs and concepts. Furthermore, in educational environments, SDL equips students with the skills and cognitive adaptability to thrive in unpredictable situations, while also fostering a culture of innovation that enhances their personal and professional development. It is also the opinion of Du Toit-Brits (2018b) that the field of education has undergone significant changes, resulting in a dynamic environment where students must possess adaptability and agility to traverse uncertain and fast-changing circumstances effectively. Furthermore, she holds the belief that SDL is at the forefront of this transformation, equipping students with the essential competencies and cognitive adaptations required to thrive in this ever-evolving environment. The ramifications of this significant

transition are extensive, offering not just individual and professional development but also a more comprehensive cultural change with creative effects on society. At the core of this paradigm shift lies the concept that traditional learning environments, characterised by disseminating information via structured and standardised media, are no longer enough in the AI world.

Therefore, this chapter proposes that students assume architects' roles in shaping their learning paths. Doing so necessitates students to develop and nurture aptitudes such as self-motivation, self-determination, critical thinking and creativity (cf. Chapter 3 for a detailed discussion on learner attributes). These endeavours include more than just academic endeavours; they are essential life skills that empower students to navigate a rapidly changing environment, where what is considered pertinent now may become outdated soon. In addition, students engaged in SDL are more likely to develop a sense of empowerment, increasing their likelihood of taking proactive actions to bring about positive community changes. Individuals are motivated not just by their achievements but also by a commitment to contribute to the advancement of society.

When students engage in learning and assume responsibility and accountability for their development, they frequently encounter a feeling of intrinsic drive and enjoyment. This immersive encounter cultivates an enduring passion for intellectual pursuits and discovery, contributing to a perpetual drive for acquiring and refining information and competencies. Furthermore, to effectively integrate SDL into the curriculum, academic institutions must provide conducive settings that foster a self-directed environment for self-authorship. Doing so necessitates a re-evaluation of the responsibilities of educators as facilitators and mentors who provide guidance and assistance to students in their educational journeys (Cook-Sather 2015; Du Toit-Brits 2018a). The transformative and holistic continuing SDL framework proposed by Du Toit-Brits (2018b), which influenced and informed the development of the new proposed framework depicted in Figure 2.1 – namely, *A heutagogical self-directed environment for self-authorship* – provides insights into SDL's transforming capabilities, enabling students to become self-authoring individuals. This new proposed framework represents a heutagogical self-directed environment for self-authorship and also promotes personal growth, flexibility and a lifetime dedication to acquiring knowledge by focusing on constructing meaning, cultivating critical thinking skills and creating a mentality that embraces progress.

Concerning Figure 2.1, essential inputs for developing self-authorship in the self-directed environment are illustrated by inward-facing polygons around the outer edge of the diagram. The outputs (educational outcomes



Source: Author's own work.

Key: SDL, self-directed learning.

FIGURE 2.1: A framework representing a heutagogical self-directed environment for self-authorship.

and developmental changes) experienced by the student along the path to self-authorship are shown by the unshaded squares in the centre. The diagram hints at a broad directionality from upper left (knowing) to lower right (becoming) for the developmental path of the student (e.g. Baxter Magolda 2001; Kegan 1994) but it is by no means unidirectional.

The concept of a *heutagogical self-directed environment for self-authorship*, as elucidated in Figure 2.1, underscores the importance of creating a unique and inclusive educational setting that empowers students to assume responsibility for their learning, fosters the cultivation of deep meaning and facilitates the development of a sense of self-authorship. Educators have a crucial role in cultivating a favourable disposition towards SDL and fostering the development of SDL skills. The desire and preparedness of students to engage in SDL may be significantly influenced

by the enthusiasm, support, inspiration and belief in students themselves and their instructors and mentors.

Alternative learning approaches (e.g. SDL, CL [cooperative learning], PBL [problem-based learning]) and ongoing engagement must be employed in learning environments. Introducing alternative learning methodologies may elicit initial student resistance; educators' consistent involvement is crucial in supporting and guiding students throughout this process. Educators face the challenge of actively promoting SDL by consistently demonstrating their commitment and enthusiasm for this educational strategy. In addition, it is essential to recognise each student's individuality, as learning environments should be mindful of and inclusive towards every student's unique needs and identity, prioritising their distinct capabilities and interests, with each student contributing to the educational experience.

Therefore, educators must also adopt a comprehensive approach to learning that transcends mere memorisation and underscores the significance of meaning-making. This approach promotes personal growth and transformation by motivating students to delve into more profound realms of knowledge and meaningful connections with themselves and others. Participating in educational activities that hold personal significance might enhance the growth of a more holistic self-awareness and identity in students. Educators are tasked with laying the foundation for SDL across diverse learning environments and providing sustained assistance. This support facilitates the gradual transformation of students into self-directed learners by offering opportunities for intentional and meaningful teaching and learning experiences.

To build self-authorship and a safe sense of self, students must be given a learning environment that is both secure and compassionate, enabling them to explore their self-authorship. This process encompasses the establishment of a confident, secure and coherent self-identity, with the cultivation of dedication and empathy, all of which synergistically contribute to genuine personal growth and the exploration of one's true potential. Also, to foster the development of self-advocacy and ownership of their education, students need to shift from a passive position in the learning process to assuming an active role as authors of their learning journeys. This modification allows students to ascertain their learning prerequisites, establish goals, choose appropriate techniques, evaluate the outcomes of those strategies and engage in collaborative interactions. Self-advocacy, autonomy and self-efficacy are essential components in a transformative, holistic SDL environment.

Self-advocacy, autonomy and self-efficacy are crucial in creating a transformational and comprehensive SDL environment. Self-advocacy

enables students to proactively seek out resources, ask for assistance and make choices that support their educational objectives, thereby increasing their autonomy in the learning process. In addition to this, autonomy offers students the liberty to investigate subjects that personally intrigue them, so enhancing their desire and involvement – essential elements for achieving successful SDL. Furthermore, self-efficacy, defined as the belief in one’s ability to achieve specific goals, fosters perseverance and flexibility in the face of challenges, hence improving SDL. These factors together contribute to the development of self-authorship, wherein students shape their identities via their choices and learning experiences. The personalised learning strategy empowers students to tailor their educational paths, thereby enhancing the significance and efficacy of their learning experiences. This approach leads to deeper, self-directed educational engagements. Furthermore, the cultivation of such skills not only facilitates students in navigating their educational trajectories but also significantly boosts their personal and intellectual growth.

Additionally, it is highly recommended that students use their learning experiences in their educational pursuits, particularly within the SDL environment. Because of this process of assimilation, students experience an improvement in their understanding abilities, enabling them to evaluate knowledge and generate original ideas critically. Consequently, the process of learning becomes more relevant and significant. The described SDL environment prioritises the development of students’ autonomy, self-awareness and ability to engage in successful SDL. Creating a conducive learning atmosphere is crucial to developing students who possess agency, autonomy and self-awareness by integrating positive mindsets, unique acknowledgements, comprehensive approaches and engaged self-creation. Such an environment would enable educators to create an *SDL environment for self-authorship*.

■ Recommendation: A paradigm shift towards heutagogical self-directed learning environments for self-authorship

We contend that fostering self-authorship requires a fundamental re-evaluation of our approach to learning. We further argue that SDL serves as an ideal vehicle for self-authorship. Thus, our perspective proposes that educators transition from an ‘instructional’ paradigm, where they impart knowledge to students, to a ‘learning culture’ paradigm. Before we propose a paradigm shift from instructional approaches to a more holistic learning culture, it is crucial to assess the strengths and limitations of existing methods. Traditional instructional techniques have historically emphasised structured curriculum delivery, standardised testing and a focus on

quantifiable outcomes, which have been foundational in establishing basic educational standards and consistency across diverse educational systems. However, the evolution of the educational landscape, characterised by rapid technological advancements and changing societal needs, necessitates a shift towards a heutagogical SDL culture. By transitioning to a heutagogical SDL culture, we aim to create educational systems that are more responsive to student's needs, fostering resilience and adaptability in their professional and personal spheres. Furthermore, the authors believe that this paradigm shift will increase engagement and motivation because students will feel more connected to their educational journeys. An emphasis on reflective practice encourages students to continuously assess their understanding and the effectiveness of their learning strategies, promoting deeper learning and greater internalisation of knowledge.

Building on the aforementioned points, the authors contend that this paradigm shift not only equips students to effectively manage their learning and professional development but also fosters a culture of lifelong learning and adaptive expertise. This approach enables individuals to apply knowledge creatively in new situations, thereby enhancing the relevance and dynamism of education. This paradigm change, representing a profound alteration in strategy or main assumptions, corresponds to current demands, where learning is increasingly recognised as a customised, ongoing and contextually driven activity. Furthermore, the learning culture, which encompasses the values, beliefs and practices that promote and support learning within an environment, is enriched through this shift, promoting a more holistic and transformative heutagogical self-directed educational experience.

This paradigm shift emphasises the creation of and need for dynamic learning environments that would empower students to identify their learning needs, articulate their learning goals and ideas, take responsibility for their learning progress, be able to do self-reflection on their strengths and weaknesses of their learning capabilities and environment, and be able to adapt, thereby cultivating a robust learning culture. A significant transformation must occur in how knowledge is perceived, enabling students to assess their learning experiences critically. In line with this argument, we propose that achieving self-authorship within the realm of learning entails the following key aspects:

1. Embracing personalised learning plans and objectives designed collaboratively by oneself and others.
2. Cultivating a deep understanding of oneself, one's needs and interests while striving for autonomy.
3. Evolving into the author of one's learning journey and life, fostering the ability to shape beliefs, self-development and self-concept.

4. Cultivating self-determination and inner motivation.
5. Embracing change is an integral part of the learning process.

In advocating for a praxis of self-authorship, we propose that educators create learning environments that facilitate personal development, improved learning performance and overall well-being while nurturing self-direction and self-authorship. By offering opportunities for SDL, intrinsic motivation is enhanced, granting students a sense of autonomy, self-efficacy and internal commitment, thereby enabling them to construct a solid internal foundation for SDL and idea generation. Learning environments that encourage autonomy, knowledge construction, independence, ownership and self-sufficiency facilitate the development of students into autonomous and self-determined persons, thereby fostering their progress. To fully embrace the praxis of self-authorship, a transformative and heutagogical self-directed environment is essential. This heutagogical self-directed environment should:

1. Initiate a profound transformation of the individual's learning needs, behaviour, determination and attitude, leading to a shift in their identity.
2. Foster the development of a personalised learning perspective.
3. Facilitate the construction of meaning from learning experiences.

To this end, it is proposed that the significance of a heutagogical, self-directed environment needs to be increasingly recognised as pivotal for fostering self-authorship among students. This heutagogical self-directed environment can empower individuals to take charge of their learning processes, thus catalysing the development of self-authorship. In this regard, we agree with Blaschke, Kenyon and Hase (2014), Blaschke and Marín (2020) and Hase and Blaschke (2021) that this paradigm shift from traditional pedagogical and andragogical approaches to a heutagogical framework facilitates a deeper engagement with learning materials, encouraging students to not only absorb knowledge but also critically evaluate and apply it in diverse contexts. Furthermore, the self-directed nature of heutagogy aligns with modern educational needs, promoting lifelong learning and adaptability in an ever-evolving global landscape. In addition, the authors conclude that heutagogical practices do not merely enhance educational experiences but are fundamental in helping individuals become architects of their own lives, contributing significantly to their personal development and societal involvement.

■ Conclusion

In conclusion, this chapter explained the importance of using SDL in education to generate and foster an educational setting that allows students and educators to build their identities and autonomously

create significance. This chapter argued that learning potential, student contributions and collaboration are essential, as this paradigm shift challenges educators' authority, encouraging the interchange and appreciation of ideas and opinions. Moreover, this chapter showed that a fundamental step in adopting a heutagogical self-directed environment for self-authorship is to cultivate a growth mindset among contemporary students. Successful implementation of a heutagogy self-directed environment for self-authorship relies heavily on both educators and students committing to profound change and fostering a strong desire for personal and collective growth. This commitment necessitates creating a supportive learning environment that facilitates this mindset shift. It is critical to establish conditions that not only encourage experimentation and SDL but also provide the necessary resources and support systems that enable learners to thrive. Such an environment should be flexible and adaptable.

Consequently, this chapter underscored the significance of SDL as a learning approach that brings about transformation. It places particular focus on fostering self-authorship and facilitating personal development. Expanding upon these fundamental principles, the next chapter (cf. Chapter 3) delves into the crucial significance of SDL attributes demonstrated by students and educators in facilitating the accomplishment of curriculum and pedagogical objectives. This seamless transition allows for an exploration of the profound influence of SDL on educational practices and outcomes.

Unveiling the catalyst: Exploring learner and educator self-directed learning attributes as a mechanism to attain curriculum and pedagogical objectives

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■ Abstract

Frequently, learners¹ exhibit a high level of engagement with the learner support materials provided by their educators during classroom instruction while displaying a diminished interest in supplementary endeavours that require independent, critical, creative and analytical thinking. Without learning support materials such as handouts, textbooks and information and communication technologies, learners may rely exclusively on their educators to achieve academic success and meet the objectives of the curriculum. Ideally, learners ought to strive to decrease their reliance on educators and exert stronger autonomy in their pursuit of knowledge, skills and experience, akin to the approach adopted by their educators. By implementing such an endeavour to be autonomous, learners exhibit increased self-directedness and are more apt to achieve curricular and pedagogical objectives. The authors of this chapter believe that increased self-directedness should counter the negative influence of traditional or conventional teaching strategies that are 'boring' and may cause diminished performance and interest levels. Thus, the authors further posit that implementing self-directed learning (SDL) in educational settings is necessary for attaining curriculum and pedagogical objectives. Such implementation is made feasible by facilitating higher SDL attributes among learners and educators.

In an endeavour to solve the learning barriers such as those cited in the previous paragraph, the authors were inspired by and aim to resolve this central enquiry: 'How do the self-directed learning attributes displayed by learners and educators function as catalysts in facilitating curriculum and pedagogical goal achievement?' Furthermore: 'How does the intricate interaction of these attributes within the educational context contribute to the potent mechanism of self-directed learning?'

In pursuit of resolutions for the research questions above, the authors of this chapter believe that to achieve higher levels of self-direction, learners must engage in self-autonomy and that such engagement is prudent. Engaging in self-autonomy should enable learners to manifest SDL attributes such as proactivity, creativity, innovativeness and novelty. The SDL attributes mentioned earlier should contribute towards learners' lifelong experiences and attainment of curriculum goals within the challenging, dynamic, expanding 21st century learning environment. In complement, educators also need to manifest SDL attributes towards the same goal of attainment of curricular and pedagogical objectives. To set a compatible SDL environment, the educator must promote and enhance SDL attributes among learners and themselves to achieve curricular and pedagogical objectives.

1. This chapter focuses on the school environment in which, within the South African educational context, the child at school is referred to as a 'learner'.

■ Introduction

In examining educational dynamics, Rashidov (2020) observes that learners show greater interest in the information presented directly by educators in classroom settings, while their engagement wanes during supplementary activities that demand independent and analytical thinking. This dependency becomes even more pronounced when learners lack access to resources like textbooks and information and communication technologies (ICTs), relying heavily on their educators to meet curriculum goals. To counteract this dependency, Van Leeuwen and Janssen (2019) advocate for a reduction in educator control, encouraging learners to independently seek knowledge and skills. Echoing this sentiment, Lazorak, Belkina and Yaroslavova (2021) propose the emulation of educator behaviours as a pathway to self-directed learning (SDL).

The urgency for SDL is amplified in the fast-paced, ever-evolving information age. Van den Berg and Du Toit-Brits (2023) highlight the enhancement of ICTs that continuously reshape the knowledge landscape, urging learners and educators to adopt SDL to keep pace with advancements. This dynamic era offers new educational mediums like MOOCs (Massive Open Online Courses) and diverse online tools, broadening the scope for SDL and enabling individuals to remain current with innovations in their fields. Hadini et al. (2020) stress that swiftly acquiring knowledge and adapting to changes are crucial skills in today's world. Consequently, SDL has become essential in preparing learners to contribute meaningfully to society and act as responsible citizens, as noted by Du Toit-Brits and Blignaut (2019). To further understand its significance and implementation, this chapter aims to explore how educators and learners can cultivate SDL to meet their pedagogical and curriculum objectives. It emphasises the necessity for specific attributes that facilitate the development of SDL and self-direction, highlighting the pivotal role of active participation by both educators and learners in this process. The subsequent sections will delve deeper into the requisite attributes for fostering effective SDL educational settings.

■ The necessity for self-directed learning attributes in educational settings

Self-directed learning hinges on the belief that learners who take ownership of their educational journeys are autonomous individuals. This concept, outlined by pioneers like Guglielmino (2013) and Knowles (1975), emphasises the responsibility that learners assume for their learning paths, actively seeking self-improvement and advancement opportunities. In a world characterised by rapid transformations and emerging challenges, the

significance of SDL has become increasingly pronounced. Educators and learners alike are compelled to continuously adapt to new circumstances and prospects, underscoring the escalating relevance of SDL.

In SDL environments, learners are empowered with the autonomy to direct their educational activities, whether synchronously or asynchronously, as noted by Loeng (2020). This freedom supports the cultivation of skills that go beyond traditional knowledge acquisition, encouraging the development of cognitive, metacognitive, motivational and affective attributes. These attributes are essential as they equip learners with the skills needed to successfully guide their educational paths. Therefore, recognising the importance of these attributes is crucial. They not only enable learners to guide their learning independently but also allow educators to tailor their learning and teaching strategies to thrive in such adaptive learning environments. The subsequent sections will delve deeper into the critical nature of these SDL attributes, exploring their necessity and influence in fostering a conducive learning atmosphere.

■ Attributes of a self-directed learner

Lemmetty and Collins (2020) identify six critical attributes of a self-directed learner, emphasising their ability to autonomously choose the timing, scope and sequencing of their work. These learners take responsibility for their educational activities, and recognise and address their own learning needs (Vahedi, Zannella & Want 2019). They also set personal objectives, utilise additional resources such as ICTs and clearly define their learning outcomes to foster intrinsic motivation and conscientious engagement in educational tasks.

Furthermore, several specific attributes of self-directed learners include a keen awareness of current tasks (Toh & Kirschner 2020), adeptness in selecting effective learning strategies and activities (Rashid & Asghar 2016), competence in evaluating both resources and personal performance and proficient use of interpersonal skills (Vahedi et al. 2019). These attributes highlight the learner's capacity to understand essential factors in the learning process, employ strategic methods, engage critically with material and develop interpersonal capabilities.

Table 3.1 consolidates these attributes based on an extensive analysis of existing research. This arrangement aids in understanding the attributes' implementation without suggesting a strict sequence for their application in SDL contexts. It shows that self-directed learners manage their educational paths, choosing suitable learning environments and methods, whether online or face-to-face and strategically designing activities to meet educational goals while applying creativity and originality.

TABLE 3.1: Attributes exhibited by learners.

Attributes of a self-directed learner	
Attributes:	Source:
A self-directed learner conducts themselves responsibly and:	
Takes own initiative (task awareness)	Knowles 1975; Toh and Kirschner 2020
Is aware of relevant tasks	Toh and Kirschner 2020
Decide on the preferred suitable learning environment (area, venues, time)	Lai 2015; Lemmetty and Collins 2020
Socially engages with others (educators, learners); refines interpersonal skills	Du Toit-Brits 2020; Garrison 1997; Lim and Wang 2016; Vahedi et al. 2019
Enters synchronous and asynchronous partnerships	Dziuban et al. 2018; Valiathan 2002
Diagnoses own learning needs and requirements	Andyani et al. 2020; Tan, Liu and Low 2017
Sets own learning goals and outcomes (to satisfy pedagogical needs)	Siminica and Dumitru 2013
Sets own strategies and activities (contents, sequence) to achieve learning goals and outcomes	Rashid and Asghar 2016; Vahedi et al. 2019
Is innovative, creative and novel	Kalyani and Rajasekaran 2018
Is intrinsically motivated to manipulate resources	Azeez, Fapohunda and Jayeoba 2019
Identifies, selects and uses their learning resources	Biemiller and Meichenbaum 2017; Tan et al. 2017
Achieves set goals	Vahedi et al. 2019
Conducts own assessment of goal and outcome achievement	Siminica and Dumitru 2013
Gains lifelong confidence and competence to compete	Biemiller and Meichenbaum 2017
Applies knowledge to situations	Knowles, as cited by Du Toit-Brits 2018a
Is proactive and not reactive	Knowles, as cited by Du Toit-Brits 2018b

Source: Authors' own work.

The role of educators in fostering self-directedness involves providing support and guidance without relinquishing their responsibilities (Lemmetty & Collins 2020). It is essential to maintain a balance between learner autonomy and adequate educational support, as highlighted by Tuzlukova and Singh (2019) and further supported by Baru, Tenggara and Mataram (2020), Du Toit-Brits (2018a) and Grow (as cited in Tredoux 2012). These viewpoints emphasise that the extent of educator involvement should be adjusted according to the learner's level of self-direction and stage of development. The subsequent sections will explore the progression levels through which learners evolve towards complete self-directedness.

■ Progression levels of learner self-directedness

According to Tredoux (2012), Grow's model suggests that SDL is a process that involves multiple stages or levels, during which the learner advances from a state of complete dependence to gradually developing interest, becoming engaged and ultimately achieving maturity in self-directedness. The progression from dependence to self-directedness

occurs under the supervision and guidance of the educator. In a later section dealing with attributes of an SDL educator, the authors expound more on the said guidance. Within that section, the authors outline the educators’ duties in facilitating the learners’ advancement towards self-directedness. While undertaking the SDL process, the individuals (learner or educator) fulfil their duties within the confines of their SDL attributes. As discussed in this section, several attributes within SDL are demonstrated in Table 3.2.

Table 3.2 describes actions taken to achieve specific learner attributes, which can be used as input measures for impact analysis. The acquisition of learner or educator attributes is associated with producing measurable outcomes. The process of inputting information or data into a system leads to the production of either a primary or secondary result. Every outcome confers advantages to the learner, the educator or both parties involved. Furthermore, Table 3.2 suggests that educators’ commitment to SDL principles (input) is likely to lead to the cultivation of self-directed learners (primary output). They will generate a dependable resource or assessment of ICT using the same input. The authors of this chapter are of the opinion that when a learner achieves emancipation, it leads to a confident and proficient individual who actively engages in SDL. The primary output of a given input is a learner who exercises autonomy in selecting their preferred time, sequence, goal or order.

Moreover, as illustrated in Table 3.2, the self-directed learner operates within their designated SDL attributes throughout the SDL process. This systematic approach generates a range of inputs and outputs that can

TABLE 3.2: Analysis of input and output: Attributes of a self-directed learner.

Attributes of a self-directed learner (inputs, outputs and beneficiaries)				
Input	Primary output	Beneficiary	Secondary output	Beneficiary
Adherence to SDL principles/goals	Self-directed learner	Learner	Assessment criteria	Evaluator Educator
Emancipation of learner	Confidence Competence	Learner	Active participant	Learner
Emancipation of learner	Time selection Sequence Goals/order	Learner	Diligent learner	Learner Educator
Self-directedness	Awareness Strategies Activities Interpersonal skills	Learner	Assessment strategies	Evaluator Educator
Educator’s guidance and support	SDL	Self-directed learner	Measurement indicators for resource evaluation	Evaluator Educator

Source: Authors’ own work.
Key: SDL, self-directed learning.

benefit the learner and their educator significantly. Self-directed learners play a pivotal role in achieving curriculum and pedagogical objectives, as they need to exhibit self-motivation, active engagement and a sense of accountability and ownership towards their learning. Furthermore, learners and educators who embrace SDL tend to experience improved retention of information, enhanced problem-solving capabilities and the acquisition of lifelong learning skills.

■ Implementation of self-directed learning strategies to accomplish curriculum and pedagogical goals

Self-directed learning strategies represent a transformative approach in education, moving away from traditional teacher-centred methods to learner-driven experiences that foster autonomy, motivation and metacognition. Implementation of SDL within educational frameworks requires meticulous preparation, robust support systems and integration with technological advancements to achieve curriculum and pedagogical goals.

The efficacy of SDL is grounded in its ability to empower learners to actively determine their learning needs, set personal objectives, select appropriate materials and assess their progress. This process not only enhances the learning experience but also contributes to more meaningful and sustainable educational outcomes (Loeng 2020; Mok & Mo 2018). By fostering attributes such as learner independence and motivation (see Table 3.1), SDL aligns well with contemporary educational paradigms that emphasise lifelong learning and adaptability (Tan et al. 2017).

However, the successful adoption of SDL is not without challenges. Traditional educational settings, typically characterised by fixed curricula and instructor-led delivery, can pose significant barriers to the integration of SDL strategies (Ginzburg, Santen & Schwartzstein 2020). These environments often lack the flexibility necessary to accommodate individual learning paths and may hinder the cultivation of essential metacognitive abilities crucial for successful SDL (Karatas & Arpacı 2021).

To counter these challenges, educators must adopt a dual role as facilitators and supporters of learning. This involves creating a setting that enables learners to take charge of their educational paths, fostering a feeling of responsibility and commitment towards their learning goals (Brockett & Hiemstra 2018; Guglielmino 2013). Providing scaffolded support is crucial in helping learners develop the competencies needed to navigate their learning processes effectively. This support can take various forms,

including strategic guidance, resource provision and emotional backing, all aimed at enhancing the learner's ability to manage their educational activities autonomously and with accountability (Du Toit-Brits & Van Zyl 2017).

Furthermore, the incorporation of ICT resources is crucial in enhancing the facilitation of SDL (Van den Berg & Du Toit-Brits 2023). Technological tools can provide diverse learning materials, enable flexible learning schedules and support the personalisation of learning experiences (Sumuer 2018). By leveraging ICT, educators can offer a more adaptive and responsive learning environment that caters to the unique needs and preferences of each learner. Moreover, these technologies can facilitate the integration of the organised requirements of the curriculum with the adaptable nature of SDL, hence augmenting both learner engagement and academic success (Vahedi et al. 2019; Van den Berg & Du Toit-Brits 2023).

Social interactions also significantly impact the successful implementation of SDL. Collaborative learning environments, whether formal or informal, encourage the sharing of ideas, peer-to-peer support and collective problem-solving, which are vital components and strategies of SDL. Social involvement facilitates the development of a more profound comprehension of one's learning processes as well as those of others, hence enhancing the overall learning experience (Belcher & Palenberg 2018; Roumell 2016). Educators need to foster a community that supports these interactions, promoting a culture of mutual respect, shared responsibility and accountability.

In addition to providing ICT and social support, educators must also focus on developing the intrinsic motivation of learners. Self-directed learning is heavily reliant on the learner's internal drive and interest in their learning process (Du Toit-Brits 2022). Motivation is both a prerequisite for and an outcome of successful SDL. Educators can enhance learner motivation by ensuring that learning activities are relevant, challenging and aligned with individual goals and interests (Du Toit-Brits 2022).

To ensure that SDL strategies are effectively implemented to meet curricular and pedagogical objectives, educational institutions and policymakers must invest in training educators in SDL principles and strategies. This includes not only the theoretical aspects but also practical skills in managing diverse learning environments; implementing problem-based learning, collaborative learning, critical thinking and problem-solving, adaptive learning strategies, self-monitoring and reflection, time management; employing ICT tools effectively; and facilitating social learning dynamics. Such preparation ensures that educators are well-equipped to guide and support learners through their self-directed educational pathways (Van den Berg & Du Toit-Brits 2023).

Finally, the establishment of clear learning objectives and the use of self-assessment techniques are critical in the SDL process. These elements help learners monitor their progress and adjust their learning strategies, accordingly, ensuring that they remain aligned with both their aspirations and the educational standards required by their educational institutions (Siminica & Dumitru 2013). Therefore, while SDL offers numerous benefits in terms of learner engagement and educational effectiveness, its successful implementation requires a comprehensive and nuanced approach. By addressing the challenges of traditional educational settings, adequately preparing and supporting educators, integrating suitable technologies, facilitating social interactions and nurturing learner motivation, educational institutions can harness the full potential of SDL to meet their curricular and pedagogical goals.

■ **Fostering collaborative partnerships between learners and educators in self-directed learning**

The fostering of collaborative partnerships between learners and educators in SDL environments represents a pivotal transformation from traditional teacher-led paradigms to learner-centric education. This shift emphasises the importance of reciprocal, socially engaged interactions that aim to not only meet curricular and pedagogical goals but also enhance the educational experience by promoting autonomy, mutual respect and shared responsibilities. Research in the field of education has underscored the considerable advantages that emerge when learners and educators collaborate as partners in the educational experience. As noted by Blignaut and Du Toit-Brits (2023), the collaborative nature of SDL establishes a nurturing and supportive environment that deviates from the conventional, hierarchical teacher-student dynamic. Instead, it encourages a cooperative relationship aimed at achieving common educational objectives. This is supported by Tan et al. (2017), who emphasise that such partnerships are grounded in mutual respect and trust, critical elements for a functional and effective educational relationship.

Educators in SDL contexts assume a facilitative role, wherein their primary responsibility shifts from delivering content to creating a conducive learning environment. This approach is designed to cater to the individual needs of the learner, allowing for a personalised and meaningful educational journey. However, this approach presents challenges, particularly when addressing the varied levels of motivation, skills and knowledge among learners as SDL demands considerable self-motivation and self-regulation from learners, traits that are not uniformly present across all individuals.

To counteract these challenges, educators must skilfully balance granting learners autonomy and independence with ensuring the attainment of specific learning outcomes. This balancing act requires a nuanced approach, sometimes necessitating additional organisation and directional support to ensure that learners remain on track to fulfil their educational objectives (Lodders & Meijers 2017; Momennejad 2022). The adaptability of this approach is crucial, allowing for a flexible yet structured environment where both educators and learners collaborate closely to ensure that the educational goals are met effectively and meaningfully.

Broadening the scope to consider the social implications of SDL, research also indicates that the collaborative partnerships fostered in SDL contexts extend beyond individual achievement to encompass significant social value (Du Toit-Brits 2020; Dziuban et al. 2018; Garrison 1997; Valiathan 2002). The social engagement inherent in these partnerships is critical in enhancing the social dimensions of education, empowering both learners and educators as active participants in the educational process. This empowerment is facilitated through the creation of an open, inclusive atmosphere that values diverse perspectives and promotes active participation, mutual respect and shared decision-making (Breed 2016; Kemp, Baxa & Cortes 2022).

In this collaborative partnership, the co-creation of knowledge occurs through a dynamic exchange of ideas and active engagement, which fosters a deep sense of ownership and commitment to the learning process. This not only equips learners with critical cognitive skills such as critical thinking, problem-solving and effective communication but also instils a sense of motivation, belonging and capability to pursue and achieve their objectives (Du Toit-Brits 2022). Educators, in this partnership, function as mentors and facilitators, tailoring their support to meet the unique needs of each learner while also deriving valuable insights into the learners' interests and learning styles. This understanding enables educators to design and deliver a curriculum that is both effective and resonant with the learners' needs.

The collaborative partnerships also provide a platform for educators to observe the direct influence of their guidance on learners' progress and achievement, which can lead to greater professional satisfaction and growth (Kim & Yang 2020). The reciprocal nature of this relationship not only meets educational and curricular goals and objectives but also transforms the educational environment into a dynamic, evolving space where learning is a mutually enriching and self-directed experience. Also, the integration of innovation and creativity within SDL, as suggested by Kalyani and Rajasekaran (2018), underscores the flexibility and adaptability required in these partnerships. Educators are encouraged to embrace their originality and inventiveness, thereby enhancing their teaching methodologies and interactions with learners. This freedom to innovate within SDL is crucial for

fostering environments where learners can take initiative, whether in synchronous or asynchronous settings, to explore their creativity and establish personalised learning trajectories under the guidance of their educators (Kaushik & Walsh 2019; Lombard 2018; Vahedi et al. 2019).

Thus, the authors believe that the collaboration between learners and educators in SDL settings is not merely a means to achieve educational outcomes but a transformative process that cultivates individuality, creativity and a deep, mutually beneficial partnership. This partnership not only achieves curricular and pedagogical success but also enriches the educational landscape by introducing elements of social engagement, personal relevance and continuous innovation. Therefore, understanding the role and significance of being a self-directed educator in this collaborative partnership within this dynamic learning environment becomes essential.

■ The significance of being a self-directed educator in educational settings

As stated earlier, the traditional approach to disseminating knowledge and acquiring competencies is insufficient in today's fast-paced society. Developing SDL attributes is crucial for learners as it involves taking responsibility for their academic endeavours and actively seeking additional resources to enhance their understanding of diverse subjects. It therefore is imperative for educators to embrace a proactive stance in fostering SDL and its relevant attributes and to implement a pedagogical approach that empowers learners (Du Toit-Brits 2018a; Robinson & Persky 2020). Cultivating SDL attributes among learners can enhance their capacity to adapt to changing situations and to take advantage of developing opportunities throughout their lifespans (Du Toit-Brits & Bignaut 2019; Nasri 2019). The achievement of this goal relies on the crucial role of an autonomous and self-directed educator.

As expressed above, an educator's role in the SDL process is paramount, as they bear multiple obligations in enabling SDL (Nasri 2019). The aforementioned refers to the establishment of a safe and welcoming environment that promotes a feeling of comfort among learners, motivating them to ask questions, express their opinions and engage in bold initiatives (Du Toit-Brits 2018a; Nasri 2019). Furthermore, within the SDL context, educators offer learners instructional support and evaluative input at different junctures along the learning journey. The process of guidance and feedback is integral to assisting learners in establishing attainable objectives, furnishing them with appropriate resources and materials and evaluating their advancement through feedback (Nasri 2019). Another role of the self-directed educator is to foster introspection, as this act of reflecting holds significant value in the context of SDL (Nasri 2019).

Self-directed learning educators should motivate learners to engage in reflective thinking regarding their educational experiences and discern their acquired knowledge and areas that require further development (Nasri 2019).

Furthermore, in alignment with the perspective of Du Toit-Brits and Blignaut (2019), we affirm the significance of fostering SDL attributes as a vital component of education (Nasri 2019), and as seen earlier, it is the responsibility of educators to actively facilitate the cultivation and enhancement of these attributes within learners. Hence, the significance of a self-directed educator within education and knowledge acquisition cannot be underestimated (Du Toit-Brits 2018a). Based on Du Toit-Brits (2018a), a self-directed educator should possess specific attributes that contribute to establishing a conducive learning environment, enabling learners to assume ownership of their academic pursuits. The educator's action of establishing a conducive learning environment, in turn, promotes the self-directed learners' autonomy, resourcefulness and overall achievement. By embracing a self-directed approach, educators can equip learners with the essential attributes necessary for success in the contemporary era (Du Toit-Brits & Blignaut 2019; Nasri 2019). To synthesise the topics mentioned earlier, the following section elucidates the attributes of a self-directed educator.

■ Attributes of an educator in self-directed learning

The capacity to act as an independent self-directed educator holds significant value in fostering the growth of learners' abilities and skills essential for their self-sufficiency (Porter & Freeman 2020). Porter and Freeman (2020) maintain that educators who take the initiative in directing their learning and teaching can effectively cultivate their professional development by continuously improving their skills and expanding their knowledge. To thrive in an SDL setting and context, a self-directed educator must possess essential attributes. As the authors of this chapter, we aim to highlight the salient attributes of self-directed educators:

1. Educators must have adequate facilitation skills. This is of utmost importance. Instead of trying to control or coerce their learners through the educational process, educators should be able to offer direction and advice to their learners. The responsibility of cultivating a supportive and self-directed environment that supports learner autonomy and encourages accountability for academic success falls on the shoulders of educators.
2. Educators need to be able to adapt and wish to engage in new experiences. It is necessary to display adaptability and openness to accommodate each learner's unique requirements and preferences. In addition, teachers need to be able to adapt the lesson's pace and the

instructional methods they use to cater to their learners' individualised educational requirements.

3. Educators should demonstrate empathy for their learners by acknowledging and understanding the diverse backgrounds, life experiences and individual preferences regarding the instructional approaches they find most engaging.
4. The ability to communicate effectively is a criterion that must be met to work in the field of education. They should actively listen, provide constructive feedback and motivate learners to express their perspectives and concepts.
5. Familiarity with pedagogical theories is essential to an educator's skill set. This knowledge empowers educators to effectively implement these theories in practical instructional situations, thereby facilitating the creation of impactful learning activities and assessments.
6. Educators must demonstrate an unwavering commitment to continuous learning and professional development. They should be willing to explore innovative concepts and techniques and be open to experimenting with various pedagogical approaches and methodologies.
7. Educators should have a genuine passion for teaching and be driven by the progress and development of their learners. This dedication will help learners maintain engagement and enthusiasm, even in challenging circumstances.

As seen above, self-directed educators must be accountable, assume responsibility and take ownership of their teaching in their learning environments. Educators should also stay abreast of current research and educational trends through self-directedness, adjust their instructional strategies to meet evolving learners' needs and consistently enhance their pedagogical practices. Such instructional strategies have the potential to result in improved academic achievements among learners. The authors use Table 3.3 to enumerate statements describing the attributes of an educator in SDL environments based on numerous sources to further elaborate on the importance of the educator's self-directedness.

As illustrated in Table 3.3, the attributes deemed critical for self-directed educators include the ability to engage in self-reflection, possess a curious disposition, be adaptable, demonstrate self-motivation and exhibit a collaborative approach, to mention only a few. Therefore, educators with SDL attributes must facilitate and promote learners' self-directedness. Educators also need to act as self-directed agents and demonstrate the significance of assuming responsibility for one's teaching journey by being self-directed learners themselves. Educators who exhibit SDL attributes are more prone to possess an in-depth comprehension of the learning process, enabling them to furnish their learners with guidance and resources

TABLE 3.3: Attributes of an educator in self-directed learning environments.

Attributes of a self-directed educator	
Attributes of the self-directed educator	Source
Is an agent that socially engages the learner	Du Toit-Brits 2020; Garrison 1997; Roumell 2016
Determines and prioritises learner's curriculum and pedagogical needs	Andyani et al. 2020; Tan et al. 2017
Sets an informal and assessment learning environment	DoBE 2011
Supports blended learning	Horn and Stalker 2017; Khaloufi and Laabidi 2017
Emancipates learners to decide on learning goals, activities and venues	Lai 2015; Tredoux 2012; Vahedi et al. 2019
Implements methodological, pedagogical and metacognitive information and strategies	Brockett and Hiemstra 2018
Designates technologically enhanced homework	Lai 2015
Uses effective strategies for the learner to be self-directed	Lemmetty and Collins 2020; Palmer, Chu and Persky 2019
Involves learners in ICT or resource evaluation, selection and integration	Belcher and Palenberg 2018; Khaloufi and Laabidi 2017
Utilises criteria and instruments to select resources that promote SDL-compatible learning competencies	Du Toit-Brits and Blignaut 2019; Tuzlukova and Singh 2019
Augments learners' intrinsic with extrinsic motivation	Azeez et al. 2019
Is not dominant and limits interference	Lai 2015
Provides conceptual information	Brockett and Hiemstra 2018
Pursues curriculum goal achievement	Siminica and Dumitru 2013
Aspires to produce competitive, knowledgeable, skilled, 'world-class' citizens	United Nations Educational, Scientific and Cultural Organization (UNESCO) 2013
Is the expositor, coach, guided motivator, facilitator and consultant	Du Toit-Brits 2018b; Grow, as cited by Tredoux 2012; Kwan (2003, cited by Tredoux 2012)
Monitors assessment outcomes	Brandmo, Panadero and Hopfenbeck 2020

Source: Authors' own work.

Key: ICT, information and communication technologies; SDL, self-directed learning.

that foster the development of SDL attributes. These educators can cultivate an environment that promotes curiosity, analytical reasoning and SDL in the classroom and facilitate the acquisition of fundamental competencies such as problem-solving, judgement and continuous learning among learners. In addition, educators who adopt SDL attributes persistently pursue professional development and remain abreast of current pedagogical strategies and approaches, ultimately enhancing their learners' academic experiences, thus fostering self-directedness and attaining curriculum and pedagogical objectives.

■ Fostering learner self-directedness: The crucial role of educator autonomy and guidance

In contemporary educational paradigms, fostering self-directedness in learners has gained prominence as a critical objective. Central to this endeavour is the crucial role of self-directed educators, whose influence

extends beyond conventional teaching methods. The preceding section underscores the significance of educators embracing SDL by acquiring diverse skills and attributes to empower learners in making informed decisions about their educational environment. Such decisions encompass evaluating the merits of traditional classroom-based instruction, commonly called the ‘brick-and-mortar’ setting, and exploring alternative learning platforms, including online modalities (Horn & Stalker 2017). A pivotal attribute of self-directed educators involves autonomy and intrinsic motivation (Du Toit-Brits 2018a).

In line with Azeez et al. (2019), intrinsic motivation denotes the inclination to invest one’s energy in a particular task because of the inherent pleasure derived from that task. Hence, a crucial attribute of self-directed educators lies in their intrinsic motivation to enhance the efficacy of their teaching, thereby fostering SDL skills among their learners. This notion finds support in the works of Du Toit-Brits (2018a) and Louws, Meirink, Van Veen and Van Driel (2017) and proves essential in achieving curriculum and pedagogical objectives. As mentioned earlier, intrinsically motivated educators assume diverse roles based on the learner’s degree of independence, aiming to promote and nurture the learner’s autonomy and self-directedness. The following section explores self-directed educators’ strategies to navigate various roles and levels of SDL, facilitating their self-directed progress.

■ **Nurturing self-directed learning: The multifaceted role of educators as coaches, motivators, facilitators and consultants**

In this chapter, we contend that education is not solely about imparting knowledge but equipping learners and educators with the skills, values, attitudes and mindset to navigate their educational journeys proactively. At the heart of this transformative approach (see Chapter 2) lies the figure of the self-directed educator, whose role transcends the traditional boundaries of teaching. The educator’s position in the SDL process is of utmost importance and undergoes many transformations throughout distinct stages. These stages encompass the educator’s roles as a coach, motivator, facilitator and consultant, which are contingent upon the learner’s readiness to actively engage in SDL (Du Toit-Brits 2020). These positions exemplify a continuum towards cultivating SDL among learners, to attain curriculum and pedagogical goals. Educators assume a pivotal position in the attainment of curriculum and pedagogical objectives that prioritise the cultivation of critical thinking, the cultivation of lifelong learning skills and the ability to adapt to an ever-evolving information landscape. It is important for educators engaged in SDL to recognise that their level of self-directedness depends on their skills, attributes, abilities

and intellectual understanding, all while effectively fulfilling the aforementioned tasks (Abid, Hussain & Shoab 2019).

Consequently, the educator responsible for implementing SDL must possess the attributes (see Table 3.3) and necessary skills to assess the learners' preparedness and willingness for SDL (Mok & Mo 2018). As mentioned earlier, this assessment enables the educator to determine the most appropriate approach for guiding the learner through the various stages towards attaining self-directedness. As highlighted in the previous section regarding the progression of the learner's SDL levels, there needs to be a systematic correlation between the learner's SDL levels and the corresponding roles of the educator. In the initial stages, when the learner relies on the educator, the educator assumes the coach role. As the learner advances in their learning journey and becomes a more proactive stance in the process of acquiring knowledge, the instructor assumes the responsibility of serving as a source of motivation. As learners take a more active role in their learning process, the educator's role shifts to that of a facilitator. Ultimately, as learners achieve self-direction, educators adopt the role of a consultant. Notably, through the SDL stages, the educator's authority gradually diminishes, and their involvement remains at the periphery.

Kwan (2003, cited in Tredoux 2012) categorised the roles of educators, encompassing the labels of expositor or coach, guided motivator, facilitator and consultant. Kwan also outlines the progression of the learner's self-directedness through four stages, denoted as 'Stages 1 to 4'. These stages represent the learner's transition from a state of passivity and dependency to one of interest and motivation, involvement and commitment, and finally, self-directedness and initiation. Notably, delineating these stages emphasises that SDL does not absolve educators of their responsibilities (Lemmetty & Collins 2020). Learners still require guidance and support from instructors to enhance their learning experiences, including implementing effective learning techniques (Palmer et al. 2019) and establishing an informal SDL atmosphere (Song & Bonk 2016).

The level of learner receptiveness to the involvement of educators in the SDL environment highlights that, despite intrinsic motivation and openness, learners benefit from extrinsic motivation influenced by external processes and social and behavioural factors (Azeez et al. 2019; Crippen et al. 2009; Joo et al. cited by Zhu, Bonk & Doo 2020), collaborative partnerships, leadership, guidance and support. Brockett and Hiemstra's research (2018, p. 78) suggests that learners may lack confidence and comprehension of the ICT resources necessary to achieve curriculum objectives without adequate support from educators. As a result, it can be argued that in SDL settings, learners require the guidance and assistance of educators to attain their academic objectives successfully and progress to higher levels of self-directedness.

Based on the previous discussion, it is evident that educators who can guide learners through learning and instruction are crucial in achieving the goals of curriculum and pedagogy in contemporary educational systems. In the context of the changing educational environment, educators who possess qualities such as flexibility, adaptability and a steadfast commitment to SDL and lifelong learning play an essential role in encouraging the self-directedness of learners. Educators' independent practice towards enhancing their professional growth and ability to think creatively enables them to devise and execute tactics that foster SDL among learners proficiently. To conclude, educators' vast responsibilities, including coaching, motivating, facilitating and consulting, enhance their ability to address learners' varied learning requirements and preferences. These multifaceted roles are crucial in fostering an environment conducive to SDL, thereby promoting SDL among learners and educators.

In the following section, the authors of this chapter provide recommendations for educational institutions, educators and learners. These recommendations aim to enhance and effectively implement SDL attributes among educators and learners. The ultimate objective is to facilitate the achievement of curricular and pedagogical goals within SDL environments.

■ Recommendations and implications for educator training

This chapter suggests that to enhance the SDL attributes of both learners and educators to achieve curricular and pedagogical objectives, the following recommendations can be put into practice:

■ Emphasising personalised learning pathways

To fully harness the potential of SDL attributes in both learners and educators, it is imperative to create personalised learning pathways. These pathways should be designed to adapt dynamically to the individual's strengths, weaknesses and interests. For instance, curriculum designers could integrate adaptive learning technologies that analyse learner performance and preferences to tailor educational content accordingly. Also, educators should be trained to develop flexible pedagogical strategies that can be adjusted in real time based on learner feedback and learning analytics.

■ Strengthening educator's role as facilitators

Transitioning the role of educators from traditional content deliverers to facilitators of learning can significantly boost SDL. Professional development programmes should focus on equipping educators with the skills to guide

enquiry, foster critical thinking and encourage exploration. This includes training on asking provocative questions and managing project-based learning. Additionally, educational policies should support educators in taking risks and innovating their teaching methods to promote a more learner-centred environment.

■ **Cultivating a culture of continuous feedback**

Continuous feedback is important in an SDL environment. This approach can provide both educators and learners with the insights needed to improve their methods and strategies. This can be done by implementing regular peer reviews where both learners and educators share feedback on learning experiences, which can foster a supportive community focused on continuous improvement. Also, the use of digital tools needs to be promoted to facilitate real-time feedback and reflection, allowing learners to adjust their learning paths and educators to modify their instructional strategies promptly.

■ **Leveraging digital platforms for collaborative learning**

Digital platforms can serve as catalysts for both developing and showcasing SDL attributes, namely, online forums, and collaborative tools can be used to encourage learners to engage with peers, discuss learning materials and develop critical thinking skills outside the traditional classroom setting. Educators can also utilise these platforms to share resources, strategies and pedagogical innovations with colleagues, promoting a culture of collaboration and lifelong learning.

■ **Encouraging metacognitive skills development**

Developing metacognitive skills is essential for effective SDL as it enables learners to understand their learning processes and preferences. This can be done through the integration of metacognitive activities such as learning journals, planning and reflection sessions, and self-assessment exercises into the curriculum. However, educator training also needs to focus more on metacognitive teaching strategies that can help educators guide their learners in becoming aware of their learning tactics and strategies, thus enhancing their learning autonomy.

These recommendations aim to cultivate learning environments where SDL attributes in both learners and educators are recognised as pivotal mechanisms for achieving curriculum and pedagogical objectives.

■ Conclusion

To this end, it is proposed that the transformative power of SDL must be recognised in achieving educational goals. This exploration underscores SDL not merely as a desirable skill but as an essential catalyst in modern education paradigms. Learners, equipped with SDL attributes, exhibit a remarkable ability to adapt to evolving educational landscapes, demonstrating resilience, initiative and a continuous passion for their learning. Educators, on their part, transition from traditional gatekeepers of knowledge to facilitators and co-learners, adapting teaching strategies that foster learner autonomy and critical thinking.

The synergy between learner and educator attributes in SDL creates a dynamic learning environment where curriculum goals are not only met but also exceeded. This environment encourages innovation, critical enquiry and the practical application of knowledge, aligning closely with contemporary pedagogical objectives that prioritise adaptability and proactive learning. Furthermore, the incorporation of SDL within the curriculum is not without its challenges, including the need for substantial support structures and a shift in traditional teaching mindsets. Ultimately, by fostering SDL attributes among both learners and educators, a foundation for achieving curriculum and pedagogical objectives is laid where learners are prepared not merely for exams but for lifelong success and adaptability in an ever-changing world, marking a significant stride towards educational excellence.

Bridging the gap: Nurturing self-directedness in higher education teacher training and teachers' job demands

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■ Abstract

This chapter² focused on insights into how teacher training can be improved to better prepare novice teachers for the complexities of modern education and the integration of self-directed learning (SDL) strategies. This chapter emphasised the significance of equipping novice teachers with the necessary competencies and methodologies to facilitate SDL among their learners.

2. In the chapter title, 'Bridging the gap: Nurturing self-directedness in higher education teacher training and teachers' job demands', we refer to job demands (workload) instead of training, because literature refers to job demands as workload.

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Self-directed learning is an essential element of education that empowers learners and teachers to take charge of their learning and teaching and develop proficiencies in critical thinking, problem-solving and continuous learning. Integrating SDL into the academic syllabus and providing sufficient assistance for novice teachers to execute it competently can enhance learner involvement and incentive and cultivate an atmosphere of independent learning and self-motivated enterprise. Consequently, this can lead to more substantial educational encounters and enhanced scholastic accomplishments.

■ Introduction

The previous chapter explored the attributes of self-directed learning (SDL) among learners and educators in general education settings. This chapter is linked to Chapter 3, emphasising SDL's role in education. The rapidly evolving and complex 21st-century landscape, particularly within the Fourth Industrial Revolution (4IR) context, makes disseminating knowledge within educational institutions pivotal. Novice teachers often confront unforeseen challenges, anticipating their university-acquired knowledge will be sufficient (Louws et al. 2017; Oppenheimer 2017; Richards & Farrell 2016; Tican & Deniz 2019). Higher education institutions (HEIs) must reform pedagogical paradigms to integrate SDL principles into teaching methodologies (Boser 2017; Fashant et al. 2020; Haiyan, Walker & Xiaowei 2017; Harrington 2018; Van Wyk 2017).

Barbousas (2023) highlights the need for novice teachers to develop, adapt and synthesise information into comprehensible knowledge; adapt teaching methodologies to diverse contexts; and engage creatively with peers and stakeholders (Kayembe & Nel 2019). Despite their enthusiasm, novice teachers face challenges hindering their integration into today's transformative education landscape (Darling-Hammond 2023). Many teacher training programmes do not address the specific requirements of novice teachers in underperforming schools (Rice 2023). However, by fostering a collaborative environment, where researchers and policymakers work together, we can develop rigorous, context-specific training programmes for teachers in demanding environments (Rice 2023).

Novice teachers need ongoing professional development and mentorship to cope with teaching challenges, as limited knowledge can lead to frustration and inefficacy (Ayoobiyan & Rashidi 2021). Inadequate teaching abilities and lack of consistent feedback can result in decreased job motivation and negative attitudes towards the profession. Support structures play a crucial role in mitigating stress and preventing burnout (Bakker & De Vries 2021). Furthermore, it is imperative for novice teachers to understand curriculum development to create effective lessons and ensure alignment with educational goals (Ke Lomi & Mbato 2020).

Establishing a meaningful connection between knowledge and learners' needs necessitates well-designed curricula and resources.

Darling-Hammond (2023) highlights the importance of ongoing learning and continuous professional development for novice and experienced teachers to address diverse and unpredictable learning requirements. Training programmes should cultivate a mindset encouraging persistence in solving complex challenges and learning from experiences and peers. Self-directed learning and continuous professional development principles are essential for all teachers, including those experienced but lacking formal SDL training. Addressing technology-oriented pedagogy challenges is crucial, particularly in South African educational contexts, where resource inadequacies hinder technology integration (Du Plessis & Mestry 2019). Tertiary institutions should prioritise developing SDL abilities among teachers to foster effective learning and provide appropriate learner support (see Chapter 3) (Olivier 2022).

The 4IR emphasises the urgency of improving SDL competencies to meet the educational landscape's evolving demands (Olivier 2022). Atibuni, Manyiraho and Nabitula (2022) and Taylor (2019) underscore the need for teachers to possess adequate knowledge and readiness to navigate challenges inherent to South African schools. Chisholm (2019) stresses the importance of equipping learners with skills for a technologically advanced world. Adaptability and SDL skills are essential for all stakeholders in the academic spectrum (Selvi 2011). These competencies are increasingly critical as the 4IR transforms various sectors, necessitating a robust understanding of its core principles.

Zhelyazkova (2021) outlines the key 4IR principles, including interoperability, information transparency, decentralisation, real-time capabilities and flexibility. Integrating these principles into classrooms is challenging, particularly in South Africa, where the education system struggles with performance issues (Centre for Development and Enterprise 2023). The education system must focus on interdisciplinary knowledge and technology skills to improve outcomes and address foundational gaps hindering learner engagement with 4IR tools. A multidisciplinary approach is crucial to addressing the shortage of qualified teachers and adapting curricula to include necessary SDL skills (Kayembe & Nel 2019).

The 4IR Committee (Simpson 2020) suggests aligning the education system with 4IR demands, including technology-focused curricula and modernised assessment methods. Despite efforts to train teachers in computer skills and coding, there is a pressing need for self-directed novice teachers to implement a 4IR-focused curriculum. The education system must be resilient, adaptive and forward-thinking to meet 4IR demands (DBE 2021). Addressing standardised curriculum guidelines and assessment requisites adds complexity, requiring teachers to balance fulfilling mandates

with fostering creativity and critical thinking (Marr 2019). Consistent commitment to acquiring new proficiencies and adapting to the evolving educational milieu remains imperative (Kayembe & Nel 2019).

■ Problem statement

One of the main goals of contemporary educational methodologies is to promote learners' autonomy in designing and managing their own learning experiences. Moreover, these methodologies strive to empower learners to effectively employ their learned knowledge in practical situations by leveraging digital resources (The 4th Industrial Revolution and Its Impact on Education 2019). Novice teachers are required to demonstrate adaptability in addressing learners' changing needs and expectations and the unique opportunities and challenges technology brings. Furthermore, Phillips and Condy (2023) assert that a noticeable disparity between theoretical understanding and practical implementation, usually known as the theory-practice gap, presents additional noteworthy challenges. Although these novice teachers acquire knowledge about 4IR and SDL and their ramifications during their university education, applying this theoretical understanding to develop successful educational practices that align with their learner's needs and interests may be challenging (Steyn 2004).

However, according to Callahan (2016), the collaboration between higher education teacher training institutions and schools fostering practice teaching does not promote the development of self-directedness in novice teachers enough. Consequently, practice teaching experience often does not provide sufficient opportunities for novice teachers to exercise autonomy, initiative and reflection in their learning and teaching. Instead, they follow their mentor's and supervisors' prescribed curriculum, methods and assessment without critically examining their beliefs, assumptions and practices (Hine & Thai 2018).

As a result, these novice teachers frequently lack the knowledge and experience necessary for self-direction concerning efficient classroom and self-management, subject knowledge and interpersonal interactions with learners and teachers (Hine & Thai 2018). The lack of the knowledge and experience necessary for self-direction and 4IR can lead to frustration, stress, anxiety and low self-efficacy among novice teachers, negatively affecting their professional performance and retention. Research shows that novice teachers receiving inadequate training or preparation are likelier to quit within the first five years (Sun 2016) because of a lack of knowledge and experience. This finding underscores the critical need for comprehensive teacher training programmes that effectively equip novice teachers with the necessary skills and knowledge. This chapter's research tried to answer the following questions:

How does the current curriculum for training teachers help new teachers gain the subject knowledge and self-direction they need to deal with problems in the school system and meet the needs of the 4IR? What factors influence the effectiveness of teacher training in equipping novice teachers with the necessary content knowledge and self-directedness for the challenges of the schooling system and the 4IR?

The research questions are designed to investigate the extent to which the current teacher training curriculum aligns with the chapter's aims. The first question examines how well the curriculum fosters both subject knowledge and SDL, essential for novice teachers to address school system challenges and adapt to the demands of the 4IR. The second question delves into identifying the factors that affect the effectiveness of teacher training programmes in achieving these competencies. Together, these questions aim to provide insights into how teacher training can be improved to better prepare novice teachers for the complexities of modern education and the integration of SDL strategies.

■ Theoretical framework

Swanson (2013, p. 122) explicitly asserts that '... [t]he theoretical framework is the structure that can hold or support a theory of a research study ...'. The theoretical framework is a blueprint that researchers often borrow in constructing their research enquiry (Mensah et al. 2020). The theoretical framework serves as the groundwork for conducting research. Vygotsky (1978) defines the Zone of Proximal Development (ZPD) as:

[T]he distance between the actual development level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with a more capable peer. (p. 86)

Also, Guvesa and Solomonovich (2017) define ZPD as a spectrum of demanding tasks that individuals cannot master independently but can achieve successfully with the assistance of skilled peers or adults. This perspective highlights the importance of collaboration and guidance in achieving higher levels of understanding and skill. Novice teachers frequently have many challenging responsibilities throughout their initial years in the teaching profession. These responsibilities fall within the ZPD, as they often require support from more experienced colleagues. Several teachers encounter significant stress levels resulting from the expectation that they must independently complete these demanding responsibilities, such as preparation, disciplinary actions and administrative tasks, relying solely on the knowledge and abilities acquired through their practical teaching experiences (Richards & Farrell 2016). This expectation often leads to overwhelming pressure and can hinder their professional growth.

Hence, the ZPD emerges as a crucial framework that necessitates careful consideration. Its significance lies in its ability to guide the training and support of novice teachers by more experienced peers, enabling them to accomplish teaching responsibilities and foster SDL effectively. One further pedagogical notion that seeks to enhance the self-directedness of novice teachers is utilising the social constructivist technique known as scaffolding. The partnership between a proficient peer and a novice teacher in knowledge and skill development is paramount. According to Heilmann (2018), scaffolding is a cognitive learning process that involves collaborative interactions between a learner and a knowledgeable adult or peer.

Additionally, according to Schwab (2016), emotional intelligence is the fundamental basis for acquiring SDL skills necessary for success in the 4IR era. These skills include self-awareness, self-regulation, motivation, empathy, self-direction and social skills. The affective variables also contribute to the development of self-directedness. Therefore, adequately preparing both learners and teachers for the 4IR entails more than simply incorporating technology and providing training on new technologies. It also involves fostering interpersonal connections and relationships. Interpersonal connections and relationships are important in the context of preparing for the 4IR, especially relevant when individual collaborative efforts are deemed suitable in a learning environment.

■ Literature review

In South Africa, teachers need better disciplinary knowledge resources and academic expertise to enhance the quality of education. Self-directed learning is an essential skill for teachers in the 21st century, allowing them to adapt to the changing demands of the 4IR. Novice teachers in South Africa often lack self-direction and pedagogical skills, highlighting the need for support and guidance during the induction period. Job demands, such as workload and managerial skills, can lead to burnout among teachers, while low job satisfaction and inadequate support contribute to high turnover rates. In their early careers, novice teachers with three years or less experience face additional stress and challenges. Addressing these issues in teacher training programmes is crucial for improving the education system. This research concentrates on the following key concepts: novice teachers, teacher training, SDL, teacher job demands and job satisfaction.

■ Novice teachers

Ngwira and Potokri (2019) define and explain a *novice teacher* as a credentialed individual who has been teaching for three years or less. These teachers actively participate in educational programmes and workforce

preparedness initiatives to enhance their professional growth. The aim is to provide SDL opportunities for novice teachers to support the development of their teaching practice during the early stages of their teaching careers. According to Harmsen et al. (2018), the teaching profession has the highest stress levels in European countries. High stress levels are attributed to the increased vulnerability of new teachers who experience burnout symptoms and deal with significant workloads.

Moreover, a study in the United States categorises novice teachers as individuals who enter the professional domain in vulnerable conditions marked by a lack of practical experience and exposure to challenging teaching environments. These circumstances ultimately negatively affect their general well-being, frequently leading to a high rate of professionals leaving the field during the first year of employment (Harmsen et al. 2018). Du Plessis and Letshwene's (2020) findings show numerous difficulties in transitioning inexperienced teachers into the full-time educational sector, even though teaching practicums are currently in place in South Africa and are intended to provide teaching training. Experiencing an unexpected and demanding situation in the real world, sometimes called a 'real-world shock', presents a significant existential risk for novice teachers (Van Tonder & Fourie 2018, p. 1336). The phenomenon contradicts their preconceived notions about their teaching duties, directly threatening their professional development (Botha & Rens 2018). In line with Curry, Webb and Latham (2016), novice teachers face formative encounters that profoundly impact their professional trajectory and future identities throughout their early teaching years.

■ Teacher training

Teacher training is the formal educational process through which prospective teachers acquire knowledge and establish skills necessary for their profession (Al-Mahrooqi & Denman 2018). The empirical data from several studies demonstrate that teachers influence learners' performance the most (Deacon 2016; Trif 2020). Almost all nations invest in the educational workforce during the training phase or before they begin working in schools (Goldhaber 2019). Some empirically supported hints indicate that teachers' preparation could be improved (Goldhaber 2019). Surveys of recent novice teachers reveal that they frequently feel underprepared for the plethora of challenges they must face in the classroom, particularly in classroom management (Kiru 2020; Kozikoglu 2017; Obadire & Sinthimule 2021; Reitman & Karge 2019; Schonert-Reichl, Kitil & Hanson-Peterson 2017).

According to research by Goldhaber, Grout and Huntington-Klein (2016) and Jacob et al. (2016), educational systems can identify attributes in job

applicants that indicate whether they will be successful in the classroom. These findings imply that there are quantifiable skills that can be used to predict teacher effectiveness and that there are abilities that novice teachers may initially struggle with but will develop proficiency early in their careers. The authors of this chapter believe that novice teachers would benefit significantly if some of these abilities could be incorporated into their preservice coursework, as concerns about the quality and methods employed in teacher training programmes within South Africa have been raised. Darling-Hammond (2023) believes that enhancing teachers' disciplinary knowledge and pedagogic expertise is crucial for improving South Africa's education quality. Without significant improvements in these areas, any other efforts will likely face limitations in their effectiveness.

In their study, Kimathi and Rusznyak (2018) analysed four policy frameworks employed in regulating, monitoring and evaluating South African teachers throughout the previous two decades. Kimathi and Rusznyak's (2018) research discovered that these frameworks impose limitations on teacher professionalism by selectively focusing on specific characteristics of professional teaching while neglecting others. Engelbrecht's (2020) study on inclusive education has revealed that initial teacher-teaching programmes in South Africa fail to adequately address the growing need for newly qualified teachers who can effectively teach in inclusive classrooms. Therefore, it is vital to enhance the self-directedness of novice teachers in South Africa by providing them with more support and guidance during their induction period. Incorporating SDL strategies into teacher training programmes is essential for equipping novice teachers with the skills they need to navigate the complexities of their profession and promote lifelong learning.

■ Self-directed learning

Self-directed learning refers to a cognitive process when individuals assume responsibility for their learning, exerting control over many aspects, such as learner attributes, which include self-efficacy and encouragement (Du Toit-Brits 2019). On the other hand, self-directedness is a broader concept that refers to a person's overall ability to guide their actions and behaviours, including but not limited to learning (Du Toit-Brits 2019). It is about being proactive, taking initiative and being responsible for one's actions. Self-directedness can influence novice teachers' willingness to engage in SDL (Linkous 2020). Novice teachers demonstrate resilience, adaptability and the ability to pursue their ambitions proactively. In summary, while SDL is about taking control of one's learning process, self-directedness is a more general trait that can influence a person's approach to many aspects of life, including learning.

Academic discourse has paid considerable attention to the issue of teachers' capacity to independently direct their learning (Mentz & Van Zyl 2016). According to Raemdonck, Thijssen and De Greef (2017), self-directedness in teaching and learning comprises several essential elements. These include recognising one's learning needs, establishing goals, selecting appropriate learning approaches, and evaluating and altering the learning process. From Knowles's (1975) definition, as seen in Chapter 1, five key aspects contribute to SDL. These are (1) setting learning goals, (2) identifying resources, (3) selecting resources, (4) selecting appropriate strategies and (5) evaluating learning outcomes. Building on these foundational principles, teachers recognise the value of incorporating SDL methodologies into their practices. Teachers must develop SDL skills to be effective SDL agents who can set learning goals, identify and evaluate resources, select appropriate facilitating strategies and evaluate their teaching (Morris 2019). Additionally, SDL promotes lifelong learning, which teachers require for professional growth (Van Tonder & Du Toit 2020).

Moreover, teachers are advised to create supportive SDL environments by employing effective teaching strategies. These strategies include motivating learners to acquire knowledge and develop the skills necessary for independent and meaningful learning (Du Toit-Brits 2019). Additionally, teachers should possess an actual drive for the subject matter and strive to foster this enthusiasm in their learners. Encouraging independence in learning, utilising teaching methods that require active learner participation and collaboration, and maintaining positive expectations for learners' development are essential elements in fostering SDL in learning environments (Wittmann & Olivier 2021).

Botha and Rens (2018, p. 3) investigated novice teachers' reality shock in South Africa. Using the 'ready, willing, and able' model developed by Shulman and Shulman in 2004, the researchers analysed the participants' experiences. The research conducted by Botha and Rens is significant to the notion of self-direction as it centres on novice teachers' initial intellectual and affective growth. Nonetheless, some novice teachers lacked the required preparation for their teaching positions. The lack of necessary preparation is evidenced by their challenges in effectively cultivating and nurturing the abilities of their learners, their inadequate understanding of pedagogical principles, their difficulties in managing the demanding teaching schedule and their uncertainty regarding the adequacy of their HEI's training in preparing them for the practical aspects of teaching. Botha and Rens' research findings indicate that novice teachers have limited self-direction and pedagogical skills.

Gavriel (2015) posits that the three essential elements of self-direction encompass competence, motivation and self-confidence. Noguera and

McCluskey (2017) assert that novice teachers often encounter challenges applying the theoretical concepts they acquired during their university studies. The concerns raised might be ascribed to Mentz and De Beer's (2020) argument that HEI often prioritises theoretical elements excessively, neglecting the integration of real-world applications. According to Van Tonder (2021), recently certified teachers with less than four years of teaching experience are advised to engage in a recalibration process. This process should consider several factors, including the school's success and the teachers' professional development and self-directedness (Arends & Phurutse 2009). Given these demands on novice teachers to develop SDL skills, it is crucial to examine the various job demands they face in their professional roles.

■ Teacher job demands

Increased job demands are directly related to burnout (Bakker, Demerouti & Schaufeli 2003; Demerouti & Bakker 2011; Madigan & Kim 2021). Physical, social, organisational and psychological factors that require employees to exert effort to achieve individual and organisational objectives are called job demands (Bakker & De Vries 2021; Lesener, Guys & Wolter 2019). Various dimensions, such as emotional demands, family conflict, workload, role conflict and ambiguity, non-availability or lack of autonomy, promotions, scholarships, administrative duties and organisational role stressors, have been used to measure job demands in different professions in developing countries (Granziera, Collie & Martin 2021).

According to Skaalvik (2015), novice teachers commonly express the personal stress they suffer caused by the significant workload associated with the teaching profession. In addition, novice teachers are assigned to complete various educational and administrative responsibilities efficiently (Manuel, Carter & Dutton 2018). However, the fields of management and leadership present challenging aspects that inexperienced teachers struggle with regarding skilfulness. These aspects generate increased anxiety and feelings of inadequacy, especially when experienced teachers demonstrate these competencies with a significant level of confidence and self-direction (Perlshtein 2015). Therefore, this viewpoint emphasises that many inexperienced teachers continue to face difficulties in developing proficiency in managerial abilities. As a result, they can significantly benefit from the mentorship of experienced teachers who excel in these areas.

However, the Department of Education (2000) predicted that, like experienced teachers, novice teachers are required to deliver a curriculum and comply with the prescribed statutory frameworks that offer guidelines for teaching and learning. The substantial job demands placed on novice

teachers not only lead to stress and burnout but also significantly impact their overall job satisfaction.

■ Job satisfaction

Locke (1969) defines *job satisfaction* as emotional well-being, gratitude and fulfilment when one achieves professional goals. Also, Evans (1997) defines *job satisfaction* as the extent to which employees feel their needs related to their jobs are met. According to these economists' definitions (Evans 1997; Locke 1969), *job satisfaction* is the satisfaction teachers report having with their working environment as they achieve their professional goals. As noted by Lopes and Oliveira (2020), critical components of professional expertise, such as teacher subject-matter knowledge, teaching experience and professional development, may influence job satisfaction and the desire to leave the profession. The level of job satisfaction among novice teachers in South Africa is relatively low. Compared to their more experienced counterparts, novice teachers reported significantly lower levels of job satisfaction (Iwu, Benedict, & Tengeh 2013). A study by Crickmer (2007) shows that novice teachers in South Africa exhibited an average job satisfaction mean of 3.7 out of 5. The study identified several issues, including workload, colleague support and school management, which received the lowest participant scores. Robinson (2015) recently researched and found that South African new teachers had an average job satisfaction mean of 3.8 out of 5. The study further revealed that the causes of the lowest scores included workload, inadequate experience and insufficient compensation. Teachers may also express discontentment with the absence of job stability, given that they are frequently engaged under temporary contractual arrangements. This circumstance can challenge individuals regarding financial stability and lead to professional discontent (Lumadi 2008).

Novice teachers often experience a feeling of being overwhelmed by the various challenges inherent in their profession, including but not limited to managing large classes, addressing behavioural issues and contending with limited access to teaching materials and tools (Mokoena 2023). Insufficient possibilities for training and development, coupled with the perception among novice teachers that they are ill-equipped to face the demands of teaching and lack ample opportunities for professional growth, are prevalent concerns. Novice teachers regularly have challenges in effectively managing learner misbehaviour, resulting in increased levels of stress and diminished satisfaction (Matla & Xaba 2020). Inexperienced teachers encounter a lack of assistance from school administrators, including limited access to coaching and mentorship.

Additionally, limited access to coaching and mentorship could add to discontentment. Inexperienced teachers frequently experience a lack of support from the education system, leading to isolation and solitude (Reitman & Karge 2019). Obadire and Sinthimule (2021) report that novice teachers face unfavourable working conditions when assigned to schools with substandard facilities, insufficient resources, and elevated violence and criminal activities. Jinot and Madhuree (2020) assert that these circumstances can present challenges in establishing a conducive learning atmosphere for learners. This can also provide challenges in delivering high-quality education to their learners. According to Botha and Hugo (2021), the low job satisfaction of novice teachers in South Africa is a significant problem, as it might result in high teacher turnover rates. The phenomenon above can adversely affect the overall education standard as it necessitates a perpetual cycle of replacing seasoned teachers with inexperienced ones.

■ Methodology

According to Leedy and Ormrod (2019), the concept of research methodology encompasses the many research methods and tools employed in the execution of a study. This section provides an overview of the research design, the target population, and the data collection and analysis methods. Additionally, the researchers address other significant factors, including sampling methods and ethical implications.

■ Research design, strategy and data collection

In the field of hermeneutics or interpretivism, it is crucial to understand the perspectives of the individuals being studied. Consequently, the researcher must obtain a comprehensive understanding of the cultural background of the participants to adequately grasp their unique perspectives and concerns regarding the topic being studied (Hammersley 2022). Therefore, the researchers used this paradigm in this study to develop an overview of the participants' perspectives on the practical elements of novice teachers' experiences. The interpretivism paradigm encompassed a review of whether the curriculum for teacher training provided them with sufficient knowledge of subject matter and SDL skills to overcome challenges in their teaching methods.

A more profound comprehension of how participants construct their realities, evaluate their experiences and assign significance to them was achieved by employing essential qualitative research approaches. The primary objective of basic qualitative research is to investigate the mechanisms through which humans derive meaning from their everyday

lives and circumstances (Merriam & Tisdell 2015). According to Nieuwenhuis (2020), qualitative research focuses on identifying and understanding the social and cultural factors that underlie certain behavioural attitudes. Moreover, the qualitative study aims to investigate enquiries about the complexities of a phenomenon by defining it and understanding it from the viewpoints of the participants engaged in it.

Nieuwenhuis (2020) asserts that qualitative research focuses on understanding the social and cultural contexts underpinning various behavioural beliefs. Furthermore, this research specifically aimed to explore the teachers' lived experiences regarding whether their teacher training curriculum equipped them with the necessary content knowledge and self-directedness to overcome challenges in their teaching practice. Therefore, the researchers followed qualitative-phenomenological research to explore the novice teachers' written reflections about their experiences concerning efficient classroom management, subject knowledge supplied by various higher education teacher training institutions and their perceptions about their SDL.

This chapter's data focus on the reflection data. Qualitative, phenomenological research was performed on the participants' immediate experiences (Leedy & Ormrod 2015) to find out if the current teacher training curriculum prepares novice teachers well enough to be self-directed and with enough content knowledge to gain the understanding they lack to overcome the job demands and to be self-directed in their learning environments.

■ Participant selection

The authors used non-probability purposive sampling and approached novice teachers willing to reflect on a research project with ethical clearance from a South African University's Research Ethics Committee (O1224-20-S2). The sample represents a heterogeneous group of novice teachers (30) who completed their teaching qualifications at a South African University representing different subject areas. Participants completed the reflections anonymously.

■ Trustworthiness of the research

The researchers meticulously followed the prescribed parameters to uphold the study's credibility. To achieve this goal, saving the original transcripts for verification was crucial. Furthermore, the auditable requirement was supported by using verbatim descriptions and direct declarations (Shenton 2004). Moreover, preserving the original transcripts was considered essential for verification. According to Mertler and Charles (2011), the study

maintained methodological consistency for an extended duration to establish dependability. To strengthen the study’s dependability, the researchers thoroughly outlined the methodologies utilised, enabling the replication of the investigation and fostering confidence in the resulting research findings. Mertens (2010) posits that transferability involves the recognition of comparable circumstances that can be utilised as illustrations to showcase the diverse interpretations of data across multiple contexts and viewpoints. To examine the transferability component of qualitative research, the researchers presented a thorough portrayal of the findings, allowing them to determine its applicability in comparable settings. The study’s emphasis on individuals and situations presents difficulties in determining the generalisability of the broader populations and contexts.

■ Data analysis and results

A thematic analysis was employed to analyse the reflection data. Emergent themes and sub-themes were identified within the data to allow the subjective meaning of the participants’ answers to be reflected (Willig & Rogers 2017). ATLAS.ti™ was used to extract the themes and sub-themes. The most meaningful responses to support the identified themes and sub-themes are presented as direct verbatim quotations from the raw data. Inductively, interesting and additional themes and sub-themes that did not directly relate to the two focus points were also identified in the data (Table 4.1).

TABLE 4.1: Categories and themes that emerged from the data.

Themes	Sub-themes
Theme 1: Teachers and self-directed learning	<ul style="list-style-type: none"> • Self-directed learning skills fostered in practice • Self-directed learning behaviours fostered by the BEd curriculum
Theme 2: Teacher perceptions of the BEd curriculum	<ul style="list-style-type: none"> • Theory and practice • Improving the BEd curriculum

Source: Authors’ own work.

Key: BEd, Bachelor of Education.

■ Theme 1: Teachers and self-directed learning

Under theme 1, two sub-themes emerged from the data. Under the first sub-theme, SDL skills only began to be exhibited when the teacher participants had a clear gap in their knowledge and skills regarding their teaching practice. The participants did not report on self-directed skills obtained throughout the BEd curriculum. SDL behaviour, however, was evident in being promoted by the BEd curriculum. Under the second sub-theme, the participants were inclined to resort to autonomously taking over their learning process; they engaged in self-reflection and collaborated with others.

□ Sub-theme: Self-directed learning skills fostered in practice

The participants observed that the BEd curriculum needed to be revised to enable them to continuously grow professionally. The participants indicated that practical teaching enabled them to identify gaps in their knowledge and skills required to improve their teaching practice:

‘It was not the degree that enabled me to identify the gap; it was experience in the classroom that showed the gap which I then researched to try and fill the gap.’ (Participant L)

Based on their practical experiences, the participants identified a lack of knowledge and skills in their teaching practice. Through independent research, they supplemented their self-identified lack of knowledge and skills in their teaching practice:

‘Like I said I continuously research things I don’t know and keep on finding out more on my own.’ (Participant I)

Participants mentioned that learning from more experienced teachers was also an approach to filling the void left by the BEd curriculum. Again, when they were exposed to a practical teaching environment, did they seek human resources to aid in their professional growth?

‘To collaborate with other teachers and adopt good practices from experienced educators.’ (Participant P)

□ Sub-theme: Self-directed learning behaviours fostered

Even though the participants felt that the BEd curriculum did not adequately prepare them for continuous professional development, it provided a foundation for them to fill the gaps in their knowledge and skills required for professional growth:

‘The curriculum gives a good foundation of the basics. I had to learn to adapt and to develop new strategies when I started teaching.’ (Participant M)

Being held accountable during their studies assisted participants in laying the foundation for their self-directed professional growth:

‘The BEd curriculum prepared me to develop and apply strategies for continuous and professional development by holding me, as a student, accountable for my studies and achievement.’ (Participant Y)

Self-reflection was identified as a behaviour fostered by the BEd curriculum through the ability to assess oneself:

‘Our curriculum focused a lot on self-reflection that had become second nature and I do it every day without realising. It really is an asset when teaching otherwise you won’t grow professionally and personally.’ (Participant I)

The BEd curriculum laid the foundation for collaboration by emphasising group work:

‘Working with groups at campus made me realise that I can do better with others.’ (Participant S)

■ Theme 2: Teacher perceptions of the BEd curriculum

Under theme 2, two sub-themes emerged from the data. Under the first sub-theme, the teacher participants highlighted the disparities between the theory of the BEd curriculum and real-world teaching practice. Under the second sub-theme, the teacher participants emphasised that the BEd curriculum is lacking in bridging the gap between real-world teaching practice and theory.

□ Sub-theme: Theory and practice

The participants found it challenging to apply the various teaching and learning strategies taught in the BEd curriculum. The participants felt that the strategies were not realistic in the context of larger class sizes:

‘Strategies taught is for small classes and individual teaching where creative thinking takes place. Not practical as school classes are big in numbers.’ (Participant X)

The core subject curriculum focused more on an academic approach to the content than a pedagogical one, leaving the participants unprepared to teach the content knowledge and skills:

‘My core module classes did not prepare me for my practical teaching sessions as we focused mainly on literature analysis and essay writing but never the actual teaching of the content itself.’ (Participant Y)

The BEd curriculum prepared the participants to apply various resources but did not prepare them to teach without resources. The participants were left unprepared to adapt or produce resources if there were none, ultimately hindering their self-directedness to reach specific teaching goals:

‘At varsity level you get to deal with the most amazing forms of resources. You can use the internet, slide shows, PowerPoints. You have access to one of the best libraries in the country. The resources at varsity level are wonderful. Then you get to a rural school like mine, where there is almost never electricity or water. We have one laptop and one projector to use between 20 teachers. We do not have enough textbooks. No white boards, only chalk boards to use IF there is chalk. Hence, we are trained with the best equipment, instead of being trained to use no equipment. This is a huge issue in South African schools. It is no use to know how to work the internet, but your school does not even have electricity.’ (Participant H)

The administrative tasks of a teacher were identified as a severe deficiency in the BEd curriculum:

‘The course taught you about how to teach the work, but nothing about the other tasks of a teacher. Things like admin, communicating with parents, collaborating with colleagues etc. Managing the different types of learners in your class (especially behaviour and learning challenges) and balancing your workload was not even touched in the degree course.’ (Participant M)

The BEd curriculum was lacking in its approach to addressing different barriers to learning, such as discipline and emotional and physical problems. Participants could, therefore, not ensure an inclusive teaching and learning experience in their classes:

‘Discipline, handling learners with emotional, developmental and physical challenges.’ (Participant 3)

□ Sub-theme: Improving the BEd curriculum

The participants strongly favoured the introduction of more practical teaching as part of the curriculum to address the discrepancies they perceived in the curriculum:

‘Give students more practical experience. Not only to observe, let them set papers, let them mark them, let them discipline classes, do invigilation for exams, sit in hearings etc. They need to know what is happening in schools, not a glittered version.’ (Participant H)

■ Discussion of results

From the responses of the teacher participants, the development of SDL skills during their initial teacher training was not evident. Only when they were placed in practical teaching circumstances in their classrooms did they begin to develop the ability to identify gaps in their existing knowledge and skills of their teaching practice. A significant gap that the participants identified was being left unprepared to work without a lack of resources. These gaps were filled through self-study, a skill that was not directly attributed to their training nor specifically attributed to practical teaching.

Although the participants did not explicitly mention SDL skills not nurtured by the curriculum, they did perceive that their training fostered the positive behaviour of being accountable for their learning and employing self-reflection. Being responsible and liable for one’s professional development indicates individual autonomy. This behaviour is paramount for a self-directed individual to possess attributable to the need for individuals to take the initiative in the learning process (Knowles 1975). In addition, Sosibo (2019) explains that autonomy is central to SDL ascribed to the individual acting on intrinsic motivation to overcome autonomously

identified gaps. Self-reflection is also necessary because it is part of evaluating (Helyer 2015), a skill essential for self-directed teachers to evaluate their teaching (Morris 2019).

The participants noted that their training focused on a multitude of group work, which they credited for making it easier to collaborate with others. Knowles (1975) points out that finding and utilising human resources is a self-directed attribute. Still, the participants' further responses do not indicate a self-directed application of these human resources. The participants noted that they sought guidance from more experienced teachers to learn what they did not know. As Callahan (2016) and Hine and Thai (2018) point out, utilising human resources by relying too much on skilled teachers may not promote self-directedness because novice teachers do not exercise their autonomy, do not take the initiative and do not reflect on their teaching and learning. Overutilising human resources in the form of experienced teachers may lead the participants to not reflect on their teaching and learning when they identify gaps in their knowledge and skills, but only to find solutions from others, not always through their research.

Although it is not always harmful to seek guidance from more experienced teachers, the problem lies in the process needing to be structured and not solely relying on the process to be initiated by the novice teacher. Collaborating between a novice and experienced teacher that scaffolds knowledge and skills is necessary to foster self-directedness within a teacher (Robinson & Persky 2020). The participants were eager to seek help from more experienced teachers. Knowles (1975, p. 18) identifies that 'individuals should take the "initiative", with or without the help of others...'; this 'help' does not refer to doing everything for another individual but assisting with the learning process. The help should thus not be interpreted as doing the work for the novice teacher but as guiding the novice teacher to develop their knowledge and skill, otherwise known as scaffolding (Kicken, Brand-Gruwel & Van Merriënboer 2008; Robinson & Persky 2020). Additionally, this provided 'help' should promote autonomy so that an individual is intrinsically motivated by controlling the learning process and promoting self-directedness (Ferland 2023).

Although collaboration between novice and experienced teachers is highly promoted (Majocha et al. 2017), initial teacher training may be blamed for overburdening experienced teachers owing to not focussing on a more well-rounded initial teacher training. As participants noted, the curriculum focused more on theory and needed to be more practical in their classroom practice. Real-life problems such as weak discipline, physical and emotional barriers, being under-resourced and large classes

requiring more focus on the curriculum leave novice teachers unprepared when they enter schools. The participants wished that the curriculum would not only focus on relevant theory and teaching and learning strategies but also focus on actual real-life teaching contexts, where they could learn how to apply what they have theoretically learned practically. Other than a gap between curriculum theory and teaching practice, the participants also pointed out that they were unprepared for many administrative tasks, including paperwork and dealing with parents.

The participants felt that the BEd curriculum did not fully prepare them to teach. Because SDL skills are not emphasised, it does not prepare them for lifelong professional development. While demonstrating a willingness to enhance their teaching and learning practices, novice teachers encountered a significant deficiency in their SDL endeavours. However, they acquired some abilities through practical teaching experiences. In addition to the lack of school support, inexperienced teachers may not be encouraged to engage in SDL. Instead, they may be expected to adopt an adapt-or-die approach. The lack of preparation for self-directed teachers within the BEd curriculum and schools hinders their ability to effectively incorporate SDL principles into their teaching and learning methodologies (Boser 2017; Fashant et al. 2020; Haiyan et al. 2017; Harrington 2018; Morris 2019; Van Wyk 2017). As Francom (2010) explains, SDL principles are to ensure:

- the level of SDL in activities is equal to a learner's level of self-directedness
- learning gradually becomes more learner-directed
- progress from teacher to learner direction of learning over time
- support in the acquisition of subject matter knowledge and SDL skills together
- self-directed learning skills and subject knowledge are parallelly grown
- learners practice SDL in the context of learning tasks
- contextualisation of SDL within the teaching and learning tasks.

In addition to being unable to incorporate SDL principles, the participants were also left unprepared regarding the content knowledge and skills. This unpreparedness is attributable to them being trained to approach subject content more academically. This unpreparedness left a gap in their ability to teach the subject content. The unsatisfactory feeling of the participants regarding their training in the subject content and skills points to a lack of pedagogical knowledge and skills rather than actual subject content knowledge and skills.

The teacher participants also indicated that the BEd curriculum focused on preparing novice teachers for 'ideal' circumstances rather

than real-world contexts. What can be gathered from the participant responses is that the BEd curriculum focuses on aspects of the 4IR, such as technology and collaboration. Still, it does not prepare them to bring learners to the required level to function effectively in classrooms that incorporate aspects of the 4IR in their teaching. There is no scaffolding to the 4IR knowledge and skills, just a fall-in or fall-out approach in the BEd curriculum.

■ Limitations of the study

The empirical data utilised in this study was collected through open-ended questionnaires in the form of reflections. Despite the explicit instruction for participants to provide detailed explanations in their responses, a subset of participants opted to offer brief answers. While some responses lacked depth, they were nevertheless concise and aligned with the existing body of literature.

■ Recommendations

Recommendations based on the findings can include:

1. *Revise the BEd curriculum:* The study highlights the need to revise the curriculum to better prepare teacher candidates for the demands of real-world teaching. That said, the revision should be focused on SDL skill development in the entire programme. Practical teaching experiences, administrative tasks and strategies should also be incorporated into the curriculum to aid teaching in resource-constrained environments.
2. *Incorporate SDL principles into the BEd curriculum:* Ensure prospective teachers are equipped with the required skills for continuous professional development by integrating SDL principles into the curriculum. In addition, emphasis should be on developing SDL behaviours such as accountability, self-assessment and self-reflection.
3. Provide prospective teachers with more practical teaching experiences, including opportunities to collaborate with colleagues, create lesson plans, discipline students and manage classrooms. The experiences they are exposed to should reflect real-world scenarios to decrease the gap between theory and practice.
4. Enhance the focus on pedagogical knowledge and skills in the BEd curriculum. Teacher candidates should be better prepared to teach subject content effectively, especially in contexts with large class sizes and limited resources.
5. Ensure that prospective teachers are ready and prepared to facilitate learning in environments that promote collaboration and the use of

technology by developing strategies to integrate 4IR elements into teacher education programmes.

6. Schools should provide support and mentoring for novice teachers, emphasising a structured approach to collaboration with experienced educators. Encourage novice teachers to take initiative, reflect on their teaching, and gradually develop self-directedness.

■ Conclusion

This chapter focused on how facilitating SDL among learners by integrating SDL into the BEd curriculum can enhance learner involvement and motivation and improve educational experiences and achievements. The literature points to novice teachers needing more training and preparation for self-direction, leading to frustration and low self-efficacy. In turn, it can lead novice teachers in South Africa to struggle with workload because of a lack of support and inadequate skills and experience in management and leadership. As a result, their job satisfaction is relatively low, which can contribute to high turnover rates in the profession. Based on the empirical evidence, it can be inferred that participants did not acquire SDL skills throughout their initial teacher training. The participants in this study demonstrated the capacity to recognise deficiencies in their knowledge and address them through self-study only after being exposed to real-world teaching scenarios.

Nevertheless, the participants involved in this study acknowledged that the training they received played a significant role in promoting their sense of responsibility for their educational development and the cultivation of self-reflective thinking. These attributes (see also Chapter 3) are considered fundamental components of SDL. The participants also saw that engaging in collaboration with teachers who possess significant expertise proved to be beneficial. The curriculum received criticism for its excessive emphasis on theoretical knowledge and insufficient focus on actual teaching abilities, resulting in novice teachers being inadequately equipped to address real-world difficulties. Overall, the participants felt that the BEd curriculum needed to prepare them to teach adequately or for lifelong professional development. The need for SDL skills in the BEd curriculum and schools creates a gap in preparing effective teachers who can integrate SDL principles into their teaching methodologies.

In conclusion, the journeying of 'Bridging the gap: Nurturing self-directedness in higher education teacher training and teachers' job demands' has accentuated the fundamental role of nurturing self-directedness in the professional development of educators. As we move to our next chapter, 'Improving academic success: Cultivating self-directed learning to address

procrastination in higher distance education', it becomes evident that SDL extends beyond teacher training to influence students' academic success in higher distance education directly. This seamless joining between empowering educators and enhancing student self-directedness sets the stage for a comprehensive discussion on strategies to cultivate SDL and tackle procrastination, ultimately contributing to a more effective and engaging educational landscape.

■ Ethical clearance number

The ethical clearance number for this study is NWU-01218-20-A2.

Improving academic success: Cultivating self-directed learning to address procrastination in higher distance education

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■ Abstract

Academic procrastination, i.e., the irrational delay of important academic tasks, is a potentially harmful behaviour that is highly prevalent in higher education (HE), especially distance education (DE). Given the wide range of adverse outcomes, including mood, well-being and academic performance, interventions might benefit many students. In this chapter, we presented a framework that is aimed at reducing academic procrastination. It consists of a conceptual framework based on a theoretical foundation. We detailed how various concepts related to academic procrastination are linked, the crucial role that self-directed learning (SDL) can play, which intervention strategies have the highest potential and what the associated predictive models should encompass. The framework's components are showcased through a *use case*³, namely, a Java programming course. The chapter concludes with an outlook on future research that is necessary to lay the foundation for implementing this framework.

■ Introduction

The preceding chapter focused on incorporating self-directed learning (SDL) strategies into higher education (HE) teacher training. This chapter aimed to promote academic success through the implementation of SDL in distance HE to address procrastination. These two chapters are linked in the sense that SDL is the overarching theme with the intention to employ SDL to improve teaching and learning experiences while addressing academic challenges. That said, *procrastination* is commonly conceptualised as the irrational delay of important tasks (cf. Steel 2007) and is a frequently encountered phenomenon that affects many situations in daily life. While procrastination is common in educational settings (academic procrastination in this case), it is prevalent among students in HE, particularly in distance education (DE) (Rahimi & Hall 2021; Svartdal 2017).

Importantly, procrastination cannot be blamed on intellectual differences between people who do and people who do not delay doing their tasks. As Steel (2007) points out, procrastinators typically realise the irrational nature of their behaviour. Instead, procrastination is thought to result from interpersonal differences in self-regulation, motivation and organisational skills (Rahimi & Hall 2021; Steel et al. 2018; Wolters, Won & Hussain 2017).

3. A *use case* is a concept that shows how a system can be used to achieve a certain goal, using a selected scenario. In this context, the system is our framework, the goal is providing interventions to foster SDL and reduce procrastination, and the programming course serves as the scenario.

Some approaches also suggest that personality traits are contributing factors, such as perfectionism and the personality characteristics associated with the Dark Triad (cf. Lyons & Rice 2014), while others highlight situational factors, such as the characteristics of the task at hand. In this context, self-regulation is a metacognitive skill that refers to monitoring, manipulating and improving one's learning, e.g., selecting and implementing appropriate learning strategies. Procrastination is strongly associated with self-regulatory issues, with some authors even defining it as a 'self-regulatory failure' (Sirois & Pychyl 2013), e.g., a lack of inhibition capability, which means that procrastinators have trouble regulating their thoughts, impulses, behaviour and emotions. This is linked to low conscientiousness, high impulsivity, thought control issues and impaired mood regulation (Gustavson et al. 2014; Rebetz, Rochat & Van der Linden 2015).

Procrastination is also thought to be a motivational issue because of its association with low self-efficacy (i.e. students believing that they have the necessary capability or knowledge to complete their tasks), task aversiveness (i.e. a strong dislike of certain types of tasks), a lack of personal value of certain tasks, unclear or distant deadlines (i.e. reducing the perceived urgency of tasks), inability to delay gratification and a general lack of motivation (Grunschel, Patrzek & Fries 2013; Rebetz et al. 2015). Moreover, procrastination is linked to insufficient time and effort management skills (Hailikari, Katajavuori & Asikainen 2021). Procrastinators typically struggle with setting, prioritising and pursuing goals (e.g. Wang et al. 2021). Further reasons for this type of behaviour include fear of failure (i.e. students prefer to avoid tasks that they are afraid of as a consequence of low self-efficacy, for example); self-handicapping strategies (i.e. students sabotaging themselves so that they can attribute poor performances to their lack of effort, rather than an intellectual deficit, which preserves their self-worth) (cf. Schwinger et al. 2014); psychological reactance, which means a preference for options that are not available anymore (cf. Malatincová 2015); or decision paralysis (Shaffer & Kazerouni 2021).

Unsurprisingly, procrastination can lead to various adverse outcomes, including unsatisfying performance, reduced mood, feelings of guilt and regret, increased stress, lower well-being and a higher risk of academic dropout (Bäulke, Eckerlein & Dresel 2018; Grunschel et al. 2016; Oflazian & Borders 2023). Given how common and potentially career-damaging procrastination is – especially in the long term – it is crucial to find ways to counteract it. One way to counter dilatory tendencies is to use SDL skills such as self-monitoring and self-management. Self-directed learning means that students take charge of their learning process, as per the definition of Knowles (1975) provided in Chapter 1. As procrastination is

often conceptualised as self-regulation failure (as explained above), which means that students fail to monitor or improve their learning skills effectively, fostering SDL skills could be a viable countermeasure (Nemati, Shomal Oskoei & Saberi 2023; Schommer-Aikins & Easter 2018). It is suggested that students could improve their self-regulation and time management by increasing their self-directedness and thus decrease the risk of procrastinating in terms of their academic tasks. One reason procrastination is so common in DE is that this type of learning context requires students to have a high level of responsibility, persistence, attention and diligence (Klingsieck et al. 2012; You 2015). Instead of an educator taking responsibility for structuring the students' time schedules and workload in the classroom, DE relies on students handling their workload and time management by themselves (You 2015). In other words, it requires proficient use of SDL skills.

This chapter presents our conceptual framework for future studies on interventions to reduce procrastination in DE by fostering SDL skills. It is envisioned as a cyclical process: we predict procrastination via measurement of SDL, which forms the basis for interventions aimed at promoting SDL skills and targeting the reasons behind procrastination, in order to reduce procrastination, followed by another prediction at a later point in time, which starts the cycle anew. This conceptual framework is based on a theoretical foundation, which is another important aspect of this chapter. The theoretical foundation is based on current empirical research that showcases the relationship between procrastination, strategic delay, self-efficacy, self-regulation and SDL and highlights our findings in this field (Imhof, Bergamin & McGarrity 2021; Imhof et al. 2022). The theoretical foundation thus explains how the relevant variables are connected, while the conceptual framework entails a cyclical process that is used to predict procrastination and provide interventions to foster SDL.

As the envisioned interventions will be provided within a learning management system (LMS) in a fast and scalable manner – be it semi-automated or fully automated – accurate predictions will be necessary, which machine learning (ML) models can provide. To illustrate the framework, we present a Java programming course as a *use case* and detail what kind of interventions could be provided in LMSs that are frequently used in DE. We also highlight our computational approach, which is based on prior research in this field (Imhof et al. 2021, 2022). The remainder of this chapter is organised into five sections. Firstly, we present our *use case* in detail and then explain our theoretical foundation. We then present the conceptual framework and discuss what intervention strategies could be employed as part of our envisioned predictive models. We end the chapter by providing an outlook on future research and our conclusions.

■ Use case: Java programming course

This section presents our *use case* in detail: a Java programming course at the Swiss Distance University of Applied Sciences (FFHS). The 5-ECTS course, Java – Fundamentals, is a Computer Science bachelor programme module. It comprises five thematic blocks and uses a blended learning approach, so students learn partly independently in their spare time and partly through face-to-face lessons, either online or on campus. The ratio of self-paced learning to face-to-face lessons is 4:1. The latter are usually delivered on Saturdays or Monday evenings, as this suits most students at the FFHS, who have part-time or full-time jobs and cannot attend more classes in person. Each lesson is a repetition and extension of the content taught on Moodle's LMS, but mostly it provides an opportunity for theoretical exercises and programming tasks and projects. The course follows a flipped classroom approach: before each lesson, students are expected to read book chapters with theoretical content about Java (syntax, data, expressions, classes, objects, conditionals, loops, object-oriented designs, inheritance, polymorphisms, exceptions, recursions and collections), solve quizzes to check their current knowledge and keep track of their progress, and solve programming tasks to prepare for the lesson. The programming exercises are a mixture of mandatory exercises and voluntary bonus tasks. After solving more exercises during the lesson, the students complete the remaining uncompleted tasks at home. At the end of the course, which takes an entire semester (i.e. August to December), the students write a final exam, which accounts for 70% of the final grade; 12% of the grade is allotted to pop quizzes, another 12% is for the programming exercises submitted and the final 6% is for the presentation of exercises.

We chose this course because learning programming languages is a unique challenge for people who tend to procrastinate. The immediate error messages of the interpreter when trying to programme (even for the most minor errors) can cause frustration, which has a negative effect on self-efficacy and thus encourages further procrastination for people who respond strongly to negative feedback. Frustration is one of the most common emotions experienced by programming novices (Bosch, D'Mello & Mills 2013). In our experience, this affects many programming beginners in an introductory academic course. Procrastination manifests mainly in the affected students not practising enough, as they cannot cope with the negative feedback provided by the interpreter and thus regularly miss achieving the learning objectives. Acquiring programming skills requires practice through independent writing of code and dealing with interpreter feedback (Häberlein & Häberlein-Klumpner 2017). This process is comparable to learning a natural language: only by applying and speaking

the language is proper acquisition possible. Moreover, many students fear learning programming languages because they believe programming is complex and demands much mental effort (Yassine et al. 2017). This often leads to dissatisfactory outcomes (Shaffer & Kazerouni 2021). When designing interventions to address this issue, attention needs to be paid to aspects of the learning experience that may influence the success of these interventions. These aspects include the reasons for the delay in attending to coding assignments (such as task aversiveness, programming anxiety or lack of personal relevancy), task-specific characteristics (such as perceived or actual difficulty) and institutional or environmental conditions. These factors and other considerations are explored in the next section.

■ Theoretical foundation

In this section, we provide the theoretical underpinnings of our conceptual intervention framework by highlighting prior research on procrastination, including the differences between procrastination and other types of dilatory behaviour (such as strategic delay), and how it relates to SDL. This section also provides an overview of current empirical findings on the links between procrastination and SDL and other relevant learning concepts, such as academic self-efficacy. The section further details how SDL can be measured, which includes an overview of commonly used SDL questionnaires and their advantages and disadvantages. We further point out which contextual factors for dilatory behaviour matter the most in DE, be they on a personal or an institutional level.

Given the negative consequences commonly associated with procrastination, thinking that delaying tasks is inevitably maladaptive would be tempting. However, multiple authors have suggested that a positive, productive counterpart to procrastination exists. While seemingly very similar on the surface, this behaviour does not result in negative consequences. This type of dilatory behaviour was originally known as *active procrastination* (Chu & Choi 2005), and it is distinguished from damaging, 'passive' procrastination. As this is arguably an oxymoron (as procrastination is often harmful) (cf. Chowdhury & Pychyl 2018), other terms have gained favour. These include *active delay* (Corkin, Yu & Lindt 2011), *purposeful delay* (Grunschel et al. 2013) and *strategic delay* (Klingsieck 2013). We will use the term *strategic delay* for the remainder of this chapter, as this term best reflects what sets the concept apart from procrastination for our purposes.

Strategic delay differs from procrastination in multiple ways but also shares some similarities. As Klingsieck (2013) notes, both are acts of delay. There is an intention to begin or to complete a task, the task at hand is of personal importance or otherwise necessary, and the delay happens

voluntarily in both cases, i.e., there is no outside circumstance that necessitates a delay. The differences between *procrastination* and *strategic delay* are indicated by aspects unique to each behaviour. *Procrastination* is characterised by the irrationality of the behaviour (as procrastinators delay attending to tasks despite being fully aware of the consequences) and subjective discomfort, among other negative consequences. *Strategic delay* is characterised by a preference to work under pressure, i.e., strategic delayers purposefully increase pressure on themselves, as they need it to be adequately motivated; the ability to meet deadlines; higher levels of satisfaction; and intentionality of the decision. Strategic delay may also involve prioritising other tasks, collecting more information before working on a task, attaining a state of cognitive flow and learning efficiently by maximising performance while minimising effort (Kim & Seo 2013; Klingsieck 2013).

This distinction is part of the theoretical foundation because interventions should consider whether an act of delay can be classified as procrastination or strategic delay. As strategic delay does not lead to adverse outcomes, interventions would be pointless at best and counterproductive at worst. After all, providing students with interventions they do not need is not only a waste of resources but may also overload and confuse them with superfluous information, which could potentially result in lower performance.

Another crucial distinction between the two types of dilatory behaviour is the level of self-efficacy. *Self-efficacy* is an individual's belief in their capability to perform a task successfully (Bandura 1977). Academic self-efficacy is central to procrastination, as selecting appropriate strategies is crucial when beginning and completing tasks (cf. Wäschle et al. 2014). Low academic self-efficacy means that students are not confident about their metacognitive skills and are thus more prone to avoid their responsibilities (thus to procrastinate), while students with high academic self-efficacy choose successful strategies, which may involve strategic delay. Increased self-efficacy is also associated with higher motivation and persistence (Moreira-Fontán et al. 2019). Moreover, research has shown that procrastination is negatively related to self-efficacy and positively related to strategic delay (Chowdhury & Pychyl 2018; Corkin et al. 2011). Unsurprisingly, procrastination and strategic delay are negatively linked (Corkin et al. 2011). The relationship can also be thought of as a vicious and virtuous circle. As Wäschle et al. (2014) note, students with low self-efficacy may fall into a vicious circle of procrastination because they view tasks as aversive and are thus less likely to engage with them. This decreases the chances of success, increases the likelihood of avoiding such tasks in the future and further decreases self-efficacy (Wäschle et al. 2014). However, a virtuous circle also works in the other direction: high self-efficacy increases

motivation, which makes the successful application of learning strategies more likely and increases self-efficacy again.

Self-efficacy is not the only academic concept that is strongly tied to procrastination and other types of dilatory behaviour. Another crucial factor is *self-regulation*, which is often considered a core aspect of procrastination as a concept, as evidenced by the conceptualisation of procrastination as a 'self-regulatory failure' (Sirois & Pychyl 2013). Most models of self-regulation involve three core components that interact with each other (Wagner & Heatherton 2014), i.e., an intended state, monitoring and regulation. The intended state can be a goal or a set of standards, e.g., finishing a course or learning regularly. Monitoring refers to awareness of one's action, comparing it to the intended state and setting off an alarm if the current action no longer aligns with the desired goal. To solve this conflict, the third component of regulation comes into play by inhibiting the competing impulses. Alternatively, self-regulation can be considered a set of learnable skills: setting goals, creating strategies, managing time effectively, monitoring and evaluating progress, acknowledging the cause of the results and developing future goals (Schunk & Zimmerman 2023). A failure of self-regulatory processes can then be triggered by negative emotions (cf. Villavicencio & Bernardo 2013): students may experience fear of failure or have other negative feelings about their tasks (task aversiveness) and cope with these emotions by avoiding the stimulus – in this case a task – by procrastinating.

Self-regulation is also an essential skill involved in a popular learning concept, namely, SDL. The definition of SDL provided in Chapter 1 emphasises a learner's autonomy, responsibility and initiative in the learning process. Self-directed learning also involves learner characteristics (see Chapter 2), such as self-efficacy and motivation (Saeid & Eslaminejad 2017). The proactive stance taken by self-directed learners to take initiative in their learning process can assist in promoting self-efficacy (Murniati, Hartono & Nugroho 2022). Other cornerstones of SDL include self-monitoring, self-management, evaluation and regulation of the student's learning (Zhu, Bonk & Doo 2020). Self-regulation is one of the primary dimensions of SDL, besides motivation and metacognition (Mentz & Van Zyl 2018). Thus, based on the research presented above, procrastination is closely associated with self-regulation, self-efficacy, motivation and SDL. Prior research has shown that SDL is negatively linked to procrastination (Nemati et al. 2023; Schommer-Aikins & Easter 2018) and positively linked to self-efficacy (Saeid & Eslaminejad 2017). Given these strong links, it appears to be a viable strategy to combat procrastination by promoting and fostering SDL.

As our conceptual framework is at least semi-automated, the relevant concepts need to be assessed efficiently and need to be scalable (rather than interviews or observations). While LMSs allow log data analysis, analysis of learning concepts such as self-efficacy, self-regulation and SDL relies on subjective data and is usually measured with a questionnaire. Several questionnaires have been developed to measure SDL skills, perceptions and tendencies, i.e., the Self-Directed Learning Readiness Scale (SDLRS) (Guglielmino 1977), the Self-Rating Scale of Self-Directed Learning (SRSSDL) (Williamson 2007), the Self-Directed Learning Instrument (SDLI) (Cheng et al. 2010), the Self-Directed Learning Aptitude Scale (SDLAS) (Abd-El-Fattah 2010) and the Self-Directed Learning Scale (SDLS) (Lounsbury et al. 2009).

Guglielmino developed the SDLRS to assess university students' readiness and attitudes towards SDL. The original version consisted of 41 items (Hoban et al. 2005), and the later version consisted of 57 items, with eight dimensions of the SDLRS being established, namely, openness to learning opportunities, creativity, ability to use basic study skills, problem-solving skills, positive orientation to the future, self-concept as an effective learner and love of learning (Cadorin, Bressan & Palese 2017). The SDLRS was not only used extensively but was also criticised, particularly regarding its validity in measuring SDL readiness (Hoban et al. 2005). Further criticism reported a factor comprising mainly reverse-scored items (Chen & Fan 2023).

The SRSSDL was developed and validated by Williamson (2007) in a study that focused on nursing students. The 60-item questionnaire revealed five dimensions: awareness, learning strategies, learning activities, evaluation and interpersonal skills (Liu et al. 2023). The SRSSDL provides a thorough construct to measure students' SDL skills (Alotaibi & Alanazi 2021). The SRSSDL has been used worldwide in several research papers that have indicated that it helps measure students' SDL skills, is relevant for multidisciplinary contexts and facilitates students' active engagement in learning (Williamson 2017).

The SDLI was also developed and validated among nursing students by Cheng et al. (2010). The 20-item instrument established four SDL dimensions: motivation, self-monitoring, planning and execution, and interpersonal relationships (Cadorin et al. 2017). It demonstrated high internal consistency with a Cronbach's alpha, $\alpha = 0.916$ (Cadorin et al. 2017). *Cronbach's alpha* is a common measure of internal consistency that indicates the extent to which the scale items are consistent. The closer the value is to 1, the more consistent the scale is.

The SDLAS was developed to measure undergraduate students' SDL ability and comprises 26 Likert-scale items. The dimensions of self-management, motivation and self-monitoring were established. The internal consistency for the different dimensions was good: $\alpha = 0.82$ for self-management; $\alpha = 0.84$ for motivation; and $\alpha = 0.86$ for self-monitoring (Abd-El-Fattah 2010).

These instruments are well established, but all share the drawback of having more than 20 items, which is quite time-consuming for students to fill in, especially if multiple rounds of measurement are necessary. A shorter alternative was created by Lounsbury et al. (2009) - the SDLS. It has only 10 items, which all load on the same factor and assess a student's capacity to learn without relying on others, e.g., finding the solution to a problem without having it spoon-fed beforehand. In our study (Imhof et al. 2021), we implemented the SDLS in a predictive model and obtained an internal consistency of $\alpha = 0.81$. Each questionnaire has a role to play as determined by the context and goals of the study. By administering a questionnaire that measures students' SDL abilities and tendencies, valuable insight can be gained into students' readiness and predisposition to take responsibility for their learning process. Results from such a questionnaire could shed light on how SDL might mitigate or exacerbate a student's procrastination tendencies.

Delay can be measured in multiple ways as well. While dilatory behaviour - whether maladaptive (like procrastination) or purposeful (like strategic delay) - can easily be assessed via log data, the subjective component requires other approaches. Measuring procrastination requires distinguishing between trait and state as the two are correlated, but only on a moderate level (0.59) (cf. Krause & Freund 2014). It is still highly debated whether procrastination is primarily a personality trait (as evidenced by its stability across time and different situations) (Steel 2007) or more dependent on contextual factors, such as task characteristics (Hoppe, Prokop & Rau 2018; Nordby, Klingsieck & Svartdal 2017). While procrastination is stable, Malatincová (2015) also notes that it is necessary to distinguish between the subjective experience of procrastination and the actual delay, as they are not the same and may even be different constructs altogether.

In order to minimise the effort on the student's part, the analysis of behaviour should take precedence over assessing questionnaire data whenever possible. Our research (Imhof et al. 2021, 2022) shows that predicting delay using log data (predicting behaviour with behaviour) also yields better results than when using trait variables as predictors. However, measuring SDL currently still requires the use of questionnaires. While some

results have been reported to suggest that learning concepts such as time management skills (Park et al. 2018) and self-regulation (Li, Baker & Warschauer 2020) can be approximated by analysing clickstream patterns as indicators, this still requires more research. Thus, questionnaires still need to be included in our framework for now.

Apart from all the personal factors discussed thus far, environmental and contextual factors can also help explain procrastination and other types of dilatory behaviour. As Nordby et al. (2017) point out, these factors have received much less attention in research than personal factors. They include the educator's organisation (Corkin et al. 2014), setting strict deadlines (Bisin & Hyndman 2020), the previously mentioned task aversiveness, task difficulty (Hebing 2016) and peer effects (e.g. wrong role models) (cf. Nordby et al. 2017). In our study (Imhof et al. 2021), one of the strongest predictors of delay was the type of deadline, specifically whether the deadline was communicated (i.e. a specific day and time were indicated on Moodle) or left vague (i.e. only a relative deadline was provided, such as 'two weeks after the next face-to-face lesson'). The assignments with clear deadlines were far less likely to be delayed than the more vaguely defined deadlines. Assignments with unclear deadlines may be perceived as more distant than they actually are, which reduces the perceived urgency to complete them and thus increases the probability of delay (Huang et al. 2021).

■ Conceptual framework

This section provides more details about the conceptual framework, particularly the adaptive model, and what kinds of interventions could be provided, again in general and explicitly targeting our programming *use case*. We discuss which interventions are particularly suitable for addressing specific reasons for procrastination and what role SDL plays in the intervention approaches. We also briefly touch upon the distinction between fully automated and semi-automated interventions, and the implications of these interventions for educators and students.

Our conceptual framework could be automated within an LMS by implementing an adaptive learning system consisting of three components: the domain model, the learner model and the adaptive model (Vagale & Niedrite 2012). *Adaptive learning systems* are technical solutions that allow learning content and presentation modes to be adapted to the needs of individual students (Adams Becker et al. 2018; Imhof et al. 2020). As these systems allow for more flexibility than other approaches, they have the potential to foster SDL (cf. Zainuddin & Perera 2018). Instead of providing all students with the same content or presentation mode,

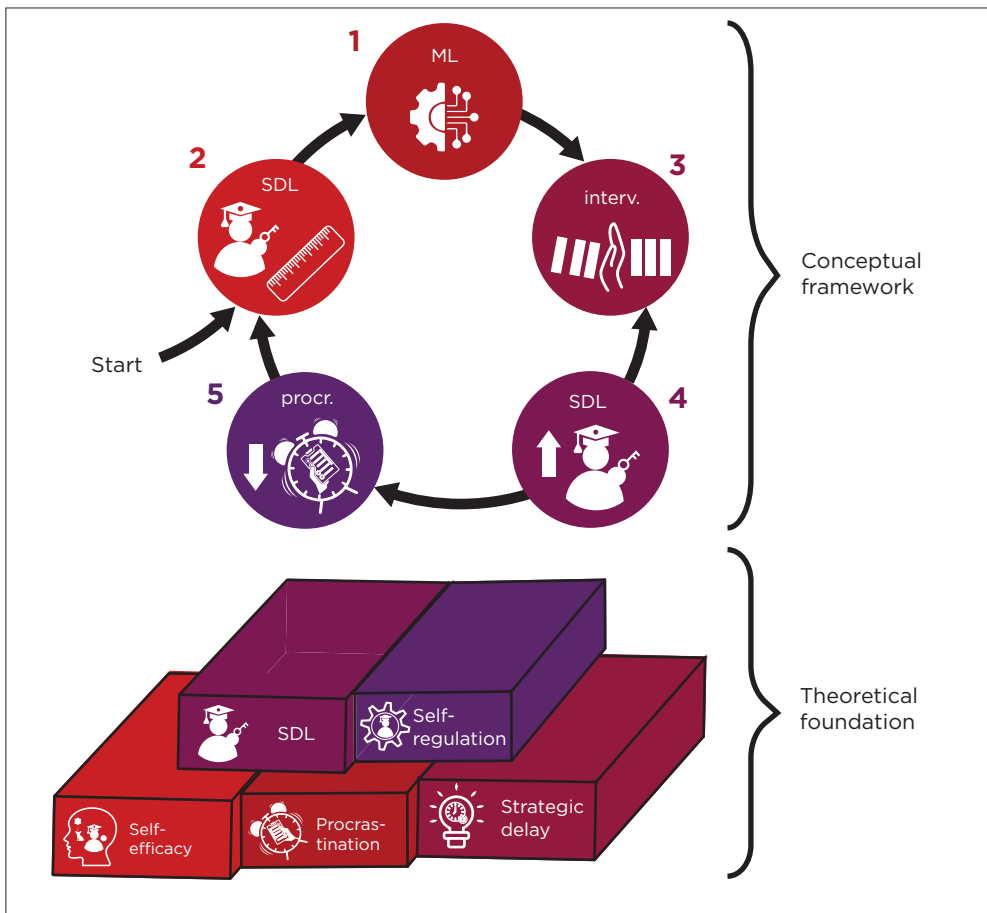
adaptive systems identify specific characteristics of individual students and their needs and react accordingly by changing aspects of the learning experience on the platform. This adaptation is achieved by having the three components interact: the learner model represents each student, assesses pre-defined traits via sensors and then processes the data via the so-called learner modeller. These traits could include abilities, knowledge (e.g. based on test or quiz scores), personality traits (e.g. diligence based on log data) or preferences (e.g. based on click distributions). The domain model contains the learning content of the course and details how it is structured (e.g. how different tasks and files are connected), as well as what the intended learning outcomes are. The domain model also details the granularity of the adaptation, meaning the level at which adaptations are supposed to happen (on a step level, task level or curriculum level). The third model (the adaptive model) absorbs information from both of the other models and decides if and how to adapt the objects of adaptation, based on whether certain conditions are met. These objects can be the content, instructions, mode of presentation, learning paths or, in our case, interventions.

If applied to our *use case*, the procedure could be (see Figure 5.1):

- Step 1: Firstly, the learner model sensors assess the SDL level for the individual student, based on questionnaire scores (as explained in the previous section). Measuring SDL is crucial, as being self-directed is essential for success in an adaptive learning system (Forsyth et al. 2019). Our proposed approach involves a concise SDL scale, such as the SDLS, to prevent students from becoming disengaged because of the extensive use of questionnaires. In combination with log data, which could also be derived from historical data from previous semesters, a representation of the student is created if available.
- Step 2: Based on ML algorithms, as will be explained in the following section, the system then automatically predicts the probability of each student delaying the submission of their next programming tasks, which is also entered into the learner model as an additional facet. Ideally, this will include contextual data to indicate the likely reason for procrastinating, e.g., fear of failure, as this has implications for subsequent interventions.
- Step 3: Once enough information is collected, the system will provide an intervention that could be fully automated or semi-automated.
- Step 4: After receiving the intervention, the system will measure SDL again and then update the learner model. If the interventions are successful, SDL should be improved compared to the first measurement taken in step 1. As this entails multiple rounds of SDL measurements, short questionnaires are advisable, as noted before.

- Step 5: Procrastination (or delay) will then be measured, e.g., by assessing whether students delay their programming tasks. Dilatory behaviour is expected to be reduced, which increases the chances of academic success.
- Step 6: The adaptive model will decide if another intervention is necessary and continue the cycle by starting with step 1 again.

As indicated in the previous section, this framework rests on a theoretical foundation. Adaptive learning environments have previously successfully been used in computer science (Gasparinatou & Grigoriadou 2015) and programming courses (Ling & Chiang 2022; Troussas, Krouska & Sgouropoulou 2020), but there is also some mixed evidence. Toth, Rosenthal



Source: Authors' own work.

Key: ML, machine learning; interv., intervention; SDL, self-directed learning; procr., procrastination.

FIGURE 5.1: Graphical depiction of the conceptual framework and its theoretical foundation.

and Pate (2021), for instance, investigated the effects of an adaptive learning system on SDL in the context of pharmaceutical education and found that time management and procrastination actually worsened after the introduction of that system. The authors note that careful consideration needs to be given to training and supporting students so they become more proficient in their SDL skills.

In terms of intervention strategies for procrastination, Van Eerde and Klingsieck (2018) conducted a meta-analysis and analysed the results of 24 studies following four different approaches: self-regulatory skills (e.g. time management); cognitive behavioural therapy (CBT); other therapeutic approaches; and resource-based interventions. Cognitive behavioural therapy-based interventions yielded the best effect, which is thought to be an effect of the intensity of this type of intervention, i.e., a therapeutic approach. Notably, the meta-analysis also revealed that improving time management skills alone may not be enough to overcome procrastination, as this approach alone fails to address underlying emotional issues, such as fear of failure, which may be a critical driving force of procrastination for a substantial number of students, especially in a programming course. Despite being successful, these interventions have many drawbacks. They are intense, time-consuming and beyond the skillset of most educators, so applying them to DE (e.g. adaptive learning systems) is an additional challenge that should not be ignored. Furthermore, intentions often fail to translate into actual behaviour, especially when tempting alternatives (such as social media access) are present, or students fall into habits (Hen & Goroshit 2020), which is a common issue in procrastination.

As the choice of intervention should depend on the reasons behind the behaviour and the type of delay (Van Eerde & Klingsieck 2018), intervention approaches should rely on more than one strategy. Students who delay tasks, because they are afraid of them, might benefit from psychoeducational measures, e.g., by giving them helpful information about how to fight programming anxiety and increase their self-efficacy. While psychoeducation is often a part of psychotherapy, it can also be provided as an online self-help intervention. For instance, Brog et al. (2022) recently investigated the effectiveness of ROCO (resilience and optimism during COVID-19), which is an intervention that is aimed at reducing psychological distress experienced during the recent pandemic. The intervention consisted of six thematic modules, each containing brief texts, videos, illustrations, exercises and weekly tasks that address emotion regulation skills. While the intervention did not reduce symptoms of depression successfully, it did lead to a significant increase in emotion regulation skills and resilience. A similar intervention could benefit SDL and procrastination, as emotion regulation is a key element of self-regulatory failure (Wagner & Heatherton 2014).

By increasing emotion regulation, which is a type of self-regulation, the negative impact of emotions on the learning process could be prevented, which would affect SDL and procrastination positively (cf. Peistaraitė & Clark 2020, who found a positive effect on a similar learning concept, namely, self-regulated learning [SRL]).

Students with suboptimal time management skills (and thus a lack of SDL skills) may appreciate a prompting system, e.g., a system that reminds them that they have not coded in a while or that a deadline for an upcoming assignment is approaching. Programming anxiety can be counteracted by providing students with a countdown timer, which increases the sense of urgency and focus on the task at hand, and this has reportedly influenced students, according to other researchers (Aban & Fontanil 2015; Olipas & Luciano 2020). Introducing such a timer is also a viable strategy from an SDL perspective, as an acute awareness of a tight schedule requires students to self-monitor more and to utilise appropriate, efficient strategies to solve the task promptly. A different approach was followed by Shaffer and Kazerouni (2021), who conducted a quasi-experiment wherein they investigated the effect of a milestone-based treatment on project and course outcomes in a Java course. They found that students in the treatment group, who were tasked with completing four milestones with deadlines set by the course instructor, procrastinated less and achieved better results than their peers in the control group that had no such milestones. Shaffer and Kazerouni (2021) then argued that segmenting an immense task into more manageable chunks should reduce the many self-regulatory issues that programming novices face.

Another promising strategy is to implement gamification elements in non-gaming environments. In a recent study, Palaniappan and Noor (2022) introduced gamification elements into a Python programming course on Moodle by awarding badges and displaying rankings on a leaderboard. As their results show, this intervention had a positive impact on students' academic performance and their level of self-directedness. Self-management, motivation and self-monitoring all increased after the intervention. Neumann et al. (2021) presented an additional intriguing approach using chatbots to support self-study, with promising results having been obtained.

Some students may engage in procrastination because of their aversion to specific tasks. However, these students may be more motivated if they are presented with the same assignment in an alternative format or if the task is contextualised in a way that aligns with their preferences or experiences (see Van Vorst & Aydogmus 2021). For example, a programming assignment could be reframed to match the student's interests. Adapting these elements to the preferences of individual students is possible in

adaptive learning systems, but this requires the selection of relevant student characteristics for the learner model and additional effort in terms of instructional design, as many different versions of the same task would have to be designed. Evidence suggests that providing content on an adaptive learning system can foster SDL on its own, without further interventions (e.g. Toth et al. 2021). Despite the negative impact on procrastination as outlined above, Toth et al. (2021) found that some students' SDL scores improved after implementing an adaptive system. Although the authors could not conclude that introducing the adaptive system improved SDL overall, they found positive effects for some factors, such as improved examination and stress management.

Another way to foster SDL in an adaptive learning system is via adaptive scaffolding, which has been proposed to support students who may struggle with the metacognitive demands of SDL. After all, thinking about their learning strategies, planning ahead, processing incoming information, adjusting their approaches and monitoring their progress may be overwhelming to some students. The idea behind scaffolding is to provide support that will gradually fade away as the students' competencies increase (cf. Noroozi et al. 2018). For example, Ley, Kump and Gerdenitsch (2010) developed a system that recommended various learning goals to their students in three conditions. In the fixed scaffolding condition, the goals were retrieved from the domain model; in the personalised scaffolding condition, the recommendations were ranked according to the learner model; and in the control condition, the learning goals were recommended randomly. Their results showed that students in either experimental condition performed better than those in the control condition and reported that they felt more supported.

These interventions do not have to be forced on every student; instead, they could be offered as suggestions or recommendations. The flexibility that adaptive systems grant educators also aligns with one of the major tenets of SDL, namely, letting students take charge of their learning progress. This is crucial in order not to alienate students and to account for false predictions that can result. As pointed out, strategic delayers do not need interventions and might perform worse if provided with too much unnecessary information. This highlights the need for accurate predictions within the adaptive system, which increases trust among students and educators. As highlighted by researchers, trust, acceptance and understandability of the mechanisms behind adaptive learning systems are essential for developing these systems further and adopting them in educational contexts (Alamri et al. 2019; Cavanagh et al. 2020).

A related point of discussion with educational implications is whether the intervention should be provided semi-automated or fully automated.

A fully automated intervention means that no input from educators is needed. Instead, the adaptive system autonomously provides interventions, e.g., prompts, recommendations, personalised instructions and scaffolding. However, this does not imply that educators have no way of intervening. They would still be able to monitor the provision of interventions and step in if necessary. While full automation has not yet been implemented in any scalable capacity in the field, it might be an exciting prospect in the coming years.

The main issue is again the high level of accuracy that this endeavour would require and perhaps also a lack of trust among students. Educators might also fear they are being replaced, which should be avoided. With a semi-automated system, the educator would still play a significant role by being notified of the system's prediction, upon which they could decide to act. In this case, the educator acts as a mediator between the system and the student, which mitigates the risk of wrong predictions interfering with the student's learning process. It is also debatable whether a false positive (falsely warning a student about their predicted delay) or a false negative (not warning a student about delaying their assignment) is worse, which has implications for the adaptive model. Depending on which of the two errors is considered more harmful, the model will be cautious with its predictions.

■ Prediction models

As our framework aims to provide SDL-based interventions (such as prompts, scaffolding, reframed tasks, psychoeducational elements and recommendations, as outlined above) on an LMS, specifically as part of an adaptive system, we must rely on accurate predictions to ascertain whether students require intervention. After all, many students do not procrastinate or delay tasks strategically and productively, e.g., because they prefer to work under time pressure (Klingsieck 2013). Providing these students with the same SDL-based interventions as actual procrastinators could prove counterproductive, as it may alienate them or increase their cognitive load unnecessarily. As strategic delayers are successful in their endeavours (Klingsieck 2013), there is little need for any intervention in the first place. For this reason, our approach needs appropriate ML models that can deliver accurate predictions in a scalable and efficient manner, preferably in real-time. This section explores the prerequisites, characteristics, merits and drawbacks of these ML models.

To determine what models could be implemented to predict dilatory behaviour, we conducted a study (Imhof et al. 2022) in which we compared the predictive performance of multiple ML models based on data collected during another procrastination study (Imhof et al. 2021). The aim was to

determine the algorithms that yielded minimal errors between the values for predicted and actual delays in submitting mandatory online assignments. The delay was operationalised as the temporal difference between the submission of an assignment and the deadline, as defined by the educators or course developers. As we used both objective and subjective predictors, we ended up comparing our selection of ML algorithms (Naïve Bayes, K-Nearest Neighbours, Radial Basis Function Networks, Feed-Forward Neural Networks, Regression Trees, Gradient Boosting Machines, Random Forests, Support Vector Machines, Bayesian multilevel models as a baseline) for different sets of predictors: only subjective predictors (i.e. questionnaire scores), only objective predictors (i.e. log data indicators) and all predictors combined. Procrastination (trait), strategic delay (trait), general academic self-efficacy and SDL were each assessed with a short questionnaire: the Academic Procrastination Scale – Short Form (APS-S) (McCloskey 2012), the APS (Choi & Moran 2009), the general academic self-efficacy scale (GASE) (Nielsen et al. 2018) and the SDLS (Lounsbury et al. 2009), respectively. The objective predictors were the number of clicks on the assignment, the number of clicks on relevant course activities and the interval between the start of a block and the first click on the assignment.

The results revealed a different ‘winner’ in each category: Gradient Boosting Machines emerged as the best model for the subjective data; for the objective data, it was the Bayesian multilevel models with random slopes; and for the combined data, Random Forests was the most successful algorithm. These results imply that multiple algorithms should be considered when predicting delay, rather than using the same model for different kinds of data. Assuming that the data for predicting dilatory behaviour are collected accurately, the performance of ML algorithms depends on various circumstances, such as data size, the number of predictors and intervention time. *Data size* refers to the data collected from the participants, in our case, students. If the data set is large enough, the ML algorithms can make more appropriate correlations between the student input data, the type of dilatory behaviour to be predicted and the interventions to be provided. If the data set is small, ML models may over-fit the existing data and provide poor predictive performance when new data are collected. A conclusive example in this sense is neural networks, which are known for their high predictive performance when the amount of data are large enough. When the collected data are small, these models provide inaccurate predictions compared to other models, as we observed in our previous study (Imhof et al. 2022).

The number of predictors (data dimensions) depends on the subjective and objective variables observed and collected from the students. The subjective predictors are questionnaire-related data collected from students at the beginning of the semester. Some subjective predictors might be updated occasionally, as some questionnaires are repeated.

However, the number of subjective predictors in combination with the objective predictors plays a vital role in predictive performance. Support vector machines are generally considered the most accurate ML models, but are computationally expensive when the data dimension is high in most prediction tasks. In our study, support vector machines provided outstanding prediction performance when combining subjective and objective data sets, but without being the best option for any of these cases. However, in the proposed framework, special attention should be paid to the computational complexity of the ML algorithms, as both the data size and the data dimension are higher than in our previous study, and the data are collected in different iterations during the semester, as shown in Figure 5.1.

Another important aspect related to the prediction performance of the dilatory behaviour is determining the optimal time for the intervention during the semester. As we observed in our previous study, the prediction performance increases when more data (especially objective data) are considered in calculating the predictions. This is in line with the results of Xing and Du (2019), who found an increase in predictive performance when predicting dropouts in MOOCs (Massive Open Online Courses). Therefore, in the proposed framework, we expect the same trend of performance increase as the data are accumulated over time. However, the optimal intervention time should be chosen so that the prediction performance of the ML models is high enough. This aspect is crucial for training the ML models because once the intervention is performed, the data subsequently collected are biased; therefore, it cannot be used to train the models further and improve their predictive performance. Two distinct phases are considered in the data collection process to maximise the benefit of the proposed framework. In the first phase, subjective and objective data are collected without intervention. These data are used exclusively to train and test the ML models. Once the predictive performance stabilises without significant fluctuation as more data are collected, the ML model is successfully trained and can be used in the second phase. In this second phase, the predictions provided by the ML model will form the basis for intervention in each iteration, and the impact on SDL and procrastination can be further investigated.

■ Conclusion

We conclude this chapter with an outlook on future research that will be necessary to lay the foundation for implementing our conceptual framework in the field, which will assist students in reducing their maladaptive dilatory tendencies. Before our framework can be applied and in-depth application-oriented research can be conducted, several fundamental questions and

issues must first be addressed. For instance, there is a need for adaptive learning systems with a learner model that involves a more extensive variety of aspects of the students. To date, motivational factors and metacognitive abilities have rarely been used to inform learner models (Nakić, Granić & Glavinić 2015), and to the best of our knowledge, no adaptive system in the literature has involved SDL as part of its learner model. A recent study performed by Harati et al. (2021) investigated a system that incorporates a similar learning concept, SRL – cf. Linkous (2021) for an in-depth discussion about the differences between SDL and SRL.

Another issue is the viability of assessing learning-relevant concepts such as SDL, self-efficacy, self-regulation and monitoring with log data and context data alone. For the adaptive process to be as non-intrusive as possible, these concepts should ideally be assessed without relying on lengthy questionnaires. However, more research is necessary to find valid log data-based indicators of these learning-relevant concepts. The same goes for contextual data to identify the likely reason for dilatory behaviour. An intervention targeting fear of failure requires verification regarding whether students are delaying their tasks for that reason, for instance. Another open question is which of the presented intervention techniques should be included in an adaptive system, which requires more empirical data about the effectiveness and acceptance of these approaches. How to provide them in a semi-automated manner also requires further research.

This chapter presents a proposed conceptual framework for an adaptive system that is based on SDL designed to combat academic procrastination, with various potential intervention strategies that target procrastination and its causes by promoting SDL skills. While much progress has been made as far as individual components of this framework are concerned, there is still a need for more research before the system can be implemented in the field to foster students' SDL skills and reduce their maladaptive dilatory tendencies, and reduce the risk of dropping out and other negative consequences.

In conclusion, the important part of SDL in addressing procrastination within higher DE has been evident in its positive influence on academic success. Encouraging an active and positive approach to learning provides students with the needed skills to steer the encounters of remote education successfully. As we shift to the next chapter, we will investigate the space of continuous professional development, exploring how SDL between lecturers contributes to curriculum transformation.

Continuous professional development through self-directed learning among lecturers in curriculum transformation⁴

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■ Abstract

Curriculum transformation is often seen as complex and difficult, leaving lecturers frustrated and perplexed. A lecturer's own perceptions and skills to engage with curriculum transformation and pedagogical decisions might be to blame for curricula that are unable to address the needs of industry, respond to societal challenges, or equip skilled workers to contribute to the economy. This chapter (1) explores how the curriculum can be unpacked to improve curriculum contextualisation, (2) highlights student-centred practices linked to the inclusion of self-directed learning (SDL) in the curriculum and (3) discusses the need to improve continuous professional development (CPD) for lecturers to enhance curriculum transformation.

■ Introduction

Curriculum transformation is frequently perceived as challenging and intricate in South African and international higher education (HE) contexts (Slabbert-Redpath 2022). Curriculum transformation is often intertwined with social, political, historical or cultural factors and issues of marginalisation. Diverse perspectives and interpretations of what transformation entails further complicate the agenda. Additionally, the concept of the curriculum is rarely straightforward or unbiased.

It is evident from experience and data collected that lecturers' understanding of the curriculum influences their decisions to change the curriculum and how they engage with teaching, learning and assessment (TLA) or implement student-centred practices and self-directed learning (SDL) strategies. Lecturers' understanding and contextualisation of the curriculum also influence their professional development practice, linked to their contribution to the scholarship of curriculum practices (SoCP) and the scholarship of teaching and learning (SoTL). The introduction to SoCP and SoTL originates from continuous professional development (CPD).

Continuous professional development is currently on the agenda for most higher education institutions (HEIs) in the global HE landscape. The shift to remote online TLA, because of the COVID-19 pandemic, exposed the gaps, needs and strengths of CPD programmes, specifically with a stronger focus on SDL practices for lecturers in their learning environments and curriculum. Continuous professional development is essential for lecturers, as the ever-evolving HE environment demands they remain updated and embrace lifelong learning (Engin & Atkinson 2015). Maphosa, Mudzielwana and Netshifhefhe (2014) argue that university lecturers cannot effectively manage critical tasks like curriculum planning and

development related to curriculum transformation without appropriate training and the necessary knowledge and skills.

The curriculum transformation process involves embedding subject-specific knowledge and skills in teaching and learning practices through SDL practices and CPD. Lecturers are the key role players in the HE context and have to fulfil multiple roles, such as the lecturer (mediator of students' learning through fostering SDL practices) and lifelong learner (responsible for own learning using CPD). Incorporating pedagogical principles into CPD programmes (cf. Chapter 4) can help lecturers develop the skills and mindset needed to create a learning environment that promotes self-direction, autonomy, critical thinking and lifelong learning among students. This approach aligns with the goals of curriculum transformation by fostering more adaptive, responsive, inclusive and self-directed curricula.

However, when lecturers face a change of curriculum, they are often confronted with a lack of understanding of how to adapt their curricula and the parameters of what they can change in the curriculum. One way to improve lecturers' knowledge, competencies and skills is through CPD practices focusing on curriculum transformation with SDL. Self-directed learning emphasises the development of the capability to learn autonomously. In the context of curriculum transformation, SDL supports the idea that students and lecturers should be empowered to take control and accountability of their learning processes.

When lecturers take control of their own learning (through SDL), they will employ SDL skills such as self-reflection, self-determination, motivation, self-regulation, perseverance, adaptability, resilience, capability development, metacognition, confidence and student-centredness in their curricula. Guglielmino (2013) highlights that a student-oriented curriculum fosters SDL, equipping students with the SDL skills to acquire new information readily and competently throughout their lives. Techniques such as using diverse teaching and learning tools, enhancing peer learning activities and creating a positive learning environment contribute to meaningful student engagement and learning. One avenue of incorporating SDL and student-centredness into curricula is contextualising the curriculum (Du Toit-Brits 2018).

When lecturers decontextualise their curricula, they play a crucial role as change agents of SDL (Du Toit-Brits 2018). Incentives, time agreements and CPD investment should support curriculum transformation. The SoCP can enhance HEIs' involvement in curriculum transformation research, communities of practice (CoP) and SoTL initiatives.

While it is true that HEIs offer CPD opportunities linked to facets of curriculum transformation, there is a palpable need to devise purposeful and dedicated initiatives. These initiatives should be explicitly designed to enhance the competencies of lecturers and support staff, enabling them to actively participate in curriculum transformation efforts, such as student-centredness and SDL, to address and overcome barriers to curriculum transformation effectively.

As documented in the literature, various barriers hinder the progress of curriculum transformation. These barriers encompass a range of challenges. Firstly, the sheer volume of students observed by Ishmail in 2004 can exert significant pressure on the transformation process. Moreover, as identified by Ishmail (2004) and Powell (2010), low morale represents a critical barrier to the transformation agenda. Another challenge lies in teaching within multicultural classrooms, which inherently demands nuanced instructional approaches.

Moreover, the shortage of CPD opportunities and staff upskilling (Ishmail 2004) are recognised as obstacles to curriculum transformation. Additionally, lecturers' unfamiliarity with current trends, methods and developments can cause anxiety and reluctance, prompting them to defend their existing curricula and remain within their comfort zones (Powell 2010). Other factors affecting curriculum transformation include the absence of a research-focused orientation, significantly impacting the process (Powell 2010). The presence of imbalances in power distribution among staff, as articulated by Vorster (2010), and within organisational structure, as noted by Dirk (2013), also contributes to the complexities associated with curriculum transformation. These power dynamics hinder effective communication and collaboration, thereby perpetuating systemic barriers to change.

This chapter aims to clarify how the curriculum can be unpacked and demystified to improve curriculum contextualisation (linked to barriers impacting curriculum transformation), highlighting student-centred pedagogy and heutagogy related to the inclusion of SDL in the curriculum. This may improve the CPD of academic staff and SoCP and SoTL outputs. The following section explains this chapter's theoretical framework, methodology and data analysis.

■ Theoretical framework, methodology and data analysis

The theoretical foundation that underpins this chapter rests on the framework of social constructivism, with a specific focus on Vygotsky's (1987) insights. Central to our discussion is Vygotsky's construct of the

‘zone of proximal development’ (ZPD) and its implications for scaffolding student learning. We employ these ideas to elucidate how the curriculum can often harbour concealed and inadvertent connections within the context and delivery of TLA. As articulated in 1987, Vygotsky’s argument posits that the curriculum can facilitate and augment student learning across the ZPD as students traverse the spectrum from actual to potential development. The ZPD provided a framework for examining the existing curriculum and exploring the potential for its transformation. By employing cultural-historical activity theory (CHAT) alongside the ZPD, we could delve into the intricate and often contentious concept of curriculum transformation and SDL.

HE landscapes involve diverse stakeholders within HEIs, nationally and internationally, in curriculum transformation. Our chapter presents findings from a systematic review of public curriculum documents and data from lecturer questionnaires and interviews. We utilised CHAT for analysis, importing all data into Atlas.ti for coding and network diagram creation. Following activity theory principles, we summarised results using tables and CHAT diagrams. This chapter elaborates on triangulated findings and suggests improvements for CPD to impact SDL and curriculum transformation in HE. A brief concept clarification is provided to guide our arguments.

■ Unpacking the curriculum

The notion of curriculum is often contested, as various schools of thought regarding what the idea implies. In Le Grange’s 2019 discourse, the curriculum is described as a multifaceted construct, meaning it is shaped by context, historical periods and foundational philosophical paradigms. Le Grange (2019) advances the proposition that the curriculum intricately connects the delineation of the content and what and whose knowledge is encompassed therein.

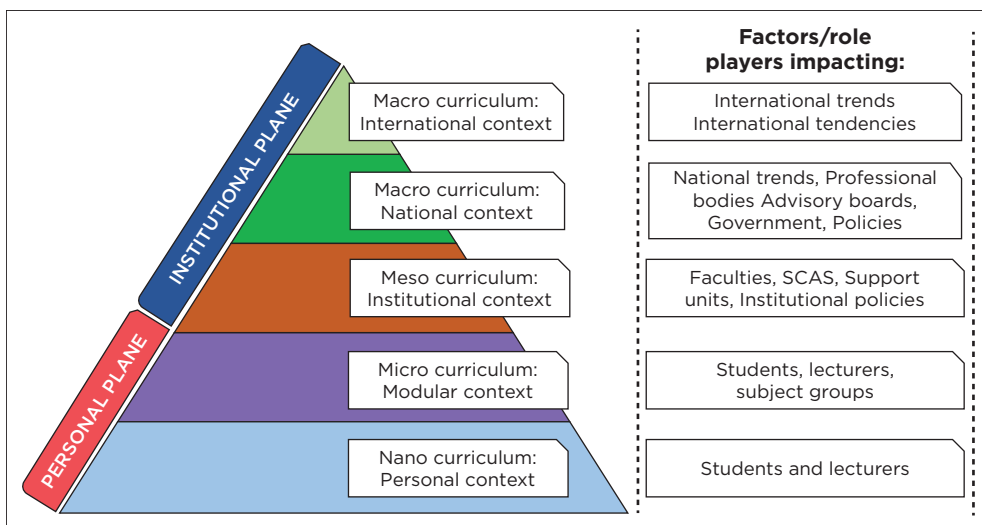
In an academic context, the concept *curriculum* embodies an array of knowledge, ranging from subject lists, topics and resources integrated into a course of study to teaching methodologies, assessment practices, skills, values and pedagogy. Curricula are influenced by several factors, including the nature of the discipline or field, the curriculum designer’s philosophical beliefs, the students’ characteristics and the broader educational context in which it is implemented. A curriculum encompasses the entire educational experience, from the meticulously planned processes to the actual teaching and students’ personal experiences during learning. It also acknowledges the ‘hidden curriculum’, which includes the unwritten, unofficial and often unintended lessons, values and perspectives that a curriculum implicitly

conveys and embodies (Council for Higher Education [CHE] 2021). Our view on curriculum aligns closely with the principles articulated by the CHE.

The curriculum can be understood as the layers or levels at which various role players engage with the curriculum that is context-bound or context-specific. Van den Akker (2004) delineates the distinct layers of the curriculum, which unfold hierarchically. These layers begin at the overarching and most pivotal level, followed by the curriculum’s macro, meso, micro and nano levels. Precisely defining these layers is far from straightforward because of the intricate and ever-evolving nature of the curriculum’s constituent elements. Curriculum development is inherently non-linear and inherently social. The process of shaping the curriculum takes on various forms across different levels, as highlighted by Van den Akker (2004, 2006) (also see Figure 6.1 and Table 6.1):

- Macro – transnational ideas or international comparative level; and national level, including policy intentions, national systems or core national objectives.
- Meso – policy guidance at an institution or institution-specific level.
- Micro – classroom-level curricular practices level.
- Nano – personal and individual level.

Figure 6.1 clarifies the various layers of the HE curriculum, contextualised using Rogoff’s (1995a, 1995b) planes, and highlights the critical participants involved at each level.



Source: Rogoff (1995a, 1995b) and Slabbert-Redpath (2022).
Key: SCAS, Senate Committee for Academic Standards.

FIGURE 6.1: The higher education (HE) curriculum contextualised with Rogoff’s planes as conceptualised in this chapter.

TABLE 6.1: Summary of Rogoff's (1995a, 1995b) planes (Slabbert-Redpath 2022).

Plane	Level of curriculum	Curriculum implementation	Context	Example	Role players	Components
Institutional plane	Macro curriculum (Largest level)	Formal curriculum Planned curriculum Implicit curriculum	International context National context	International and national BED qualifications	International trends International policies National trends Accreditation bodies (DHET, CHE, HEQC) Professional bodies National policies and frameworks for HEIs	Benchmarking Tendencies and trends International and national comparability Purpose and rationale Need for qualification Financial viability Contextual factors Employability Curriculum underpinnings
Institutional plane	Meso curriculum (Institutional level)	Intended curriculum Prescribed curriculum Official curriculum Formal curriculum Blueprint Curriculum-as-plan	Qualification and programme level	BEd qualification and programmes	Institutional committees overseeing curriculum change report to the Senate. Faculties Support units and services	Internal institutional compliance Enrolment planning and resourcing Qualification development, design, and planning Qualification standard (outcomes) Policies Institutional culture Access and epistemological access Contextualisation
Personal plane	Micro curriculum (Smaller level)	Implemented/implicit curriculum Student experienced curriculum	Modular level	Modules in the BEd qualification	Lecturers Subject groups and teams	Module alignment Pedagogy Outcomes Assessment

Table 6.1 continues on the next page→

TABLE 6.1 (cont.): Summary of Rogoff's (1995a, 1995b) planes (Slabbert-Redpath 2022).

Plane	Level of curriculum	Curriculum implementation	Context	Example	Role players	Components
		Curriculum-in-practice				TLA activities
		Enacted curriculum				Classroom practices
		Practiced curriculum				LTSM (media, content, and resources)
		Assessed curriculum				ICT
		Actual curriculum				SDL
		Lived curriculum				Blended learning
		Experienced curriculum				Learner/student support
		Process of TLA				Contextualisation
Personal plane	Nano curriculum (Smallest level)	Attained curriculum	Personal level	The BEd module lecturer and students	Lecturers Students	CPD
		Hidden curriculum				SoTL
		Curriculum-as-praxis				Motivation
						Personality
						Skills, values, and knowledge
						Culture
						Religion
						Beliefs
						Gender
						Language
						Sexual orientation
Interpersonal plane	To use Rogoff (1995a, 1995b), at an interpersonal level, one needs to use humans (persons), such as the lecturer or students, as the subject of an activity system and compare or juxtapose two activity systems with the two human subjects in each activity system. However, the chapter focused on lecturers' perceptions, and we only collected data from lecturers. Therefore, using the interpersonal plane in the chapter was impossible.					

Source: Authors' own work.

Key: BEd, Bachelor of Education; DHET, Department of Higher Education and Training; CHE, Council for Higher Education; HEQC, Higher Education Quality Committee; HEI, higher education institutions; TLA, teaching, learning and assessment; LTSM, Learning and Teaching Support Material; ICT, information and communication technologies; SDL, self-directed learning; CPD, continuous professional development; SoTL, scholarship of teaching and learning.

Table 6.1 summarises the planes linked to the curriculum level, curriculum implementation and context and provides examples to explain further the levels and key role players and components of each level. Table 6.1 should be used in conjunction with Figure 6.1.

■ Curriculum transformation to contextualise the curriculum

Understanding curriculum transformation and contextualisation is crucial before unpacking SDL. Curriculum transformation involves rethinking and redesigning the curriculum to meet current and future educational needs, ensuring it is relevant, self-directed and effective. By understanding this, lecturers can ensure that SDL strategies are aligned with the overall goals of the transformed curriculum, promoting coherence and consistency in educational delivery.

Contextualisation involves adapting the curriculum to make it relevant to the specific context in which it is being taught, considering cultural, social, local as well as learning needs. Contextualisation ensures that SDL applies to the students' backgrounds, experiences and needs, making learning more meaningful and engaging. Contextualisation also links to the development of appropriate learning strategies; facilitates student autonomy, engagement and motivation; ensures inclusivity and equity; strengthens critical thinking, problem-solving and SDL skills; and integrates technology and modern resources, highlighting the needs for CPD for lecturers.

A brief discussion of curriculum transformation and curriculum contextualisation will follow.

■ Curriculum transformation

To understand curriculum transformation, we must first examine what transformation means. Du Preez, Simmonds and Verhoef (2016, p. 2) state that the Greek term for transformation, *metaschimatismos*, highlights a change in form and encompasses ideas of remodelling, modification and restructuring. The term 'transformation' itself is complex and open to interpretation, but it fundamentally means 'to undergo and cause a change of form'. In HE, transformation can be understood as:

... part of the broader process of South Africa's political, social and economic transition, which includes political democratisation, economic reconstruction and development, and redistributive social policies aimed at equity and a necessity, not an option, in the South African context. (Du Preez et al. 2016, p. 2)

Transformation in South African HEIs involves more than just altering the composition of staff and students or changing governance structures and curricula. It also requires transforming organisational culture and fostering the development and acceptance of new and shared values. Such transformation necessitates a change in mindset among all participants in the diverse nation to ensure quality, success and access to academic opportunities (Fourie 1999). According to the CHE (2013), a transformed HE system would support an emerging, non-racial and progressive democracy by producing critical, independent citizens and skilled, socially committed graduates who can contribute to social and economic development.

Curriculum transformation in HE is a deliberate process where current curricula are modified to incorporate the values, goals and aims of HEIs. In South Africa, this transformation is influenced by institutional objectives, industry demands and social justice issues, including decolonisation and Africanisation. It also addresses responsiveness to social context and epistemological diversity and improvements in pedagogy, student retention and success (Badat 2010; Ramrathan 2016; Soudien 2010).

Furthermore, Jansen (2017) explains that curriculum transformation deeply affects the identity of a HEI by raising challenging questions about its self-perception in relation to the nation and the world. Jansen adds that the university curriculum becomes a focal point because it holds symbolic value far beyond its practical functions, such as subject content selection, teaching methods and learning acquisition. The curriculum embodies values, commitments and ideals, with those in power determining what is deemed worth teaching and learning, whether implicitly or explicitly. Curriculum transformation is also known as curriculum reform, renewal or change in the literature. These changes or reforms should address and respond to 'wicked problems' and societal issues (Rittel & Webber 1973).

A core function of universities can be described as a central and essential part of the local community involved in regional development and local economic growth and plays a robust vocational role in society to address societal issues (Moscardini, Strachan & Vlasova 2022) and the national transformation agenda. In South Africa, numerous policies and guidelines guide transformation and curriculum changes in HE. The government establishes the transformation agenda and compliance requirements through entities like the DHET, CHE and SAQA (South African Qualifications Authority) (Menon & Castrillon 2019). This compliance focuses on technical aspects such as credits, notional hours, articulation options, NQF (National Qualifications Framework) levels, level descriptors, learning outcomes, assessment criteria, module types and learning activities. Menon and

Castrillon (2019, p. 31) argue that the curriculum has become ‘an aggregation of complexity assessment’ involving elements like NQF levels, module outcomes, the volume of learning and teaching credits, weighting and activities. They highlight that external initiatives shape the language of curriculum design and planning. The curriculum is viewed as performative, which is challenging to measure. The regulatory and compliance language becomes the standard for gauging curriculum transformation, leaving the actual and hidden curriculum unassessed. In internal and external programme evaluations (IPE/EPE), curriculum reviewers rarely evaluate curriculum transformation and SDL skills, and there is little consensus on what this evaluation should entail or imply (Menon & Castrillon 2019). The lack of a shared understanding of what curriculum transformation entails in the HE landscape is problematic and does not assist lecturers in engaging with curriculum transformation implementation.

The most direct connection to implementing curriculum transformation in current HEI programmes is found in existing programmes’ IPE/EPE, which use the CHE’s programme accreditation criteria. Menon and Castrillon (2019) emphasise that the South African HE landscapes lack monitoring and evaluating curriculum and transformation. Ensuring the quality of curriculum transformation is primarily embedded within the structures of each HEI, with minimal guidance on the specifics of ‘how’ and ‘what’ curriculum transformation should involve in South African universities.

The South African university has retained its traditional British university structure for 28 years after apartheid. The curriculum, rooted in Eurocentric knowledge, is pivotal to addressing social and educational challenges, emphasising access, epistemological access, responsiveness and equity in national HE transformation debates. There has been a lack of significant changes to the South African HE curricula over the past century, resembling characteristics observed in colonial-era education (Ramrathan 2016). Howson and Kingsbury (2021) characterise the curriculum as outdated and needing transformation. They describe curriculum reform as a contentious and intricate social process that involves individual, disciplinary, and institutional identities and mirrors the power dynamics within academia.

Disciplinary and institutional identities mirror the power dynamics within academia. The power dynamics in curriculum reform involve a shift from a top-down, policy-driven approach to a bottom-up one that emphasises understanding and enactment. Under a top-down approach to curriculum transformation, faculty often encounter discrepancies in perceptions and may not take ownership of or perceive the relevance of initiatives. Similarly, students may perceive the curriculum as top-down when they lack opportunities to contribute or make choices. Fostering a self-directed

environment where faculty and students have a voice in the transformation process is essential to address these concerns. Curriculum transformation is crucial in linking SDL by shaping the HE environment and framework for students to thrive as self-directed individuals.

■ Curriculum transformation connects with self-directed learning

Curriculum transformation connects with SDL through the following:

■ Alignment of goals and aims

Curriculum transformation involves rethinking and redesigning the curriculum to meet current educational and societal needs and goals. When the curriculum is transformed to emphasise skills such as critical thinking, problem-solving and reflection, it inherently supports SDL. This alignment ensures that SDL activities are purposeful and integrated into the broader educational outcomes and aims.

■ Fostering autonomy and responsibility

A transformed curriculum often encourages students to take more responsibility and accountability for their learning. By incorporating elements that promote independent learning, such as project-based assignments, research opportunities and collaborative learning experiences, the curriculum transformation nurtures SDL skills. Students learn to set goals, work collaboratively, manage their time effectively and seek resources autonomously.

■ Promoting active engagement

Curriculum transformation can shift the focus from passive learning to active engagement. Self-directed learning requires students to seek knowledge actively, reflect on their learning process and apply what they have learned. A transformed curriculum typically includes interactive and participatory learning methods that encourage students to engage actively with course content, thus preparing them for SDL experiences.

■ Emphasising lifelong learning skills

Self-directed learning is closely tied to the development of lifelong learning skills. A transformed curriculum often emphasises acquiring skills such as information literacy, critical thinking and adaptability, which are essential

for self-directed students. These skills enable students to continue learning beyond formal education and adapt to changing career and life circumstances.

■ Supporting diverse learning pathways

Self-directed learning encourages students to explore topics of interest and choose their own learning pathways. A transformed curriculum can provide flexible learning opportunities, such as interdisciplinary modules and courses, elective modules, short courses (micro-credentials) and student choices in modules that cater to diverse learner interests and needs. This flexibility allows students to be self-directed and to pursue SDL in areas that resonate with their passions and future career aspirations.

■ Integrating technology and resources

Curriculum transformation often involves integrating modern technology and resources into the learning process. This integration supports SDL by providing students access to digital tools, online databases, multimedia resources and collaborative platforms that facilitate independent learning and research.

In essence, curriculum transformation creates an environment that nurtures the skills, attitudes and behaviours conducive to SDL. By aligning educational outcomes, fostering autonomy, promoting active engagement, emphasising lifelong SDL skills, supporting diverse pathways and integrating technology, curriculum transformation lays a strong foundation for effective SDL practices among students and lecturers.

In conclusion, the above-given information highlights several gaps concerning curriculum transformation and the linkage of SDL practices with curriculum transformation. Few studies explore the factors influencing curriculum – whether inhibiting or enabling – and the varying degrees of intensity of these changes (Anakin et al. 2018). Moreover, there is limited documentation on the processes that initiate curriculum changes at the university level across institutions (Anakin et al. 2018). There exists a notable absence of consensus on key terminology related to curriculum transformation (Mendy & Madiope 2020). Additionally, there is a shortage of guiding documents and frameworks guiding curriculum transformation in HEIs in Southern Africa. Curriculum transformation is depicted as a cyclical institutional process (Howson & Kinsbury 2021), with significant changes often characterised as resource-intensive and time-consuming, frequently lacking comprehensive evaluation. This complexity leaves lecturers uncertain about implementation and how to proceed with contextualisation actions to enhance curriculum transformation.

■ Curriculum contextualisation to enhance curriculum transformation

Contextualisation, as defined by the Cambridge Dictionary (2022), refers to the act or process of situating something within its context, considering the circumstances in which it exists or occurs. Curriculum contextualisation involves pedagogical strategies to enhance student success by adapting curriculum content to align more closely with the learning and teaching environment, enhancing comprehensibility and relevance and fostering SDL (Fernandes et al. 2013). According to Bernstein's pedagogic device (PD) (2000), curriculum transformation operates within the field of recontextualisation, where knowledge sourced from various contexts is selected, reorganised and integrated into the curriculum (Shay 2016). The challenge in curriculum reform lies in navigating the underlying logic, choices and principles governing this process (Bernstein 2000).

Pedagogy, andragogy and heutagogy represent different approaches to SDL (cf. Chapter 2 and Chapter 4). Pedagogy traditionally focuses on teacher-directed learning for children, where the teacher designs and controls the learning process. Andragogy shifts the focus to adult learners, emphasising their need for self-direction, practical experiences and problem-solving skills. Heutagogy extends this by promoting learner autonomy and capability, encouraging individuals to determine their own learning paths, reflect critically and adapt to new situations. Together, these frameworks highlight the evolution from dependent to increasingly self-directed and autonomous learning across different stages of development and contexts. This chapter uses pedagogy and heutagogy interchangeably as many educational authors, such as Bernstein (2000), Jansen (2009) and Le Grange (2011a), in literature use the term *pedagogy* when they refer to the methods and practices of teaching and learning aimed at improving and adapting the curriculum to meet student needs and societal demands better. Pedagogy encompasses student-centred learning, which emphasises active engagement, collaboration and critical thinking, and employs innovative teaching methods such as technology-enhanced tools, flipped classrooms and experiential learning. It promotes interdisciplinary approaches, inclusivity and accessibility by integrating diverse fields of study and implementing universal design for learning principles. Assessment and feedback are crucial, utilising formative and summative assessments to measure learning and provide ongoing feedback, while faculty development and support ensure growth and the sharing of best practices. Curriculum alignment with current research, industry demands and societal needs ensures relevance and applicability, involving stakeholders in the development process. Reflective practice encourages lecturers to continuously improve their methods and

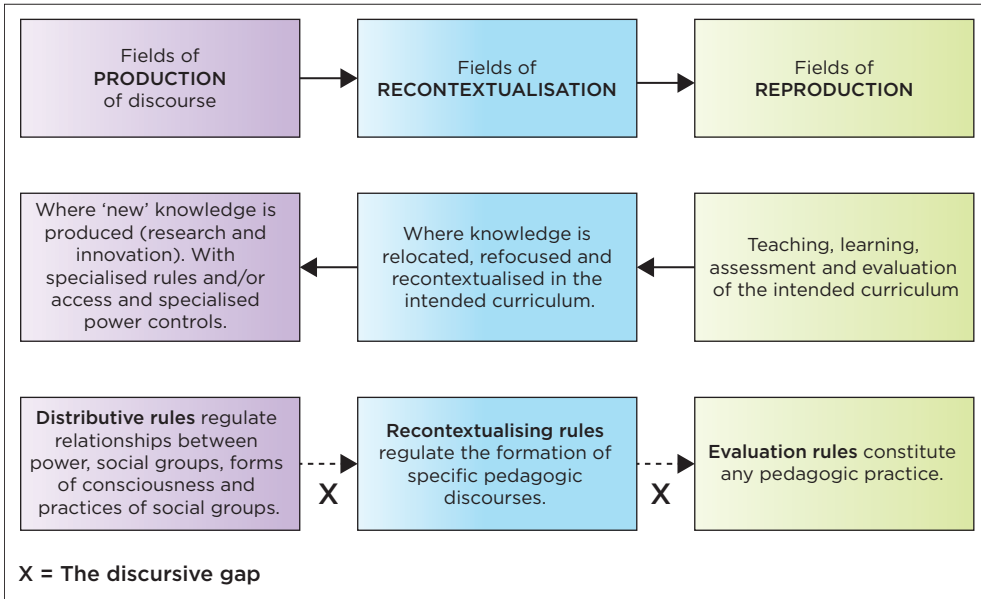
understand the impact on student learning, fostering a culture of continuous improvement and innovation to create an engaging, inclusive and dynamic learning environment that prepares students for the complexities of the modern world and the world of work.

Jansen (2009) and Le Grange (2011) advocate using pedagogy to catalyse transformative change in education. In this context, pedagogy refers to the theory and practice of education. It includes the notions of SDL, self-motivated learning and learner-centred practices in line with andragogy and heutagogy (used in adult education at HEIs). According to Todd (2014), our understanding of the temporal dimension in education should evolve to recognise pedagogy as a formative event. Todd (2014) underscores the importance of focusing on the present moment (becoming), emphasising engagement with the contextual aspects of daily interactions with students – the essence of education focusing on ‘who’ rather than ‘what’.

Furthermore, prioritising transformation involves designing policies, programmes and curricula that emphasise the complexity, fragility and sensitivity inherent in lived experiences (Todd 2014, p. 9). Le Grange (2011b) posits that transformation involves fully engaging in a contemporary world’s complexities. The concept of presence and becoming aligns with the ZPD, where attention is placed on understanding where students currently are and where they can potentially reach, particularly when they have agency and influence over the curriculum. However, curriculum transformation cannot be implemented when lecturers have gaps in their pedagogical armoury regarding the curriculum’s ‘who’ and the ‘what’ (see Figure 6.2).

When lecturers engage in curriculum contextualisation, the challenge lies in determining the breadth and depth of adjustments required – whether they involve understanding, additions, revisions, developments or inclusions. At North-West University (NWU), where there are three delivery sites, curriculum contextualisation varies depending on the specific needs of student and lecturer groups within each module and site. This variability demands a flexible approach to ensure that the curriculum remains relevant and effective across different contexts.

The primary role of academic staff in HE is to instruct students, often without formal pedagogical training, although some possess teaching experience within their discipline (or field of study). Contextualising the curriculum at the micro level (see Figure 6.1 and Table 6.1) necessitates disciplinary knowledge and pedagogical skills and connects diverse social contexts to pertinent scenarios and events (Wenger 1998). Wenger argues that curriculum change and renewal are participatory in



Source: Bernstein (2000, p. 37) and Clarence (2019, p. 93).

FIGURE 6.2: The pedagogic device.

socio-cultural practices. Whether through design, development, renewal or redesign, curriculum construction is an ongoing social endeavour influenced by various contextual factors (see Table 6.2) that extend beyond the classroom environment, impacting lecturers and students (Cornbleth 1988). Viewing the contextualised curriculum as a social process raises fundamental questions about what is taught, how it is taught, for whom and by whom (Cornbleth 1988). The curriculum is shaped by its context, and altering one affects the other reciprocally.

In the micro curriculum, the lecturer’s agency significantly influences the process of curriculum contextualisation. When there is a contextualisation gap between lecturers and students, it hinders curriculum transformation and renewal. Anakin et al. (2018, p. 206) highlight that a lack of shared understanding can impede effective implementation of curriculum change and development.

The dynamics of curriculum change are deeply influenced by specific contexts (Wenger 1998), resulting in distinct processes within HEIs and faculties. A critical competency for lecturers as curriculum designers involves their ability to contextualise the curriculum effectively for TLA. Anakin et al. (2018) identified six pivotal factors – resources, ownership, leadership, academic identity, quality assurance and student self-direction –

TABLE 6.2: The contextual influences on the micro curriculum.

Personal/social issues	TLA	Competencies	Origins	Commercialisation	Social justice
• Citizenship	• Assessment	• Graduate attributes	• Africanisation	• 21st-century skills	• Democracy
• Class	• Knowledge and knowledge production	• ICT and digital transformation	• Culture	• 4IR	• Diversity
• Disability	• Learning-centred approaches		• Decolonisation	• AI	• Equality
• Ethics of care	• Pedagogy		• Indigenous knowledge systems	• Authentic learning practices	• Equity
• Gender	• Resources and learning materials		• Language	• Entrepreneurship	• Freedom
• History	• SDL		• Western traditions	• Ethical practices	• Inclusivity
• Language and multilingualism	• Student success			• Globalisation,	• Social justice and constitutionalism
• Life experience and living environments	• TLA strategies and methods			• Graduate attributes	
• Nationality	• Lifelong learning			• Sustainability	
• Power relations				• Work-integrated learning	
• Race					
• Religion					
• Sex					
• Sexual orientation					
• Student voice and multiple perspectives					
• Wellness					

Source: University of Pretoria (2016); Lockett and Shay (2020); and Shay (2016).

Key: SDL, self-directed learning; TLA, teaching, learning and assessment; ICT, information and communication technology; 4IR, Fourth Industrial Revolution; AI, artificial intelligence.

that influence the contextualisation and transformation of the curriculum. This process of curriculum contextualisation also extends to the nano curriculum level, where lecturers' beliefs, motivation and agency play crucial roles, as highlighted by Anakin et al. Leite, Fernandes and Figueiredo (2020) outline four critical focal points in curriculum contextualisation: the contextual characteristics, student attributes, pedagogical practices (including diversification of TLA activities) and subject content encompassing knowledge and competencies. Leite et al.'s concepts resonate with how the curriculum can adapt and respond effectively at both the micro and nano levels.

Additionally, the lecturer plays a pivotal role at the curriculum's micro and macro levels, acting as a catalyst for change and as a facilitator of learning, integrating principles from pedagogy (as well as andragogy and heutagogy). In their role as facilitators, lecturers must consider a range of teaching strategies and learning activities, including SDL, blended learning methodologies, collaborative and peer learning among students, flexibility in the curriculum to enhance learning, problem-based learning (PBL), inquiry-based learning (IBL), integration of real-world problems and context, and reflective practices. Lecturers address the application and authenticity of learning experiences and methods for authentic assessment within curricula. These effective strategies to enhance student learning and engagement, understanding student dynamics and needs and fostering a student-centred approach or learning-centred methods are critical elements influencing the lecturer's facilitation of and for learning. Moreover, considerations of student support mechanisms, student success factors and the incorporation of student feedback further shape the lecturer's mediation role in facilitating learning experiences. Recognising education as value-laden, implementing pedagogy as an intrinsic aspect of daily TLA practices underscores its non-neutral nature (Maistry 2011). The intricate nature and ethical dimensions of TLA methods are indispensable for ensuring inclusivity, accessibility and an ethos of care throughout the curriculum delivery process.

In discussions of curriculum theories and instructional practices in HE, there is often insufficient acknowledgement of the nuanced role in facilitating learning. Traditional teaching and learning approaches in HE have typically centred around lecturer-directed methods such as lecturing, memorisation, rote learning and didactic instruction. However, contemporary perspectives advocate a shift towards more inclusive and transformative educational practices (cf. Chapter 2) prioritising student-centred engagement, thus SDL. De Beer and Petersen (2016) believe this evolution is crucial for fostering environments that support diverse learning needs and encourage transformative learning experiences. Mentz and De Beer (2021) further contend that the COVID-19 pandemic underscored the

prevalence of transmission-oriented teaching methods within educational contexts, highlighting the need for a paradigm shift towards curriculum designs that promote SDL and facilitate more profound curriculum contextualisation.

Curriculum contextualisation enhances the relevance and effectiveness of SDL by adapting educational content and methods to fit the specific cultural, social and local context in which learning takes place. The curriculum can be contextualised with SDL by means of the following (also see Table 6.2).

■ **Relevance to students' backgrounds and personal experiences**

Contextualisation ensures that the curriculum reflects and respects the students' cultural diversity, social norms and local realities. When contextualising SDL activities, they are more likely to resonate with students' backgrounds and experiences, making learning more meaningful and engaging. For example, using case studies or examples that relate to local issues or cultural contexts can enhance students' understanding and motivation in SDL.

■ **Enhanced motivation and engagement**

Self-directed learning requires students to be actively engaged in their learning process. Contextualising the curriculum by incorporating topics, themes and materials that are relevant and interesting to students can increase their motivation to learn independently. When students see the direct relevance of their learning to their lives and communities, they are more likely to invest time and effort into SDL activities.

■ **Facilitation of autonomy and critical thinking**

Contextualisation encourages students to take ownership of their learning by allowing them to explore meaningful topics and issues within their context. This approach promotes critical thinking as students analyse and evaluate information concerning their cultural and social surroundings. Self-directed learning within a contextualised curriculum thus nurtures autonomy as students make informed decisions about their learning paths.

■ **Cultural and social sensitivity**

Self-directed learning involves learning independently but within a framework that respects cultural sensitivities and social dynamics (see

Table 6.2, section dealing with origins and social justice). Contextualisation ensures that learning materials and activities are sensitive to cultural norms, values and practices. This sensitivity fosters a supportive learning environment where all students feel included and valued, enhancing their learning experience.

■ Preparation for real-world applications

Contextualised SDL prepares students for real-world applications of their knowledge and skills. By addressing local challenges, issues and opportunities, students can apply their learning practically and meaningfully (see Table 6.2, section dealing with commercialisation and competencies). The practical application enhances the relevance of SDL and prepares students for future careers or further education where independent learning skills are essential.

■ Integration of local resources and expertise

Contextualisation encourages the integration of local resources, such as guest speakers, community projects or field trips, into SDL activities. These resources provide valuable opportunities for students to engage directly with experts and practitioners within their community, enriching their learning experiences and broadening their perspectives (see Table 6.2, section dealing with commercialisation and indigenous knowledge).

In summary, curriculum contextualisation enriches SDL by making learning more relevant, engaging and culturally sensitive. By adapting educational content and methods to fit students' specific contexts, contextualisation supports autonomy, critical thinking and motivation, ultimately enhancing SDL's effectiveness in preparing students for lifelong learning and success. Moreover, curriculum contextualisation involves adapting curriculum content and methods to meet students' specific needs, interests and contexts of students and society. When linked with SDL, this approach becomes particularly powerful in fostering deeper engagement and relevance for students and lecturers. Self-directed learning emphasises students' autonomy and responsibility for their learning processes and goals. By contextualising the curriculum, lecturers can create SDL environments that resonate more closely with students' backgrounds, experiences, learning needs and future aspirations. This alignment enhances the intrinsic motivation and self-determination of students to engage with the curriculum content because they perceive its direct relevance to their lives and goals.

■ Student-orientated curricula and pedagogy

A student-centred curriculum is a transformative approach in HE that fosters SDL, empowering students to take responsibility for their educational journeys (Guglielmino 2013) (cf. Chapter 2). As seen from the preceding chapters in this book, SDL is characterised by students identifying their learning needs, formulating goals, sourcing materials, implementing appropriate strategies and evaluating outcomes independently (Knowles 1975). This method promotes lifelong learning by cultivating essential skills such as enquiry, critical thinking and problem-solving, which are crucial for students to adapt and thrive in a constantly evolving world (Du Toit-Brits 2020).

Implementing a student-centred curriculum necessitates the active involvement of students in their learning processes. Brockett and Hiemstra (1991) outlined several pedagogical strategies to enhance SDL, including using diverse teaching resources, engaging students as active participants, maximising peer learning and creating a supportive learning environment. Du Toit-Brits (2018) further emphasises the transformative potential of SDL in HE, highlighting the need for a holistic approach that integrates students' learning characteristics with a conducive teaching and learning environment. By focusing on SDL, lecturers can develop critical SDL skills such as self-reflection, self-determination, lifelong learning and CPD, enhancing their ability to guide and support their students effectively.

Moreover, Du Toit-Brits (2019) asserts that educators' expectations and practices significantly impact their students' self-directedness. Educators who engage in reflective practices and understand their learning processes are better equipped to foster SDL among their students, leading to improved educational outcomes and personal growth for lecturers and students.

Adopting a student-centred curriculum is instrumental in cultivating a learning environment that encourages self-directed lifelong learners. The lecturer's perspectives on curriculum, teaching, learning and student achievement influence the curriculum (Howson & Kingsbury 2021). Du Toit-Brits (2018) underscores the influence of changes in teaching and learning methods on students' approaches and outcomes related to SDL. Lecturers are urged to promote clear educational objectives, encourage independence, cultivate a supportive learning environment and nurture students' sense of autonomy. Moreover, within the context of the nano curriculum, educators assume roles as SDL facilitators of their learning, comprehending their

students' learning capabilities and taking responsibility for curriculum development through empowerment (Du Toit-Brits 2019). They also adopt a self-directed approach, engaging in reflection, lifelong learning and CPD practices to foster transformative learning and authentic assessment. Krabbe (2013) and Teng (2019) support Du Toit-Brits' argument, asserting that embedding self-directed lecturers is crucial for enhancing SDL among students.

According to Blignaut (2017), the beliefs and actions of lecturers are pivotal, as the effective implementation of curriculum hinges on their involvement. Blignaut asserts that educational change is deeply personal and emotional for lecturers, shaped by their accumulated teaching experiences rather than entering educational settings as blank slates. Diverse educational systems and pedagogical traditions often inform their epistemological experiences and perceptions. At the core of curriculum decisions lies a fundamental consideration of values related to knowledge, skills, methodologies and education's broader purpose. In defining educational purpose, lecturers engage in reflective processes to delineate the potential and limitations of education. They describe their roles and gauge their involvement within institutional structures to align with curriculum content and contextual culture. At the micro level of curriculum implementation, lecturers make crucial decisions based on their understanding of their teaching, learning and assessment frameworks; their preferences for pedagogical approaches; their facilitation of SDL; their relationships with students; and their internal motivations for implementing chosen strategies. Roberts (2015) emphasises that lecturers' beliefs regarding educational objectives and aims, disciplinary knowledge, teaching methodologies, assessment practices, student dynamics, teacher identity, stakeholder expectations, and institutional, social, and political contexts are paramount in driving curriculum transformation. In CPD, lecturers use SDL skills to transform teaching and learning, as Du Toit-Brits (2018) explains. Doing so enhances CPD and agency and fosters SDL skills like critical thinking, problem-solving and self-directedness. For lecturers involved in the nano curriculum, fostering personal SDL skills is crucial for self-knowledge, meaning, innovation, creativity and ethical care in TLA environments. In addition, Du Toit-Brits (2019) suggests that lecturer expectations influence student self-directedness. Both parties benefit by taking initiative in learning, using diverse strategies, fostering social skills, reflecting on goals and becoming self-directed learners.

The nano curriculum links teaching responsiveness (Moll 2004, p. 8), providing opportunities for lecturers to optimise learning opportunities to help students succeed in their learning efforts. Moll (2004, p. 8)

emphasises that a responsive curriculum addresses students' learning needs by teaching and assessing in ways they understand. Lecturers must align with students' learning rhythms, lecturing creatively, overcoming learning resistance, building trust and addressing the emotional aspects of learning. While the formal curriculum (content, theories, disciplinary knowledge) drives lecturers to focus on TLA as outlined in the micro curriculum, the hidden curriculum also plays a role at the nano level. The hidden curriculum consists of the unspoken values, norms and beliefs imparted to students through the formal content and the social dynamics of university, campus and classroom life (Giroux & Penna 1979), often unconsciously (Alsubaie 2015).

The lecturer's pedagogical approach affects various aspects of the hidden curriculum, including race, ethics, ethnicity, gender, language, identity, epistemological access and the framing of knowledge within the curriculum (Vorster 2010). Giroux and Penna (1979) argue that pedagogical models should be grounded in a theoretical framework that positions the HE TLA environment within a socio-political context. This perspective sees the HE classroom as a socialising agent that connects education to the workplace and other socio-political realms. Human development is reciprocal, with lecturers and students becoming agents of critical thinking and democratic participation by modifying HE curricula's content, pedagogy and methodology (Giroux & Penna 1979). Jerald (2006) emphasises that lecturers who are aware of the hidden curriculum's significance continually reassess their classroom attitudes. Scholars like Jansen (2009), Jerald (2006), and Leibowitz, Naidoo and Mayet (2017) highlight the importance of lecturers' perceptions of the curriculum, warning that ineffective use of the hidden curriculum can embed negative social beliefs and hinder social change.

Vygotsky (1987) incorporated the hidden curriculum into his socio-cultural psychology to develop a pedagogy of care and responsiveness within the ZPD. Transformative learning, closely linked to ZPD, occurs when individuals internalise concepts and knowledge rather than relying on rote learning. Engeström (2009) expands this idea by suggesting that through peer interactions and multidisciplinary learning, novices transform by internalising knowledge, actions and practices rather than merely mimicking experts.

Engeström (2001) also introduces the concept of a third space where lecturers and students collaborate to create new meanings beyond the classroom's confines. This third space in HE combines diverse knowledge, practices and discourses to foster transformative learning. Engeström's notion of expansive learning is pertinent here, as it aims to shift from problematic practices to more effective methods that facilitate

transformative change (Avis 2009). Engeström and Sannino (2010) explain that expansive learning happens when students create and implement new, more complex activities. This theory emphasises collective activity and cultural creation at the community level, linking to the ZPD, where learning and development occur collectively.

Expansive learning theory emphasises the shift in the learning process from focusing on individuals to encompassing collectives and networks. Individuals start by recognising their perceptions, affirmations and actions, which shape their beliefs. As more individuals participate, they collaboratively analyse and develop a model for the ZPD. The collective contributions of individuals help create a new and enhanced activity system (Engeström & Sannino 2010). Through expansive learning, lecturers and students can cultivate a ‘transformative agency’ to effectively address challenges during periods of change (Garraway & Winberg 2020). Transformative agency occurs when a lecturer’s efforts are increasingly geared towards driving change. According to Englund and Price (2018), this type of agency also involves understanding one’s actions in relation to others and addressing the difficulties that arise from these interactions. One way to comprehend and reflect on these changes is through SDL practices within student-oriented pedagogy.

■ Self-directed learning and student-centredness

Student-oriented curricula and pedagogy are closely linked to SDL as they prioritise the students’ role in the educational process and emphasise autonomy, active engagement and personalised learning experiences. Here’s how student-oriented curricula and pedagogy support SDL:

■ Emphasis on learner autonomy

Both student-oriented curricula and SDL prioritise learner autonomy. Student-oriented curricula encourage students to take responsibility for their learning by allowing them to make choices about their learning goals, methods and pace. Similarly, SDL requires learners to manage their learning process actively, set goals and monitor their progress independently.

■ Active engagement and participation

Student-oriented curricula also promote active learning and participation by encouraging students to engage deeply with the content through discussions, projects and collaborative activities. Self-directed learning also promotes active engagement as students explore topics of interest,

seek out resources and apply their knowledge meaningfully. This active participation fosters a deeper understanding and retention of knowledge.

■ Personalised learning experiences

Student-oriented curricula and SDL prioritise personalised learning experiences tailored to individual student needs, interests and learning styles. Student-oriented curricula often include opportunities for students to pursue independent research, projects or electives that align with their interests. Self-directed learning allows students to choose topics, methods and resources that resonate with their goals and motivations, enhancing engagement and motivation.

■ Development of critical thinking and problem-solving skills

Student-oriented curricula and SDL both emphasise the development of critical thinking, problem-solving and decision-making skills. In student-oriented curricula, students are often challenged to analyse information critically, evaluate perspectives and propose innovative solutions to real-world problems. Self-directed learning encourages students to actively seek out information, evaluate sources and apply critical thinking skills to solve problems independently.

■ Preparation for lifelong learning

Both approaches aim to prepare students for lifelong learning beyond formal education. Student-oriented curricula and SDL equip students with the skills, attitudes and behaviours necessary to continue learning independently. By fostering curiosity, resilience and self-regulation, these approaches empower students to adapt to new challenges and opportunities in their personal and professional lives.

■ Integration of technology and resources

Student-oriented curricula often leverage technology and diverse resources to support personalised learning experiences. Similarly, SDL encourages using digital tools, online resources and multimedia platforms to access information, collaborate with peers and create learning artefacts. Technology integration enhances the flexibility and accessibility of learning opportunities in both student-oriented curricula and SDL.

In essence, student-oriented curricula and pedagogy provide a supportive framework that aligns closely with the principles and practices

of SDL. By prioritising learner autonomy, active engagement, personalised learning experiences, critical thinking and lifelong learning skills, both approaches empower students to become independent, self-directed learners capable of navigating and succeeding in today's complex and dynamic world. Exploring the role of CPD in transformation is a valuable avenue. Therefore, it is worth exploring CPD's value and impact on curriculum transformation practices.

■ **The need for continuous professional development and curriculum transformation agency and the lecturer's role in curriculum transformation**

This section elaborates on the need for CPD and curriculum transformation agency, as well as the role of the lecturer as a curriculum designer, developer and implementer linked to CPD.

■ **The need for continuous professional development and curriculum transformation agency**

As stated previously in this chapter, lecturers and students are the key agents involved in HE curriculum transformation. Within HE, curriculum transformation aligns with cycles of curriculum renewal, exposing many lecturers to curriculum design, development and revitalisation practices. Lecturers are primarily responsible for curriculum transformation as they are critical to implementing reform initiatives (Huizinga et al. 2014), as the success of curriculum transformation, synonymous with reform, change or renewal, hinges upon lecturers' understanding and ownership of the curriculum.

In most faculties, lecturers typically specialise in specific academic disciplines, except for those in Education Sciences who focus on teacher training. Lecturers within education often possess formal education in pedagogy, educational methodologies and subject-specific knowledge, actively engaging in educational research. They are likely well versed in educational theories supporting pedagogical practices and participate in practical assessments within work-integrated learning environments for teacher preparation. Conversely, faculty members in other disciplines typically excel as subject matter experts within their specialised fields, often lacking formal education qualifications, practical experience or pedagogical expertise. Matiru et al. (1995, p. 2) highlight that 'only a small number of lecturers have received professional training in teaching'.

However, not all lecturers, including those specialising in Education Sciences, receive curriculum development and design as well as SDL training, regardless of their educational backgrounds. According to Maphosa et al. (2014, p. 355), many view curriculum development as daunting without a foundational understanding of curriculum design principles. The professional training gap among lecturers predominantly centres on curriculum design, development and planning. Lecturers are expected to engage actively in curriculum planning, renewal and instructional tasks without adequate preparation (Maphosa et al. 2014). Effective curriculum development requires lecturers to assess their modules critically; envision their integration within broader qualifications, programmes and degrees; and implement TLA strategies that enhance students' SDL skills. The authors emphasise curriculum developers' need to employ theoretically grounded and empirically tested principles and methods (Maphosa et al. 2014). Niemelä and Tirri (2018) advocate for CPD opportunities in HE to equip lecturers with the skills necessary for effective curriculum integration and implementation, aligning with Shulman's Pedagogical Content Knowledge (PCK) framework.

Extensive literature discusses the necessity and significance of CPD in HE (Janke & Tofade 2015; Panda 2022). This body of work indicates several factors that influence lecturers' preparedness to effectively serve as curriculum developers (and transformers) in HE, particularly about CPD. The reviewed literature encompasses a wide range of topics, including the schooling environment and its relevance to practices in HE. The role of CPD in curriculum transformation is unpacked further in the following section.

The individual lecturer must engage with the curriculum to facilitate its transformation within their teaching, linking these efforts with insights from literature across macro, meso, micro and nano curriculum levels. The lecturer serves as a professional and personal change agent at the micro and nano levels. According to Archer's classification (2007, 2013), structural, cultural and agency-related challenges are prominent in this context. Structural issues identified (listed below) significantly impact curriculum transformation:

- insufficient availability of curriculum-focused CPD training opportunities to adequately prepare educators (Bantwini 2008)
- administrative hurdles in curriculum development and revision processes (Odejide, Akanji & Odekunle 2006; Rudhumbu 2015)
- concerns and obstacles regarding procedural aspects hinder curriculum transformation (Niehaus & Williams 2016)
- inadequate skills and training in ICT/technology integration and literacy (Khoza & Mpungose 2020; Safar & AlKhezzi 2013)
- deficiencies in pedagogical skills and training for effective teaching (De Beer & Petersen 2016; Fraser 2016)

- limited time and insufficient incentives are allocated for staff to engage in curriculum transformation compared to research activities (Annala et al. 2022; Brownell & Tanner 2012)
- implementation of university-wide top-down curriculum reforms (Annala et al. 2022)
- escalation in administrative workload and paperwork (Priestley et al. 2021).

The perspectives of culture and agency are integral to considerations of the nano curriculum. While the micro curriculum represents the collective understanding of lecturers within a subject group at an institutional level, the nano curriculum pertains to individual transformations. Culturally, lecturers' beliefs and attitudes significantly influence curricula implementation and reform. When lecturers perceive curriculum reform as increasing their workload, lack support during the change process (Bantwini 2009), possess limited experience and understanding of reform practices (Chan & Luk 2013) or fail to recognise the necessity for change, they may resist adapting their practices and curricula (Badat 2010). Challenges also arise from the insufficient integration of African epistemologies, knowledge systems (including culture, customs, practices and languages) into curricula (Mendy & Madiope 2020; Shay 2016) and tensions related to professional identity (Brownell & Tanner 2012), teamwork and adjustments to pedagogy to accommodate collaborative teaching efforts (Haith-Cooper 2000).

Archer (2002) defines *agency* as the initiatives undertaken by human agents and their capacity to act within their environmental contexts. The lecturer's responses are directly associated with the nano curriculum. From an agency perspective, this involves lecturers embracing or resisting changes, influenced by their social relationships and confidence as change agents or decision-makers. This confidence extends to their involvement in curriculum transformation, alignment of values with students, integration of ethics of care, teaching philosophy and SDL instructional practices. Self-directed learning practices, encompassing reflexivity and self-regulation, also play a crucial role (Leibowitz 2012; Myburgh 2018). The strength or weakness of institutional structures shapes the opportunities and constraints for lecturers and students alike in their engagement with, or withdrawal from, curriculum transformation (Annala et al. 2022).

The student plays a pivotal role in the micro curriculum within HEIs. A critical realisation for HEIs worldwide is the evolving role of students in the academic landscape and the fundamental factors driving student success, particularly in terms of quality assurance and the advancement of academic programmes (Carey 2013). Students have transitioned from passive recipients of knowledge to active collaborators in the learning process, assuming the role of self-directed learners. This shift necessitates

increased student engagement, participation and accountability within HE curricula compared to previous models, prompting a need for curriculum renewal (Bovill & Bulley 2011). Van Zyl et al. (2020) highlight changes in knowledge modes and advocate for Mode 3 knowledge production, integrating aspects of the Fourth Industrial Revolution (4IR), artificial intelligence (AI) and emerging technologies to address contemporary issues. Sandstrom (2014, p. 25) contends that adopting Mode 3 knowledge production in HE curricula prepares individuals for professional roles and cultivates critical and creative thinkers capable of engaging with various epistemological, technological and systemic perspectives. Van Zyl et al. (2020) argue that curriculum developers must innovate and tailor educational offerings to equip students for success in the 21st-century workforce.

If we approach the issues through Archer's structure-culture-agency theory (2002, 2007, 2013) and apply them to micro-level curriculum transformation, the role of the lecturer becomes pivotal yet challenging. Lecturers, individually and within-subject groups, hold significant authority and carry substantial responsibilities within the HE environment. Their positioning within knowledge frameworks involves understanding their roles within institutional structures, assessing their influence and affirming cultural contexts. Crucially, they must actively embrace their roles as change agents in their daily professional practices. Pinar (2012) characterises curriculum development as often involving difficult conversations. When lecturers engage in these dialogues – whether with colleagues, students or themselves – they frequently find value in pursuing SDL and CPD opportunities to enhance their teaching practices through critical reflection.

■ The role of the lecturer as a curriculum designer, developer and implementer

Continuous professional development holds significant prominence within HEIs globally. The onset of the pandemic and the subsequent shift to remote and online TLA underscored various aspects, needs, gaps and strengths inherent in CPD programmes. Typically, support units within HEIs are at the forefront of CPD development and delivery. Continuous professional development is essential for lecturers as it is integral to navigating the evolving landscape of HE, necessitating their continuous adaptation and SDL (Engin & Atkinson 2015). According to Maphosa et al. (2014), effective curriculum planning and development by lecturers hinge upon adequate training, knowledge and skills acquisition. The authors contend that understanding their roles is imperative for academics to contribute to curriculum development initiatives actively.

University educators should possess the requisite competencies for developing TLA initiatives and crafting supplementary educational materials (Ishmail 2004; Powell 2010). Engaging lecturers in training and CPD programmes aligned with recommended practices and methodologies can foster departmental improvements in attitudes, values and skills, facilitating effective knowledge transfer within academic units (Powell 2010). Insufficient emphasis has been placed on lecturers' selection and capacity building to enhance TLA practices and promote curriculum transformation (Powell 2010). Many educators are ill-prepared to address the imperative of decolonial discourse in their teaching (Ammon 2019). While CPD opportunities at NWU address aspects of curriculum transformation, deliberate efforts are needed to enhance lecturers' and support staff's content knowledge to engage in transformative initiatives like decolonisation effectively. Nevertheless, lecturers must employ SDL strategies, such as reflective practice, to assess their competencies and prioritise skill enhancement crucial for success in their role as university educators.

The DHET (2018) introduced a framework to advance academics in their roles as university educators. This framework outlines six critical priorities for enhancing lecturer capabilities. These priorities include facilitating CPD opportunities tailored for university teachers; establishing supportive structures, organisations and resources; acknowledging and incentivising excellence in university teaching through leadership initiatives; fostering the dissemination and exchange of knowledge on teaching and learning practices; and nurturing the professional development of lecturers in their capacity as university educators through targeted CPD initiatives.

According to King's research (2004), TLA professionals reported participating in various professional development activities. Several activities included engaging in dialogues with colleagues; assisting colleagues in enhancing their teaching methodologies; networking with peers from different HEIs; perusing literature on TLA; utilising online resources related to TLA; participating in workshops focusing on TLA; exchanging insights with staff members in institutional support units; pursuing or holding qualifications in TLA; attending conferences dedicated to TLA; and applying for grants aimed at TLA initiatives.

Linked to King's findings, we focused on CPD opportunities related to curriculum transformation. Extensive scholarly literature exists regarding the necessity of CPD within HE lecturer training programmes (Crawford 2008; Mulvey 2008). Continuous professional development includes discussions on the principles and theories underpinning curriculum design and development, often connected with instructional design models (Meyers & Nulty 2009; Wiliam 2013), as well as the provision of CPD training

resources and frameworks aimed at facilitating curriculum enhancement (Dafoulas, Barn & Zheng 2012; Dodd 2021).

Journal articles and documents discussing the specifics of CPD opportunities for lecturers focused on curriculum development, design, renewal and transformation in HE contexts are scarce. We examined university webpages to explore the details of their CPD offerings related to curriculum development, design, renewal, transformation and fostering SDL practices in lecturers. However, access to university webpages is limited to the public; therefore, not all documents available were accessible to analyse. The main themes from our analysis focus on:

- the process and phases involved in curriculum design and development (Cornerstones 2021; Nelson Mandela University [NMU] 2021)
- instructional design strategies employ frameworks like Analysis, Design, Development, Implementation, and Evaluation (ADDIE), Technological Pedagogical Content Knowledge (TPACK) theory and UCL's ABC (Arena, Blended, Connected) cards
- the theoretical foundations, orientations and frameworks influencing curriculum development (Quinn & Vorster 2004)
- writing and defining qualification/course outcomes and the purpose of academic degrees (CHE 2017)
- constructive alignment in curriculum design (UoW 2022)
- identifying and integrating graduate attributes into curricula (Oliver 2013)
- strategies to facilitate and improve SDL approaches and strategies (Hadwen & Galloway 2008).

Many HEIs offer staff CPD opportunities to enhance curriculum design, development and renewal abilities. There is limited literature on how HEIs conduct CPD training specifically for curriculum transformation, renewal and growth. Even less attention is given to SDL regarding curriculum practices within CPD programmes. Strategically integrating SDL developmental practices into CPD programmes would be beneficial.

Maphosa et al. (2014) contend that lecturers should undergo orientation in the teaching domain to acquire a comprehensive understanding and appreciation of suitable pedagogical (including andragogical and heutagogical) approaches, alongside developing their knowledge of curriculum orientations, development and collaborative practices. Thus, lecturers must possess pedagogical and disciplinary expertise in academia to excel in curriculum-related tasks. Their role is multifaceted, often extending beyond their formal training. They should be well versed in applicable curriculum levels. Continuous professional development aids in addressing any shortcomings (Slabbert-Redpath 2022). Therefore, CPD is linked to improving curriculum transformation to support SDL in several ways:

■ **Updating pedagogical approaches**

Continuous professional development provides lecturers with opportunities to stay current with emerging pedagogical theories and practices that support SDL. Continuous professional development includes understanding how to design and implement curricula that foster autonomy, critical thinking and problem-solving skills, which are essential for SDL. By participating in CPD, lecturers can learn effective strategies for transforming traditional curricula into more student-centred and conducive environments for SDL.

■ **Enhancing technological integration**

Continuous professional development helps lecturers stay abreast of advancements in educational technology and digital resources that can facilitate SDL. Integrating technology into curriculum transformation allows lecturers to create interactive learning experiences, provide access to online resources and support collaborative learning environments – all beneficial for SDL. Continuous professional development ensures that lecturers are proficient in using technology to enhance the effectiveness and relevance of the curriculum transformation process.

■ **Developing contextualised learning experiences**

Continuous professional development supports lecturers in understanding the importance of contextualising learning experiences within their students' local, cultural and social contexts. This understanding is critical for curriculum transformation to make learning meaningful and relevant to students' lives. By participating in CPD, lecturers can learn how to adapt curricula to reflect diverse perspectives, incorporate local examples and case studies, and engage students in SDL within their contexts.

■ **Promoting reflective practice**

Continuous professional development encourages lecturers to engage in reflective practice, critically evaluating their teaching methods, curriculum designs and student outcomes. This reflective process is essential for refining and improving curriculum transformation efforts to support SDL better. Through CPD activities such as workshops, peer discussions and action research, lecturers can gather feedback, identify areas for improvement and make informed adjustments to enhance SDL implementation.

■ Supporting collaborative learning communities

Continuous professional development fosters the development of collaborative learning communities among lecturers, where they can share experiences, exchange ideas and collaborate on improving curriculum transformation practices. Engaging in CPD activities such as professional conferences, seminars and online forums allows lecturers to learn from each other's successes and challenges in implementing SDL. This collaborative approach enhances the collective expertise and effectiveness of curriculum transformation efforts.

■ Meeting professional standards and expectations

Continuous professional development ensures that lecturers meet professional standards and expectations for teaching effectiveness and student learning outcomes. By participating in CPD, lecturers demonstrate their commitment to continuous improvement and staying abreast of best practices in curriculum transformation and SDL. This professional development enhances their skills and knowledge and contributes to the overall quality of education and student achievement.

In conclusion, CPD plays a critical role in improving curriculum transformation to support SDL effectively. By updating pedagogical approaches, integrating technology, developing contextualised learning experiences, promoting reflective practice, fostering collaborative learning communities and meeting professional standards, CPD enables lecturers to enhance the design and implementation of curricula that empower students to become self-directed learners.

At NWU, the Centre for Teaching and Learning (CTL) oversees CPD, emphasising academic recognition and development. The CTL focuses on pedagogical skills and offers flexible CPD options such as webinars, sessions and online courses, which are accessible on the Centre's webpage. In addition, the University Capacity Development Programme (UCDP) aims to address transformation challenges in HE. From 2019 to 2021, opportunities were provided for lecturers to enhance their CPD and curriculum-related skills. However, there is a need to fill the pedagogical gap and provide guidance within the NWU Curriculum Framework. To support institutional curriculum transformation, CTL and Q&APP units should develop a unified approach for CPD opportunities, ensuring deep knowledge and improved pedagogical skills among academic staff (North-West University [NWU], 2021).

■ Recommendations

The chapter aimed to answer the research questions on how the curriculum can be unpacked to improve contextualisation, highlighting student-centred pedagogy. Additionally, it explored how SDL can be included and how CPD can be improved to enhance curriculum transformation. Enhancing lecturers' roles as curriculum developers and designers is crucial for improving curriculum transformation. Doing so requires contextualising curricula, promoting SDL, incorporating social justice and decolonising content. Continuous professional development is vital to empower lecturers in these areas. Continuous professional development should focus on SDL, hybrid teaching strategies and fostering self-reflective skills. That said, CPD plays a pivotal role in curriculum transformation by embedding knowledge and pedagogy into teaching, learning and assessment practices. Lecturers, as change agents, drive curriculum transformation. Expanding CPD opportunities can help lecturers improve teaching qualifications and micro-credentialing. Curriculum training and orientation are essential to bolster transformation efforts and motivate lecturers to reflect on their practices. In summary, streamlining CPD efforts is key to advancing curriculum development and equipping lecturers with the necessary skills.

Dedicated opportunities should be created to strengthen our lecturers' scholarly research and lifelong learning. An avenue to improve scholarly skills can be through research projects linked to curriculum transformation. Lecturers engaging with SoCP would contribute to closing the gap in the knowledge society of African scholars engaged with curriculum practitioner practices. Scholarship of curriculum practices (as part of SoTL) can open more praxis-based opportunities to contribute to curriculum transformation research and CoP.

Based on our findings, it is recommended that the factors listed below are considered to enhance curriculum transformation.

- Lecturers need to understand their role in curriculum transformation. When lecturers purposefully integrate and plan for curriculum contextualisation in the TLA of their curriculum, the notion of curriculum responsiveness occurs. Curriculum contextualisation is needed to deliver the curriculum to students.
- The lecturer plays a pivotal role in the process of transforming the curriculum. Curriculum transformation begins and ends with the lecturer's purposeful engagement, internal motivation, the decision to change or improve their curriculum, and the development of their self-directed skills.
- Continuous professional development opportunities should be undertaken at a deeper level to stimulate reflection critically linked to the SDL skills of the lecturer as a learner to develop transformative learning skills in lecturers and their students.

- The lecturer's role as a change agent (and SDL agent) informs the level of curriculum transformation. Incentives for curriculum transformation efforts and dedicated time on task agreements of lecturers should be considered.
- Continuous professional development opportunities should be provided to strengthen PCK, student-centred strategies, SDL and transformative learning skills, equipping lecturers to become key change agents who can affect curriculum transformation.

■ Conclusion

The concept of the curriculum is intricate and multifaceted across its different levels. Enhancing curriculum transformation requires lecturers to recognise their role as agents of change tasked with contextualising the HE curriculum. Lecturers should be equipped to improve their pedagogical practices and beliefs and see the value of using student-centred pedagogy. When lecturers become self-directed in their pedagogical practices, SDL will be implemented in the curriculum, enhancing curriculum transformation and influencing scholarly research practices. We employed the concept of the ZPD to elucidate how learning can be scaffolded. According to Vygotsky (1987), the curriculum plays a pivotal role in supporting student learning within their ZPD, facilitating their potential developmental growth. This study employs the ZPD framework to reassess learning and curriculum progression, aiming to bridge the gap between current practices and aspirational goals. To conclude this chapter, we echo Barnett and Coate's (2005) assertion that the academic community should prioritise the SoTL alongside curriculum development. While progress has been made, there remains considerable ground to cover.

Thus, the exploration of CPD through SDL has clarified the essential responsibility lecturers play in the continuing transformation of curricula. As lecturers participate in SDL initiatives, they develop and improve their pedagogical skills, amend to changing educational landscapes and add considerably to the development of student learning experiences. This serves as a natural transition into the succeeding chapter, where we enquire into the practical implementation of an SDL curriculum. Directing precisely on the amalgamation of cooperative learning-embedded assessment, the forthcoming discussion focused on innovative approaches that empower lecturers and students, fostering a collaborative educational environment.

■ Ethical clearance number

The ethical clearance number for this study is NWU-01641-19-A2.

Towards a student-centred curriculum: The case of cooperative learning-embedded assessment

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■ Abstract

This chapter⁵ discussed the value of cooperative learning-embedded assessment towards a student-centred curriculum, drawing on social constructivist and positive interdependence theories. Through a student-centred curriculum, student agency and autonomy are implied. 'The individual's ability to self-direct is of great importance to society, working

5. This chapter represents a substantial (more than 50%) reworking of A Lubbe, 2020, 'Cooperative learning-embedded assessment: Implications for students' assessment literacy and self-directedness in learning', for the degree Doctor of Philosophy in Natural Science Education at the North-West University, Potchefstroom Campus, with supervisor Prof. E Mentz and co-supervisor Prof. Kobus Lombard, https://repository.nwu.ac.za/bitstream/handle/10394/35641/Lubbe_A.pdf?sequence=1&isAllowed=y

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life, and self-development'. Involving students in the learning process through cooperative learning draws on the power of the social interdependence theory, which fosters interaction and collaboration among students and contributes to students' learning. The five fundamental cooperative learning elements (positive interdependence, individual accountability, promotive interaction, social skills and group processing) set it apart from other collaborative learning groups or group work.

Although the role of students in a student-centred curriculum differs significantly from that in a traditional curriculum, with learning being socially supported within the zone of proximal development (ZPD), assessment practices have not changed, and students are still expected to be passive during assessments. Rooted in the principles of social constructivism, cooperative learning-embedded assessment draws from the social interdependence theory. Social interdependence is structured instead of social independence or dependence. The focus of cooperative learning-embedded assessment is, therefore, learning through assessment, which emphasises the active involvement of students.

To determine the value of cooperative learning-embedded assessment as pedagogy, the study on which this chapter reports drew from questions in an open-ended questionnaire as well as from semi-structured individual interviews. The questions aimed to determine first-year Life Sciences (LIFE) students' perception of a cooperative learning-embedded assessment intervention. Open coding, with the aid of ATLAS.ti™, was used to analyse the data of the current basic qualitative study.

The data analysis revealed that students perceived cooperative learning-embedded assessment as valuable in their learning process. For example, participating students indicated that their involvement in cooperative learning-embedded assessment enabled them to be motivated to learn, to take the initiative and responsibility for learning, to formulate learning goals, to select relevant learning strategies, to evaluate their learning endeavours and to see peers as resources. These skills support a self-directed learner's development.

■ Introduction

Chapter 6 focused on curriculum transformation underpinned by self-directed learning (SDL) advocating for greater emphasis on the student in higher education. This chapter promoted a student-centred curriculum underpinned by SDL and cooperative learning-embedded assessment. There is increasing importance on empowering students and enhancing their participation and agency in the learning process, as the move towards

student-centred pedagogies has attracted considerable attention in contemporary education. The idea of cooperative learning-embedded assessment, a pedagogical strategy that embeds assessment within cooperative learning principles, is crucial to this progression because it promotes dynamic and mutually reinforcing interaction between learning and assessment (Lubbe 2020). This chapter explores the role of cooperative learning-embedded assessment and examines how this strategy integrates educational theory and practice to empower students while fostering effective group dynamics. This chapter draws from the social constructivist theory (Vygotsky 1978) and the positive interdependence (Watson & Johnson 1972) theory.

The fundamental tenet of a student-centred curriculum is the understanding that learning should be a collaborative and active process, with students at the centre of their educational journeys (Brown 2008). Student agency and development of autonomy are intrinsically linked to a student-centred curriculum (Jääskelä et al. 2020) and are helpful in the educational setting and significant in the development of SDL skills (Loeng 2020). The individual's capacity for self-direction is of value to society, the working world and one's personal growth, as argued by Loeng (2020).

The educational strategy of cooperative learning, which is based on the theory of social interdependence, is seen as a powerful way to put the principles of student-centredness and active involvement into practice (Johnson & Johnson 2015). This strategy uses the strength of positive interdependence, which has been linked to effective cooperative learning (Johnson & Johnson 2015). Positive interdependence fosters a culture where students see their successes as connected to those of their peers, inspiring a shared commitment to group success (Gillies 2016). Learning effects are further reinforced by the subsequent constructive interaction between group members (Slavin 2014). Moreover, positive interdependence, individual accountability, promotive interaction, social skills and group processing are the five distinctive components that distinguish cooperative learning from other collaborative group work (Johnson & Johnson 2015).

Conciliating the conventional role of students in assessment practices with the principles of active and participatory learning (i.e. cooperative learning) is a fundamental aspect of moving towards a student-centred curriculum. In the past, assessments frequently portrayed students as passive consumers of information, which was inconsistent with 21st-century higher education. Cooperative learning-embedded assessment links these two seemingly incompatible paradigms (Lubbe 2020). Cooperative learning-embedded assessment fosters a holistic learning environment

where assessment becomes an important part of the learning process by structuring social interdependence rather than social independence or reliance (Butera & Buchs 2019; Lubbe 2020; Watson & Johnson 1972). This method shifts the emphasis from individual performance and competition, frequently emphasised in traditional examinations, to tapping into the power of the social constructivist theory and enabling learning through assessment (Lubbe 2020; Lubbe & Mentz 2021). The social constructivist theory (see Kay & Kibble 2016; Vygotsky 1978), which encourages socially supported learning within the zone of proximal development (ZPD), strongly resonates with this point of view. Using the social constructivist theory as a lens eliminates the contradiction between assessment and learning, leading to a more unified educational environment where students actively participate in their learning process by developing their SDL skills (Lubbe 2020).

Educators could promote a shift towards empowering students, encouraging active involvement, and developing a sense of student agency, autonomy and self-directedness. Education is constantly adapting to meet the demands of a fast-changing world. In this chapter, the researchers therefore discuss the value of how the integration of cooperative learning and assessment might redefine the educational environment in a way that resonates with the varied and dynamic requirements of students. The next section outlines the problem statement.

■ Problem statement

Modern education is experiencing a fundamental transformation towards student-centred pedagogies, as it recognises the necessity of involving students actively in their educational journeys (Bremner, Sakata & Cameron 2022; Wright 2011). The realisation that education should not be a passive transmission of knowledge but rather an interactive and dynamic process fostering student agency (i.e. giving students a voice), autonomy and critical thinking should inspire the shift from traditional didactic instruction to more collaborative and enjoyable learning experiences. The conflict between traditional assessment methods and student-centred learning, however, remains an obstacle, especially when attempting to engage students actively in assessing their development (Lubbe 2020). As a result, two issues need to be resolved: how to make assessment an integral and collaborative part of the learning process (instead of a stand-alone process), while still incorporating the principles of a student-centred curriculum and cooperative learning.

The discrepancy between the changing nature of education and conventional assessment methods emphasises the necessity of bridging

the divide between ideas of student-centred learning and the predominating assessment paradigms (Bennett 2015). Integrating assessment into a cooperative learning framework poses a theoretical and practical difficulty, even though cooperative learning offers a potential path to more active and interactive learning experiences (Mendo-Lázaro et al. 2022). Improving learning outcomes and evaluative insights necessitates a complex endeavour of re-evaluating assessment as a dynamic and interactive process while ensuring the smooth integration of cooperative learning approaches and assessment processes. To realise the goal of a student-centred curriculum where students are active agents in their learning and assessment processes, it is, therefore, necessary to investigate and explicate the possibilities of cooperative learning-embedded assessment as a transformative solution to this issue (Lubbe 2020). To this end, determining students' perceptions of being involved in cooperative learning-embedded assessment will provide insight into the value thereof for a student-centred curriculum. Therefore, the question that directed this study was: *What are first-year Life Sciences students' perceptions of cooperative learning-embedded assessment?*

The next section explains the components underpinning this research, based on the social constructivist theory and social interdependence theory.

■ Theoretical and conceptual framework

Integrating cooperative learning-embedded assessment, a student-centred curriculum and SDL skills represents a dynamic framework that harmonises pedagogical theory and practice to improve learning. A thorough understanding of how these components interact to produce a comprehensive and robust educational experience is provided by this framework, which draws on fundamental ideas from the social constructivists and social interdependence theory. Learning is a socially mediated process through contact with peers and educators (Vygotsky 1978). This theoretical framework makes it possible to comprehend how these components are fully interrelated.

■ Cooperative learning-embedded assessment

Over the past 50 years, Vygotsky's theories on social constructivism have remained highly relevant and influential and shaped educational practices. It has even been foundational for subsequent theories.

The theoretical foundations of cooperative learning-embedded assessment can also be based on the social constructivist theory

(Vygotsky 1978) and the social interdependence theory (Johnson & Johnson 2015), extended in 1972 by Watson and Johnson to the ‘structure-process-outcome theory’ for cooperation. According to Watson and Johnson (1972), the outcomes of the interaction among group members are influenced by how the individual members react, which depends on how the interdependence is structured (Table 7.1). The social interdependence theory emphasises positive interdependence among group members, where individual success is intertwined with group achievement. Table 7.1 shows that positive interdependence leads to cooperation, which leads to promotive interaction among group members. Promotive interaction within a group could result in an increased effort to achieve positive interpersonal relationships and psychological health (Johnson & Johnson 2015, 2021). Members of a group help and assist one another by exchanging resources, providing and receiving feedback, encouraging one another’s increased efforts, engaging in social skills required for group success, reflecting on current and desired teamwork, and challenging cognitive skills (Johnson & Johnson 2021). Promotive interaction leads to group members focusing on the learning of all group members rather than just their own (Johnson & Johnson 2015).

TABLE 7.1: Interaction patterns of interdependence.

How social interdependence is structured	How individual group members react	The type of group interaction
Positive interdependence	Cooperation	Promotive interaction
No interdependence	As individuals	No interaction
Negative interdependence	Competition	Oppositional interaction

Source: Lubbe (2020, p. 68).

In the absence of interdependence, group members believe they can achieve their goals on their own. As a result, group members will act solely in their own interests, with no interaction between them. Negative interaction results in competitive behaviour among group members and oppositional interaction. Oppositional interaction not only causes individual group members to focus on increasing their own success but also gives rise to group members obstructing each other’s efforts to achieve their goals. According to Johnson and Johnson (2015), individualistic and competitive efforts result in decreased effort to achieve, negative interpersonal relationships and psychological maladjustment.

The presence of the following five basic cooperative learning principles distinguishes the cooperative environment from other collaborative or group work endeavours (Johnson & Johnson 2015; Johnson, Johnson & Holubec 2013):

- positive interdependence
- individual accountability
- promotive interaction
- social skills
- group processing.

These principles are the heartbeat of cooperative learning and, subsequently, of cooperative learning-embedded assessment (Lubbe 2020) and are therefore discussed below.

Positive interdependence: This principle emphasises the idea that the success of group members is interconnected. Individuals thus believe that their own accomplishments are linked to the accomplishments of their peers. Positive interdependence encourages collaborative effort because success benefits all group members. Students are more likely to support and help one another to achieve the best possible collective results when they recognise their shared goals and outcomes (Johnson & Johnson 2015).

Individual accountability: According to Tran (2013, p. 103), 'individual accountability is considered as the degree to which the achievement of the group depends on the individual learning of all group members'. Individual accountability ensures that each group member is accountable for contributing to and mastering learning. This principle discourages free riding or relying solely on others by encouraging active participation and engagement from all group members (Johnson & Johnson 2015).

Promotive interaction: Johnson and Johnson (2021, p. 56) state that positive interaction results in 'students promoting each other's success by sharing resources, helping, assisting, supporting, encouraging and praising each other's efforts to learn'. The importance of meaningful communication and interaction among group members is emphasised by encouraging interaction. Students collectively deepen their understanding of the content through discussions, explanations and sharing of ideas. Engaging in dialogue and explaining to peers not only benefit the receiver but also reinforce the understanding of the person explaining, thereby strengthening the immediate feedback process.

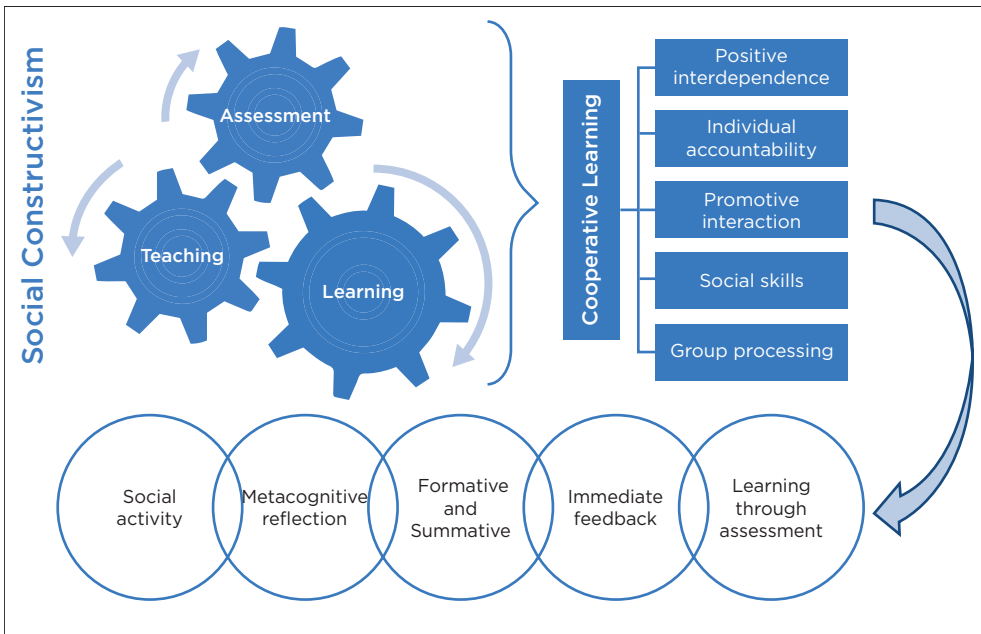
Social skills: Social skills development within a cooperative learning context is critical for effective collaboration. These skills include active listening, effective communication, conflict resolution and mutual respect (Gillies 2016). Social skills promote fluid group dynamics, ensuring constructive interactions and focus on the task. Knowing and trusting one's group members, communicating clearly and unambiguously, accepting and supporting one another, and constructively resolving conflict within the group are all important social skills to have when coordinating efforts to achieve common goals (Johnson & Johnson 2021). According to Tran

(2013, p. 104), social skills do not only promote higher achievement ‘but they also contribute to the development of more positive relationships among group members’.

Group processing: Regular reflection on the effectiveness of the group’s collaborative efforts is part of group processing. Group members evaluate what is working well and identify areas for improvement in task performance and group dynamics (Johnson & Johnson 2015). This self-evaluation encourages continuous improvement, enhancing the overall performance and cohesion of the group.

Cooperative learning-embedded assessment focuses on assessment as a social learning activity and thus on learning through assessment. Cooperative learning-embedded assessment is conceptualised as a learning activity within a social constructivist, cooperative learning context rather than as an addition to the teaching and learning process. According to Webb et al. (2019), the perspectives on productive student participation often centre on explaining one’s thinking and engaging with the ideas of others. The characteristics of cooperative learning-embedded assessment and a proposed model are discussed below.

One of the distinguishing features of cooperative learning-embedded assessment is that all assessment activities occur within a cooperative learning environment (see Figure 7.1). Each assessment activity incorporates



Source: Based on Lubbe (2020, p. 76).

FIGURE 7.1: Cooperative learning-embedded assessment characteristics.

positive interdependence, individual accountability, promotive interaction, social skills and group processing. Assignable to the social constructivist approach, teaching, learning and assessment are inseparable processes. This implies that assessment activities – as opposed to traditional competitive or individualistic assessments – are also participative in nature. Cooperative learning-embedded assessment encourages learning through assessment, emphasising the learning process rather than assessment practices (Lubbe 2020). Therefore, assessment is regarded as a teaching and learning tool.

Evident from Figure 7.1 are the following key characteristics of cooperative learning-embedded assessment (Lubbe 2020):

- *Assessment should be a social activity* – because of the theoretical underpinnings of cooperative learning-embedded assessment, the participatory capabilities of assessment instruments should be considered when selecting these instruments. If the chosen assessment instrument was not participative in nature (for example, standard individual tests), it had to be rebuilt to allow for participation, which meant the assessment instrument had to be administered in cooperative learning groups. Individual tests could benefit from a participatory component to ensure that assessment is grounded in social constructivist theory. This could be accomplished, for example, by having students write the test together. The cooperative learning group receives one copy of the same test in this case. This not only ensures that the test is a social activity but also structures individual accountability. Another option is to have students take the test in cooperative learning groups first, followed by individual testing. In this case, the test would not only be a social activity that encourages positive interdependence but also be an individual test component that encourages personal accountability. Students could also take the individual test and retake it in their cooperative learning groups. Regardless of the order in which the tests are written, social skills would be developed.
- *Assessment should provide an opportunity for metacognitive reflection* – the ability to evaluate one's own learning is not only one of the characteristics of a self-directed learner, but it is also part of the repertoire of an assessment-literate student (Price et al. 2012). Make time for metacognitive reflection when preparing for cooperative learning-embedded assessment. Metacognitive reflection, for example, could be accomplished by using reflection prompts or questions (Ifenthaler 2012). These reflection prompts or questions can be answered online or as part of the assessment tool. When students complete an individual test followed by a cooperative learning group test, they can reflect on and self-assess their individual responses while completing the cooperative learning group test. Following such an assessment,

students may be asked to complete an online reflection sheet in class (Ifenthaler 2012). In such a reflective activity, students would be asked to reflect on how they prepared for the test, how much time they spent preparing for it, whether they could adapt their learning strategies and what they would do differently the next time.

- *Assessment can be for formative and summative purposes* – the participatory nature of cooperative learning-embedded assessments, rooted in social constructivist theory and embedded in cooperative learning, enables such assessment to be used for both formative and summative assessment at the same time (Brookhart & Durkin 2003; Taylor 2011). As a result, assessment activities embedded in cooperative learning assess learning outcomes, identify learning gaps and improve teaching and learning. As a result, a cooperative learning group test is more than just a high-stakes summative assessment at the end of instruction. The results of an individual test followed by a cooperative learning group test could be used to assess learning outcomes while diagnosing learning gaps (Stiggins & Chappuis 2005).
- *Assessment should include an opportunity for immediate feed-forward* – effective feedback strategies in assessment practices are well documented. When developing and implementing cooperative learning-embedded assessment instruments, opportunities for effective feedback should be purposefully structured, and the feedback provider (i.e. peers, lecturer or both) should be identified. When students write an individual test followed by a cooperative learning group test, peers provide immediate feedback when discussing individual answers to reach a consensus on the correct answer. If the cooperative learning group test is written first, followed by an individual test, the immediate feedback provided by peers helps to close the gap between current and desired achievement (Koen, Bitzer & Beets 2012). As a result, students can act almost immediately on peer feedback. Another option would be to have students write an individual test and then work together in cooperative learning groups to create a memorandum for the written test. Students can use any relevant resources when compiling the memorandum, as learning is encouraged. The students can then use the memorandum they have compiled to peer assess the individual tests. Peers can discuss their individual tests in relation to the memorandum to ensure immediate feedback. This ongoing dialogue will allow students to improve their self-awareness and social skills. Following such a cooperative learning-embedded assessment intervention, the lecturer can prompt a whole-class discussion to encourage ongoing lecturer-peer dialogue about learning. The group-processing element of cooperative learning will also be ensured through whole-class discussion (Lubbe 2020).

- *Learning and assessment should occur within a cooperative learning environment* - creating and implementing cooperative learning-embedded assessment necessitates structuring the assessment instrument around the five basic cooperative learning elements (Lubbe 2020). It is worth noting that all five cooperative learning elements (see 7.3.1) have to be present to ensure positive interdependence, which will lead to student cooperation. Positive interdependence could be structured by ensuring that each cooperative learning group only receives one copy of the test. Students must therefore collaborate to complete the single test copy. Keeping the groups small - two or four students per cooperative learning group - would help to foster positive interdependence. Individual accountability can be structured by combining the cooperative learning group test with an individual test. Furthermore, if the lecturer decides to use the test as a summative form of assessment, the individual test may be weighted more heavily than the cooperative learning group test. Promoting positive interaction can be achieved by keeping the groups small (two or four students per cooperative learning group) and having students write the cooperative learning group test facing each other around a table. The cooperative learning group test can be used before or after the individual test to ensure small-group social skills. Cooperative learning-embedded assessment can help students improve their small-group social skills by discussing the test, explaining the work, reaching a consensus on the correct answer and providing feedback. Group processing occurs through feedback when students complete the cooperative learning group test and is performed because feedback may include advice on how to study differently, as well as content-related advice. After completing and submitting the individual and group tests, whole-class processing can occur through ongoing lecturer-peer dialogue (Johnson & Johnson 2015).
- *Learning occurs through the assessment* - a paradigm shift is required when developing and implementing cooperative learning-embedded assessment. The emphasis should not be on assessment (assessment **of** learning, assessment **for** learning, assessment **as** learning) but on learning **through** assessment. Cooperative learning-embedded assessment proposes a new approach to assessment that prioritises learning: learning **through** assessment. This assessment approach considers teaching, learning and assessment as inseparable activities within a social constructivist context. Students can learn from cooperative learning-embedded assessment because the emphasis is on the learning process rather than on the form or purpose of assessment.

It is critical for the successful implementation of a cooperative learning-embedded assessment that the above factors all be considered explicitly

when developing such an assessment. Cooperative learning activities support the ideals of promotive interdependence by fostering peer engagement, fostering shared objectives and promoting constructive discourse (Johnson & Johnson 2015). The cooperative learning principles embedded in assessment tasks make the most of the effectiveness of teamwork by allowing students to participate in assessments through active discussions and group reflection. Cooperative learning-embedded assessment is a logical outgrowth of the social nature of learning within the social constructivist paradigm. Students who participate in such assessment conversations not only strengthen their understanding but also co-create knowledge with their peers, in line with the social constructivist principles, as well as fostering autonomy.

■ Student-centred curriculum and self-directed learning

A student-centred curriculum is characterised by an educator who acts as a facilitator to support students' learning processes (Duschl, Schweingruber & Shouse 2007). The educator is therefore not transmitting knowledge to students via lectures, textbooks or recipe-like activities, with each step explicitly outlined and dictated by the educator (Duschl et al. 2007; McLean & Gibbs 2010). According to Shrivastava and Shrivastava (2020, p. 53), 'a student-centred curriculum is the one in which students themselves are accountable for the teaching-learning process'. The student is therefore at the centre of the learning opportunities and process and must be supported and empowered to take an active role in his or her learning process. A student-centred curriculum is characterised by key 21st-century skills, such as critical thinking, collaboration and SDL skills (Wulf 2019).

Self-directed learning is influenced by the writings of Knowles (1975) and Guglielmino (1978). This process emphasises how students may take charge of their educational experiences by establishing goals, creating learning strategies and monitoring their progress. Self-directed learning is also said to be 'our most basic, natural response to newness, problems, or challenges' (Guglielmino & Long 2011, p. 5). Assessment that is integrated into cooperative learning creates a setting that helps develop SDL abilities (Lubbe 2020). Students gain metacognitive abilities and a sense of agency over their learning by actively participating in the assessment tasks, identifying their learning needs and reflecting on their learning progress. The characteristics of SDL in which students actively define their educational trajectories (Guglielmino 1978; Knowles 1975; Warburton & Volet 2012) are reflected in the cooperative learning-embedded assessment tasks. According to social constructivism, SDL is therefore seen as having a part in the construction of knowledge.

In essence, a social constructivist framework that incorporates cooperative learning-embedded assessment, a student-centred curriculum and SDL created a lucid and harmonious backdrop for this study. Theoretically, social constructivism underpins the significance of group interactions, meaningful and active involvement, and student agency in the learning process. The interconnected components support one another, resulting in a dynamic, interactive environment. An explanation of the methods used in this research to answer the research question is discussed below.

■ Research methodology

The sections below position this research within the interpretivist paradigm and outline all aspects of the research methodology that were implemented during this study, keeping in mind that this study was aimed at establishing whether the implementation of cooperative learning-embedded assessment promoted a student-centred curriculum.

■ Research paradigm

The qualitative research for the study on which this chapter reports was guided by the interpretivist research paradigm. This paradigm was deemed appropriate because ‘communication, interaction, and practice’ (Tracy 2019, p. 51) are required to construct reality and knowledge, and this would allow for the consideration of diverging participant perspectives and experiences (Mwita 2022; Rehman & Alharthi 2016). The interpretivist paradigm enabled the researchers to interpret the meanings of the data gathered from the experiences of the participants. This viewpoint also influenced the inductive analysis of students’ responses.

■ Research design

According to Merriam (2009) and Tracy (2019), the focus of qualitative research is on the way in which meaning is ascribed to people’s lived experiences, and how these experiences are interpreted. To that end, a basic qualitative research design (see Merriam 2009; Tracy 2019) was used, consistent with this research objective and question of this study.

■ Research ethics consideration

National and institutional ethics guidelines and policies were followed throughout the research process, and data were only collected after ethical clearance and gatekeeper permission had been obtained from the relevant ethics committee [NWU-HS-2016-0178]. The participants were first-year

students enrolled in the Life Sciences (LIFE) module, and they were assured that no one would be penalised for not participating. Moreover, no student group or class was denied the opportunity to participate in the investigation. The research component was entirely optional, and participants were free to opt out at any time. A third party handled participant recruitment and informed consent. Only data from participants who provided informed consent were included in the analysis. The anonymity of participants was maintained throughout the data handling process, and ethical data storage procedures were followed.

■ Sampling and data collection

All first-year LIFE students enrolled at the Faculty of Education at the university where this study was conducted and who provided informed consent completed an open-ended questionnaire on their experiences of cooperative learning-embedded assessment ($n = 82$). The qualitative data were gathered using the textual data obtained from the open-ended questionnaire. According to Maree and Pietersen (2016), the analysis of open-ended questionnaires is complex because participants answer the questions in detailed phrases or comments instead of single words.

The open-ended questionnaire was administered to the participants after their involvement in the cooperative learning-embedded assessment intervention. Even though all first-year LIFE students were exposed to the cooperative learning-embedded assessment intervention, partaking in the research was voluntary.

■ Data analysis

According to Seidel (1998), qualitative data analysis is an ongoing and iterative process through which aspects are noticed, collected and thought through. Even though qualitative data analysis entails general steps to be followed (i.e. preparing the data, organising the data and coding the data), qualitative data analysis is a non-linear process. (Nieuwenhuis 2016). Open coding was used for analysing the data gathered from the open-ended questionnaires. ATLAS.ti™ was the **computer-assisted qualitative data analysis software** (CAQDAS) used to analyse the data.

■ Trustworthiness

The need to assess the quality of qualitative research cannot be overstated (Nieuwenhuis 2016; Schurink, Fouché & De Vos 2011). According to Denscombe (2021), credibility, transferability, dependability and confirmability

are the factors that qualitative researchers should consider to make sure that their study is reliable. The term *credibility* describes how believable and reliable the research is. The credibility of this study was established by carefully choosing the participant quotes to make sure that the thesis was fully supported and by disclosing any limitations upfront so that the reader would understand how the conclusions were reached. *Transferability*, which is related to the generalisability of the research findings, was established during this investigation by refraining from generalising to the entire study population to understand the perspectives of the participants better. Merriam (2009) defines *dependability* as the degree to which the research findings can be replicated in a similar setting and with comparable participants. By meticulously analysing negative cases and discrepancies, dependability was established. *Confirmability* is the degree to which the results of the research can be verified by additional research. Confirmability was established during this investigation by repeatedly reviewing the data collected and analysing it to make sure that it would be possible that the findings could be repeated by other researchers. The ethical guidelines in the research were equally important.

In the next section, the findings of this research are discussed.

■ Findings

The responses to the open-ended questionnaire are used to discuss the findings of this study and to make recommendations for careful cooperative learning-embedded assessment planning, implementation and evaluation. After the questionnaire was completed, the data were analysed using ATLAS.ti™. Codes and group codes were identified that were relevant to the research question about students' perceptions of cooperative learning-embedded assessment. The questionnaire comprised the following five questions:

- Q1 - What is, according to you, the purpose of assessment in this LIFE module?
- Q2 - Please explain the role that assessment played in your learning process throughout the LIFE module.
- Q3 - In which way did the assessment practices used in this LIFE module influence your learning throughout the semester?
- Q4 - In which way did the assessment practices used in this LIFE module influence your preparation for the examination?
- Q5 - What is your general feeling regarding the assessment practices, which were implemented in the LIFE module?

The questions posed and reflected above were designed to ascertain students' perceptions of cooperative learning-embedded assessment in terms of the perceived purpose thereof, the perceived role of cooperative learning-embedded assessment in their learning process and the perceived influence of cooperative learning-embedded assessment on their learning process.

The following code groups concerning the students' perception of cooperative learning-embedded assessment were identified upon analysing the codes:

- curiosity and motivation
- feedback mechanism
- enhanced learning
- preparation for the examination
- identifying learning gaps
- development as a future teacher
- participative nature
- self-assessment.

These code groups were analysed and will be discussed briefly. Table 7.2 presents the codes, code groups and some quotes associated with students' overall perception of cooperative learning-embedded assessment.

The data analysis of the students' responses revealed the perceived value of cooperative learning-embedded assessment relating to their learning process and progress. Some students indicated that their involvement in cooperative learning-embedded assessment triggered their **curiosity** and created a sense of encouragement and **motivation** to learn. Below are some verbatim comments of participants on this theme of curiosity and motivation. Please note that all quotations below are reproduced verbatim and unedited:

'It [cooperative learning-embedded assessment] made me realise to do more preparation.' (P21, undisclosed gender, February 2019)

'It [cooperative learning-embedded assessment] rates me in a way of expressing myself on what I know or still want to learn' (P22, undisclosed gender, February 2019)

'I'm feeling determined to put effort due to the different techniques that were applied for assessment practices.' (P27, undisclosed gender, February 2019)

The cooperative learning-embedded assessment activities seemed to have provided an opportunity for some students to be curious about the content of the LIFE module, which in turn might have encouraged learning and preparation. Furthermore, the cooperative learning-embedded assessment

TABLE 7.2: Code groups, codes and the best quotes associated with the students' overall perception of cooperative learning-embedded assessment.

Code group	Code	Best quote representing the code
Curiosity and motivation	Created curiosity	<i>Assessment [CL-EA] ... created curiosity to learn more and develop as a student.</i>
	Encouraged me to prepare	<i>It [CL-EA] encouraged me to prepare.</i>
	Motivation to learn	<i>Because I go through an assessment, I have to be fully prepared. And the way we do our assessment [CL-EA] encourages me to study.</i>
Feedback mechanism	Feedback mechanism	<i>After the assessment [CL-EA], I will know where I need to focus more, especially after getting the feedback.</i>
	Need more feedback	<i>More feedback is required.</i>
Enhanced learning	Applied knowledge	<i>It [CL-EA] helped me to understand the work better through applying it.</i>
	Enhanced critical thinking	<i>They [CL-EA] made me use critical thinking.</i>
	Identified important content	<i>[I]t [CL-EA] helped me realise what is important and what not.</i>
	Identified achievement standards	<i>[I]t [CL-EA] helped me to see what is expected of you and gives an indication of what is needed to know.</i>
	Improved work	<i>It [CL-EA] helped me to improve the work that is assigned to me.</i>
	Increased understanding of content	<i>[T]hrough the assessment [CL-EA], I gained knowledge.</i>
	Learned easier	<i>[I]t's [CL-EA] an easier way to learn.</i>
	Learned new skills	<i>I acquired new skills.</i>
	Monitored progress	<i>The assessment influenced my performance as I used all the resources which were provided to help myself to evaluate on how much I have learned on a certain content.</i>
	More independent learning	<i>The aim thereof [CL-EA] was to enable me to work and to be less dependent on the lecturer.</i>
	Problem solving	<i>I am able to sort things out easily.</i>
	Promoted learning	<i>It [CL-EA] was difficult, yet a pleasant experience and it helped me get through difficult parts of the work.</i>
	Selected appropriate learning strategies	<i>It [CL-EA] taught me to use different methods of learning or analysing concepts.</i>
	Teaching and learning strategies	<i>The tests we wrote helped me a lot as they served as summaries for my work.</i>

Table 7.2 continues on the next page →

TABLE 7.2 (cont.): Code groups, codes and the best quotes associated with the students' overall perception of cooperative learning-embedded assessment.

Code group	Code	Best quote representing the code
Examination preparation	Better prepared	<i>I was better prepared and already had an idea of the content I had to study [for the examination].</i>
	Less stressful	<i>They [CL-EA] make tests less stressful overall increasing our marks in my opinion as well.</i>
	Logical answering	<i>[H]ow to tackle questions and answer them in a more logical way.</i>
	No difference	<i>[H]ow to tackle questions and answer them in a more logical way.</i>
	Prepared me for the examination	<i>I learned the work in the same manner as always.</i>
	Time management	<i>They [CL-EA] helped to prepare for my examinations.</i>
Identifying learning gaps	Diagnosed learning needs	<i>[T]o help students either by identifying what they [know] or what they don't know. This helps them in identifying what they need to study.</i>
	Identified strengths and weaknesses	<i>I was able to identify my strengths and weaknesses.</i>
Development as a future teacher	Own future classroom practice	<i>It [CL-EA] also played a big role in preparing me for my classroom when I become a teacher.</i>
	Positive perspective	<i>Gives you a more positive outlook on assessment.</i>
Participative nature	Collaboration	<i>It [CL-EA] taught me how to interact and work in groups successfully.</i>
	Learn better on my own	<i>I am someone who studies better on my own in silence.</i>
	Learned from peers	<i>I feel very pleased with the assessments [CL-EA] that was used because I was exposed to writing tests with my peers and got to see how to approach tests.</i>
Self-assessment	Self-assessment	<i>To test how much the learner knows of the content.</i>

Source: Lubbe (2020).

Key: CL-EA, cooperative learning-embedded assessment.

intervention was a motivational tool contributing to the students who take ownership of their learning process. As none of the students indicated that they were motivated by marks or grades, it might indicate that students were intrinsically motivated by their involvement in cooperative learning-embedded assessment. Although two students indicated a need for more feedback, most students perceived cooperative learning-embedded assessment as an immediate **feedback mechanism** allowing them to learn from their mistakes.

In this regard, verbatim quotes as examples of the participants' views on feedback during cooperative learning-embedded assessment are:

'After the assessment I will know where I need to focus more, especially after getting the feedback.' (P34, undisclosed gender, February 2019)

'It [cooperative learning-embedded assessment] gives learners encouragement because lecturers provide positive feedback and help me see where my developmental needs are.' (P21, undisclosed gender, February 2019)

Most students appeared to have taken advantage of the feedback opportunities provided by cooperative learning-embedded assessment and to have recognised the value of immediate feedback towards their learning progress. One student also indicated that even more feedback is necessary. Immediate feedback, which feeds forward into students' learning process, is one of the tenets of cooperative learning-embedded assessment, which might be why, yet another student said:

'It [cooperative learning-embedded assessment] has had a positive impact on my learning, because I immediately got feedback on what I know well enough and what I need to revise' (P39, undisclosed gender, February 2019)

In general, participating students valued cooperative learning-embedded assessment not only in terms of receiving feedback but also in terms of providing feedback. In the current investigation, cooperative learning-embedded assessment was designed to include the opportunity for immediate feed-forward via cooperative learning and its basic principles. The participative nature of cooperative learning-embedded assessment appears to have provided first-year LIFE students with the opportunity to give and receive feedback and to value the feedback mechanism as beneficial to their learning progress. Not only should a self-directed learner be able to give and receive feedback, but he or she should also be skilful in utilising the feedback for improved learning, hence taking greater ownership throughout the learning process.

Most participating students indicated that cooperative learning-embedded assessment provided them with an **enhanced learning** opportunity through which they could apply their knowledge, and students said:

'I was more focused on applying the work, rather than just wanting to study everything. It required me to understand what I was learning.' (P69, undisclosed gender, February 2019)

'Assessments helped me apply the knowledge I learned from the classroom.' (P76, undisclosed gender, February 2019)

It seems that cooperative learning-embedded assessment improved students' critical thinking skills, not only relating to answering questions but also to implementing cooperative learning-embedded assessment. One participating student said:

'This [cooperative learning-embedded assessment] has influenced me by looking more critically at the type of assessment done.' (P63, undisclosed gender, February 2019)

Critically reflecting on the type of assessment to which one is exposed might enable one to be cognisant of the possible influence of cooperative learning-embedded assessment on the learning process. Another student said:

'I could identify which work was important.' (P53, undisclosed gender, February 2019)

Identifying important content is related to identifying learning gaps, another important characteristic of a self-directed learner. It seems as if the participation in cooperative learning-embedded assessment enabled most participating students to identify learning gaps by determining what is important and by monitoring their progress. The following quotes indicate some thoughts of students about the importance of cooperative learning-embedded assessment in monitoring their learning progress:

'I would go through all the assessment work again to see if I understand the work better than I did before.' (P82, undisclosed gender, February 2019)

'The assessment [cooperative learning-embedded assessment] influenced my performance as I used all the resources that were provided to help myself evaluate how much I have learned on certain content.' (P1, undisclosed gender, February 2019)

Someone who is self-directed in their learning process will be able to monitor their own learning progress. The design of the cooperative learning-embedded assessment appears to have given students a foundation on which to build the ability to keep track of their academic progress. After identifying their learning needs and tracking their progress, self-directed learners can select the best learning strategies. It was stated by several students that the cooperative learning-embedded assessment assisted them in selecting appropriate learning strategies based on feedback provided within the cooperative learning-embedded assessment.

Verbatim examples of some of their opinions are listed below:

'Assessment has helped me improve my learning methods. Through assessment, I saw that I had to adjust my learning to understand the work and not just learn the work.' (P44, undisclosed gender, February 2019)

'It [cooperative learning-embedded assessment] forced me to learn in more detail. To experiment with various learning methods. Use various resources during the learning process.' (P17, undisclosed gender, February 2019)

Through the involvement in cooperative learning-embedded assessment, students' work was enhanced, their understanding of the material was deepened, they were able to learn new skills, their learning was positively influenced, they were able to use their problem-solving abilities and they were guided in their learning process. Some students perceived cooperative

learning-embedded assessment also to support autonomous learning and said:

'Its purpose is to make learners work themselves and rely less on the lecturer.' (P73, undisclosed gender, February 2019)

Being more autonomous in one's learning is an important SDL skill. Several responses from students regarding their perceptions of cooperative learning-embedded assessment pointed to its ability to promote learning. One student said:

'The assessment gave all of us the opportunity to improve our learning because it was fair and available for everyone.' (P1, undisclosed gender, February 2019)

Another student said:

'It [cooperative learning-embedded assessment] was a good way of learning new things.' (P33, undisclosed gender, February 2019)

The quote above also indicates that most students learned while doing cooperative learning-embedded assessments; hence, they were learning through assessment. It was also stated that cooperative learning-embedded assessment was used as a **pedagogical tool**, as one of the purposes of cooperative learning-embedded assessment is to expose students to the module content. Because the implemented assessment activities were embedded within cooperative learning, they might have contributed more to students' perception of cooperative learning-embedded assessment compared to a stand-alone assessment strategy. Furthermore, some students indicated that cooperative learning-embedded assessment is valuable in preparing for the examination opportunity. One participating student said:

'I was better prepared [for the examination] and already understood the content I needed to learn.' (P71, undisclosed gender, February 2019)

The participative nature of cooperative learning-embedded assessment requires discussion for shared consensus, which might have assisted students further in taking ownership of their learning after identifying their learning gaps before the summative examination opportunity. The timely feedback mechanism within cooperative learning-embedded assessment might have fed forward. Students said:

'It [cooperative learning-embedded assessment] gave me confidence and it made me see different perspectives regarding this [LIFE] module and learn more.' (P8, undisclosed gender, February 2019)

'The feedback that I got helped me to prepare for this exam.' (P21, undisclosed gender, February 2019)

Additionally, the participatory nature of cooperative learning-embedded assessment might have contributed to additional and further learning.

Although three students indicated that cooperative learning-embedded assessment did not influence how they prepared for the examination opportunity, several students indicated that cooperative learning-embedded assessment supported their preparation. The following quotes reflect students' attitudes towards preparation for the examination:

'Can now remember long-term work needed for exams and I know what to work on.' (P56, undisclosed gender, February 2019)

'It [cooperative learning-embedded assessment] helped me to prepare more than I used to prepare.' (P9, undisclosed gender, February 2019)

The ability to **identify learning needs** implies that problem areas are identified, which relates to the identification of one's strengths and weaknesses. Several students stated that cooperative learning-embedded assessment supported them in identifying their learning needs:

'The assessment helped me realise my knowledge capability, and how much I know and also guided me in terms of areas that I need to put more effort in.' (P6, undisclosed gender, February 2019)

Another student said:

'Through assessment, I noticed my mistakes and identified my problem areas.' (P44, undisclosed gender, February 2019)

A couple of students also mentioned that identifying strengths and weaknesses is an important aspect of cooperative learning-embedded assessment, and one of the students said:

'The assessment helped me know my areas of strength and weakness and what I need to do to improve my performance.' (P32, undisclosed gender, February 2019)

The participatory nature of cooperative learning-embedded assessment and the immediate feedback mechanism might have given the participating first-year LIFE students the chance to take charge of their learning and progress. Several of the students stated that assessments that included cooperative learning had a positive influence on their development as potential teachers, and one said:

'These assessments helped me to figure out the type of teacher I want to become.' (P51, undisclosed gender, February 2019)

The following response indicates that cooperative learning-embedded assessment contributed to students becoming aware of different ways of assessment:

'We were exposed to different ways of assessment so that we would be able to use it in our own class environment.' (P49, undisclosed gender, February 2019)

In general, the positive effect cooperative learning-embedded assessment had on participating students' learning process, learning progress and

examination preparation could be attributed to students' positive attitudes towards assessment. Students might be inspired to use comparable tests in their classrooms in the future as a result. Several students mentioned the significance of the participatory nature of the group work component (i.e. cooperative learning) of cooperative learning-embedded assessment, even though two students said they learn better independently. One of them said:

'[It] [cooperative learning] was very advantageous because we can discuss some of the aspects we do not fully understand.' (P31, undisclosed gender, February 2019)

Another student said:

'The tests we wrote together really helped me a lot, because I could learn from the other people so many times. Two heads are always better than one!' (P70, undisclosed gender, February 2019)

The cooperative learning component of cooperative learning-embedded assessment gave participating students the opportunity to learn from one another. One student said:

'In a way, I was able to learn in different ways and learn from fellow students.' (P9, undisclosed gender, February 2019)

Furthermore, the cooperative learning component of cooperative learning-embedded assessment enabled students to develop social skills, and some students acknowledged the improvement in their social skills:

'It [cooperative learning-embedded assessment] developed my skills in learning to work with others.' (P43, undisclosed gender, February 2019)

Cooperative learning-embedded assessment was said to have aided in the development of self- and peer-assessment skills. The participatory and cooperative nature of cooperative learning-embedded assessment might have fostered the development of these skills.

Several students indicated that the purpose of cooperative learning-embedded assessment was to **self-assess**. Participating students said:

'To assess the learners' knowledge and understanding of the LIFE module.' (P80, undisclosed gender, February 2019)

'It [cooperative learning-embedded assessment] has helped me to reflect on my work so that I can learn from my mistakes and produce better quality work in future.' (P75, undisclosed gender, February 2019)

Another student said that the purpose of cooperative learning-embedded assessment is to:

'Check our understanding of the content [LIFE module] thus far.' (P5, undisclosed gender, February 2019)

Within cooperative learning-embedded assessment, testing knowledge may be linked to SDL skills as students diagnose their learning needs and not necessarily measure learning as a product. Next, we conclude by discussing our findings from the data generated.

■ Discussion

The findings of this study show that cooperative learning-embedded assessment has a significant perceived value in improving students' learning experiences, and it enables them to take ownership of and responsibility for their learning process and progress as self-directed learners. Several key themes emerged from the qualitative analysis of students' responses, shedding light on the multifaceted benefits and outcomes of incorporating cooperative learning-embedded assessment within the educational context.

Students consistently stated that participating in cooperative learning-embedded assessment sparked their curiosity, motivation and sense of encouragement to learn, which suggests that the participatory nature of cooperative learning activities, combined with assessment components, acts as a motivator, igniting students' intrinsic desire to participate and invest actively in their learning process. The assessment approach incorporating cooperative learning encourages students to explore and learn. It fosters a sense of ownership over their educational journey as self-directed learners and links to the principles of a student-centred curriculum and cooperative learning, where students are encouraged to participate actively in their learning process (Johnson & Johnson 2021).

One interesting finding is that participating students perceived cooperative learning-embedded assessment as a mechanism for providing immediate and constructive feedback. This feedback mechanism not only allowed students to identify learning gaps and needs but also guided their progress via continuous feed-forward. Providing immediate feedback is crucial for effective learning (Fu et al. 2022). Incorporating feedback within cooperative learning-embedded assessment allowed the participating students to refine their understanding and to improve their learning based on the timely and constructive dialogic nature of the feedback mechanism. The fact that two students indicated that more feedback was needed might be an indication that even more emphasis should be placed on feedback in the planning of the cooperative learning-embedded assessment.

Cooperative learning-embedded assessment has improved the learning experiences of the participating first-year LIFE students by encouraging critical thinking and knowledge application and by refining problem-solving skills, eventually enhancing their SDL skills. Students reported that cooperative learning-embedded assessment pushed them to think more

deeply and more critically about the learning content, which resulted in improved comprehension and retention. Although this finding is aligned with literature on cooperative learning (see Jalinus, Syahril & Nabawi 2019; Zhang & Chen 2021), it brings new insight into how assessment practices can be implemented to develop critical thinking and problem-solving skills and eventually enhance students' SDL skills.

The participative nature of cooperative learning-embedded assessment allowed the participating students to interact with their peers, share perspectives and learn from one another. The cooperative learning component encouraged these students to collaborate, communicate and view their peers as valuable resources, which aided in developing social skills. This finding is consistent with the notion that, within a student-centred learning environment, students are not only autonomous learners but also able to use the assistance of others to achieve their learning objectives (Trinidad 2020). According to the responses of participating students, cooperative learning-embedded assessment cultivated their ability to identify learning needs, select appropriate learning strategies and track their progress. These abilities indicate students' growing agency and autonomy over their learning endeavours (Knowles 1975). The assessment tasks embedded in cooperative learning gave the participating students a platform to take ownership of their learning process by actively diagnosing gaps, seeking appropriate resources and adjusting their learning strategies.

The participating students recognised the broader implications of cooperative learning-embedded assessment for their future roles as educators, which was significant. They saw the approach as a useful pedagogical tool and a way to expose them to various assessment strategies. This perception highlights the potential aftermath of incorporating cooperative learning principles in assessment tasks, as the students envisioned similar strategies being used in their future classrooms.

In conclusion, the findings of this study show that cooperative learning-embedded assessment is a valuable pedagogical tool that enables students to be actively and socially involved in the learning process. The participatory and collaborative nature of cooperative learning-embedded assessment encourages active participation, fosters critical thinking and empowers students to take ownership of their learning journey and thus be self-directed. Educators could create an environment that enhances knowledge acquisition and nurtures students' SDL skills, preparing them for lifelong learning and future roles as autonomous, empowered learners by integrating cooperative learning-embedded assessment within educational contexts. Cooperative learning-embedded assessment is a successful pedagogical methodology for the higher education context. In the next section, we discuss some recommendations from our research findings.

■ Limitations of this study

Following the review of the literature, the empirical research and the research results, a few factors were considered.

It was unfortunate that the intervention had to be so brief. Extending the intervention to more than one semester could have provided the researchers with even richer qualitative data because participants would have had more opportunities to experience the cooperative learning-embedded assessment and might have been more responsive to the open-ended questions.

■ Recommendations

The research findings and subsequent discussion highlight the critical role of cooperative learning-embedded assessment in fostering a student-centred curriculum. Several recommendations are made based on these findings to assist educators in effectively implementing this approach:

Cooperative learning-embedded assessment has to be proactively and explicitly integrated into curriculum design. Educators could promote active student engagement and a deeper understanding of content by embedding assessment activities strategically within cooperative learning environments. This integration is consistent with the principles of a student-centred curriculum in which students are encouraged to participate actively in their learning.

Creating assessment activities that are embedded in cooperative learning can stimulate students' curiosity and intrinsic motivation. Therefore, it is suggested that real-world scenarios, problem-solving tasks and open-ended questions to encourage students to explore, question and seek solutions collaboratively are incorporated within cooperative learning-embedded assessment tasks. This approach is consistent with student-centred pedagogy because it encourages students to participate in meaningful learning experiences driven by their interests and enquiries. Educators can create assessments that inspire intrinsic motivation purposefully because cooperative learning-embedded assessment increases students' motivation and sense of responsibility for their learning. Assessments relating to practical situations, individual interests and group problem-solving could increase students' enthusiasm for learning objectives. Instructors have to also emphasise the connection between assessment outcomes and personal development to inspire students to take responsibility for their learning.

Within the cooperative learning-embedded assessment process, prioritise providing timely and constructive feedback. Ensuring that

feedback is not only directed at students by educators but that it also encourages peer feedback and self-assessment is consistent with student-centred and SDL skills, which encourages active reflection and self-regulation. Immediate feedback mechanisms could help students improve their SDL skills by allowing them to adapt their understanding and learning strategies constantly.

Through cooperative learning-embedded assessment, create opportunities for collaborative learning and peer interaction. Include group discussions, problem-solving activities and shared learning experiences to encourage students to learn from one another. Educators could cultivate a cooperative learning culture that mirrors the dynamics of a student-centred curriculum by using the principles of positive interdependence and promotive interaction. Such peer interactions are crucial for immediate feedback practices, which can ultimately have an influence on students' ability to identify learning needs, an important SDL characteristic.

Students deepen their understanding and develop the cognitive skills required for SDL within a student-centred curriculum by engaging in higher-order thinking and problem-solving. Therefore, educators could create assessment tasks that are embedded in cooperative learning and emphasise the application of knowledge and critical thinking. To this end, the inclusion of tasks that require students to collaborate to analyse, synthesise and evaluate information could be considered.

Educators could contribute to developing self-directed, lifelong learners who are ready to thrive in student-centred educational environments by encouraging this sense of autonomy and future-oriented thinking. Students could be encouraged to consider the broader implications of cooperative learning-integrated assessment for their future educator roles. Further, encouraging students to consider the strategies used and how similar approaches can be incorporated into their own future teaching practices could be considered.

Providing professional development opportunities for educators, centred on integrating cooperative learning-embedded assessment into the student-centred curriculum, could be considered. Providing workshops, training sessions and resources to educators can assist in the design of effective collaborative assessment activities. This assistance can provide educators with the tools and strategies they need to create enriching SDL experiences that are consistent with the larger goals of a student-centred approach.

Finally, the findings and subsequent discussion highlight the symbiotic relationship between cooperative learning-embedded assessment and a student-centred curriculum. Educators could use the power of cooperative

learning-embedded assessment to create collaborative learning environments and empower students to shape their educational journeys actively within the student-centred paradigm by implementing the recommendations above. This integration not only improves educational outcomes but also helps to develop self-directed learners who are prepared to thrive in a rapidly changing educational landscape.

Collaboration between institutions and scholars is necessary to understand the complex assessment dynamics of cooperative learning fully. Investigating the effects on various learner demographics, figuring out the best ratio of collaborative and individual assessment components and looking at technical solutions enabling seamless integration are all part of this.

■ Conclusion

In this chapter, the data analysis highlighted the concrete advantages that students see in the assessment context embedded within cooperative learning. These findings provide helpful insights for educational professionals and institutions looking to develop more engaging and student-centred learning experiences. Educators could create a collaborative, SDL environment that encourages motivation and enables students to be at the centre of their learning process. The potential of cooperative learning-embedded assessment can be unlocked through thoughtful implementation and ongoing improvement to empower students, encourage active participation and help construct a dynamic and student-centred educational future.

In conclusion, our investigation of a student-centred curriculum focusing on cooperative learning-embedded assessment highlights the central move concerning cultivating active commitment and collaboration. In the next chapter, the focus turns to digital education by introducing block-based programming. This transition is indispensable in accepting how pre-service teachers develop decisive SDL skills and self-efficacy within digital microworlds, flooring the way for a comprehensive investigation of innovative teaching methodologies that align with contemporary education's requests. The forthcoming conversation unravels the intricacies of integrating technology into pedagogy and its transformative influence on future educators.

■ Ethical clearance number

The ethical clearance number for this study is NWU-HS-2016-0178

Introducing block-based programming: Pre-service teachers' skill development and self-efficacy in digital microworlds

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■ Abstract

This chapter aims to introduce block-based programming (BBP) and explore skill development and self-efficacy in digital microworlds that may encourage pre-service teachers' self-directed learning (SDL). The Fourth Industrial Revolution (4IR) symbolises an era of technological advancement to which higher education institutions are expected to

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respond appropriately. Integrating educational robotics in higher education has been proven to enhance students' higher-order thinking, motivation and enjoyment effectively. Educational robotics therefore has great potential to assist pre-service teachers effectively in learning, enhancing their critical thinking and problem-solving abilities and promoting their SDL skills. Constructionism guided this research, and we conducted a general qualitative study. One cohort of Postgraduate Certificate in Education distance learning students majoring in Information Technology participated over three weeks. Students worked online and were expected to develop certain activities as future teachers using the open-source Microsoft MakeCode visual programming environment for micro:bit.⁶ Data collection consisted of screenprints of block-based programme segments, short videos of programme execution and individual reflective reports regarding students' experiences. Data were analysed manually using descriptive coding. Results indicated that the pre-service education students initially experienced some challenges. However, students developed critical thinking, problem-solving and various coding skills, such as error detection and debugging abilities. Moreover, students' views on self-efficacy changed; they were motivated and developed confidence and persistence. Students also enhanced self-management and responsibility in learning and developed several SDL skills.

■ Introduction

The former chapter (cf. Chapter 7) advocated for a more student-centred curriculum. This chapter discussed introducing block-based programming (BBP) by exploring pre-service teachers' skill development and self-efficacy in digital microworlds. The link between these two chapters is their shared emphasis on methodologies that empower students to be actively involved in their learning journey. Integrating digital technology in education is a prerequisite for developing 21st-century skills to prepare students for future challenges (Ramaila & Molwele 2022; Vidal-Silva et al. 2020; Yildiz, Ates Cobanoglu & Kisla 2020). Artificial intelligence (AI), associated with the Fourth Industrial Revolution (4IR), requires developing new knowledge and solving challenging real-world problems. Essential skills highlighted by the World Economic Forum (WEF 2020, p. 6) include technological design and use; analytical and critical thinking; innovation and complex problem-solving; and abilities like initiative, flexibility, resilience and emotional intelligence. Considering the demands and opportunities of the 4IR, it is

6. A micro:bit is a small computer board, the size of a credit card that introduces learners and students to coding and robotics.

imperative to provide for such skill development in educational settings, for example, when introducing students to digital microworlds.

The so-called microworlds were first mentioned by Seymour Papert (1980, pp. 117, 118) in a study where children explored ideas and discovered learning opportunities. Microworlds are seen as rich learning contexts for blending ‘powerful ideas’ with high-level thinking and knowledge construction (Papert 1980, pp. 11, 12, 126). Costa et al. (2020) emphasised Papert’s view that microworlds have the following attributes, namely, the creation of activities to provide for expected knowledge acquisition, manipulation of objects as a means of learning and the use of concepts (e.g. variables) to be outlined explicitly within the microworld environment. Consequently, digital microworlds have intellectual and personal value and allow real-world problem-solving, computational thinking (CT), innovation and social interaction (Da Silva 2020; Dhakulkar & Olivier 2021; Papert 1980). Scholars such as Aono et al. (2017) consider BBP as an excellent way to introduce students to the digital culture of microworlds. Block-based programming can be used to develop skills such as collaborative problem-solving, decision-making and critical thinking (Da Silva 2020; Perin, Dos Silva & Valentim 2022; Vinayakumar, Soman & Menon 2018).

Penprase (2018) emphasises several skills to deal with complexity, adaptability and the importance of self-directed learning (SDL) for the 4IR. He claims:

[T]he 4IR [...] places an extremely high premium on faculty development and curriculum renewal, as well as the mandate to develop students who can think and reinvent themselves within the changing world. (pp. 223-224)

The current research, therefore, explored how integrating BBP influences pre-service teachers’ self-efficacy and encourages essential skill development in digital microworlds. The following questions guided the research:

1. Which skills are developed through block-based programming?
2. What are pre-service teachers’ views on their self-efficacy with block-based programming?
3. How does the incorporation of microworlds encourage the development of self-directed learning?

■ Block-based programming and skill development

This section explores various aspects related to BBP. Using theoretical and conceptual frameworks offers a structured foundation by delineating the main aspects of this chapter.

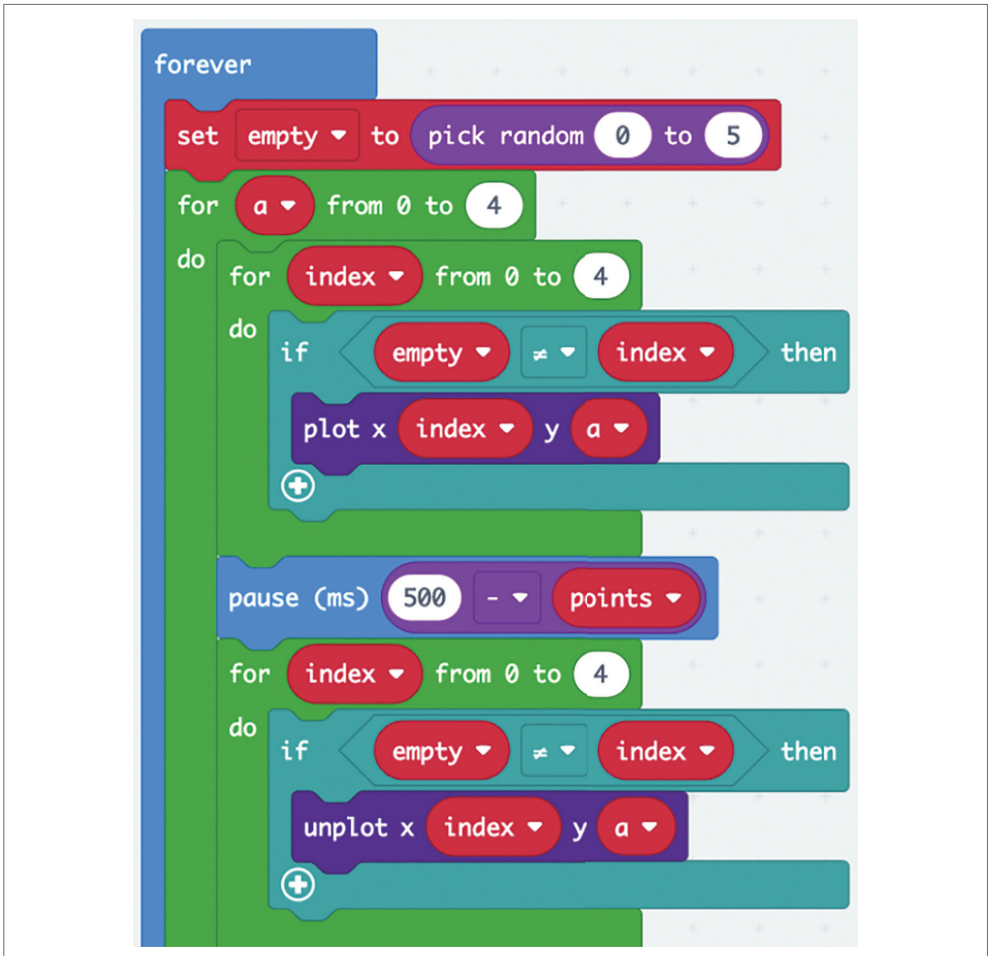
■ Constructionist approach

In 1980, Papert introduced his views on learning (constructionism) related to Piaget's constructivist theory (see Stager 2016). Constructionism is a theory that emphasises learning when students generate knowledge independently and develop objects that can be shared by others (Xerou, Papadima-Sophocleous & Parmaxi 2016). It has been suggested that actively building a shared artefact – such as a programme or model or implementing an idea – is the best approach for knowledge construction (Jackson & Klobas 2008). Papert (1980) considered microworlds primarily as a means for discovery and putting constructionist educational principles into practice. However, Girvan and Savage (2019) emphasise that simply creating artefacts is not considered a constructionist endeavour as active engagement and evidence of building and rebuilding are required to develop a deeper understanding while working on artefacts. Moreover, Kahn and Winters (2021, p. 1132) emphasise the importance of exposing and challenging students using 'constructionist microworlds' where educators or teachers facilitate 'them to move outside of themselves'. Digital microworlds are associated with the use of BBP and also allow for the enhancement of CT.

■ Block-based programming and computational thinking

Block-based programming languages have been around since the 1980s and belong to a category of visual programming languages where the programmes are executed graphically rather than textually (Aivaloglou & Hermans 2016; Weintrop 2019). Block-based programming involves dragging and dropping statements, expressed as blocks, onto a script area to develop a programme to construct animated games and stories (Barone 2020; Köksaloğlu 2022). Additionally, BBP uses visual tools to introduce non-technical people to programming aspects (e.g. iteration) and allows for creating basic programmes despite a lack of prior knowledge regarding conventional programming languages (Corral, Fronza & Mikkonen 2021). Block-based programming also reduces the learning curve, as there is no need to pay attention to programming syntax as required in high-level programming languages (Andersen, Mørch & Litherland 2022). Through BBP, students can easily and more readily experiment after seeing their coding attempts (programme output) (Noone & Mooney 2018).

Students are encouraged to approach real-world problems and promote their creative thinking in BBP contexts, which assist in the development of essential problem-solving skills and allow them to practice tackling issues systematically (Çakıroğlu et al. 2018; Çakıroğlu &



Source: Photograph taken by a student in 2022 in an unknown location and contributed by Marietjie Havenga with the appropriate permission and informed consent from the student. The use of digital microworlds enables students to develop computational thinking skills (Çakıroğlu & Mumcu 2020; Del Olmo-Muñoz, Cózar-Gutiérrez & González-Calero 2020; Pérez-Marín et al. 2020; Rose et al. 2020).

FIGURE 8.1: A programme section displayed in MakeCode visual programming environment for micro:bit.

Mumcu 2020; Weintrop 2019). In addition, BBP increases students' learning motivation and enables them to interact with one another while thinking critically, creatively and cooperatively (Broll et al. 2018; Rose, Habgood & Jay 2020; Sentance, Waite & Kallia 2019). Microsoft MakeCode⁷ is an open-source visual programming tool for micro:bit that allows learners and students to build programmes by combining several coloured instruction blocks (see Figure 8.1). Scholars emphasise that microworlds,

7. A free online platform used for coding, robotics and the development of games.

such as NetLogo, Turtle Blocks and Scratch, are valuable for learning programming skills (Dhakulkar & Olivier 2021).

Computational thinking refers to the ability to be creative, think critically, solve open-ended problems and reflect on one's thinking (Wing 2006). Formally, CT involves aspects such as thinking in terms of patterns (pattern recognition), compiling algorithms, focusing on essential information (abstraction) and decomposing a problem into simpler parts (Wing 2006).

Computational thinking is also based on the assumptions of computer science that are essential for solving interdisciplinary problems where active learning is required (Saad & Zainudin 2022). Moreover, CT is becoming essential in educational curricula to prepare students for solving open-ended problems (Madariaga et al. 2023). It is important to plan for the integration of BBP and CT in secondary and tertiary curricula. Because of the demands of the 4IR and essential skill development, such curricula aim to develop learning autonomy, self-direction, creativity and problem-solving skills. In this regard, Penprase (2018) highlights the development of self and identity and the importance of SDL for AI. Hsu, Abelson and Van Brummelen (2022) implemented a curriculum for AI using experiential learning to introduce students to BBP and evaluate their effective learning and performance over six weeks. Their results indicated that some students performed better in enhancing their learning and understanding of CT aspects. It is therefore essential that BBP is introduced in teachers' training.

■ Integrating block-based programming into pre-service teachers' training

Educational robotics⁸ (ER) enables pre-service teachers to be involved in a playful environment and serves as a motivation for developing skills such as CT and solving complex problems (Barak & Assal 2018; Casler-Failing 2018; Fegely 2020; Jaipal-Jamani & Angeli 2017; Kucuk & Sisman 2018). As a result, several courses have been designed to introduce robotics and programming to pre-service teachers. The aim is to juxtapose ER and pedagogical approaches to assist in developing the relevant knowledge and skills in pre-service teachers (Kucuk & Sisman 2018). However, some challenges when introducing BBP have been reported (see Sisman & Kucuk 2019). Pre-service teachers, for instance, encountered design challenges and consequently showed a lack of enthusiasm for developing robots

8. ER is an interdisciplinary environment that requires coding, and which uses robots and certain components with the aim to enhance learners' and students' development of high-order thinking and essential skills development for the 4IR.

(Kucuk & Sisman 2018). Another issue highlighted was debugging, which pre-service teachers considered time-consuming and often frustrating (Kim et al. 2018). Nevertheless, the exposure of participating pre-service teachers to coding and robotics increased their confidence in their ability to learn and impart programming languages (see Jaipal-Jamani & Angeli 2017). Additionally, pre-service teachers gained coding skills and improved their metacognitive abilities by using Scratch to address mathematics-based programming tasks (Daher et al. 2020). Block-based programming also enhanced prospective teachers' coding abilities and demonstrated how coding could help students build transversal skills (see Ouahbi, Darhmaoui & Kaddari 2022; Papadakis et al. 2019). For example, BBP is considered an appropriate environment and tool for teaching mathematics that requires future teachers to draw on their knowledge of pedagogy (Gleasant & Kim 2018). Gleasant and Kim (2018, p. 59) outline three guidelines to assist pre-service teachers in the use of BBP to teach mathematics:

- expanding future teachers' skills by focusing on essential programming concepts and mathematics abilities
- facilitating pre-service teachers' integration of BBP to enhance mathematical learning and conceptual understanding (e.g. lesson planning)
- facilitating and instructing pre-service teachers to relate CT and mathematics concepts 'through a teaching lens' (e.g. mathematics knowledge for teaching).

Timur et al. (2021) claim that pre-service teachers believed learning BBP and utilising the Scratch environment would be beneficial to their professional development. Block-based programming consequently assisted in obtaining new ideas for learning science using digital microworlds for the animation of experiments (see Timur et al. 2021).

■ **Block-based programming and students' self-efficacy**

The social cognitive theory, coined by Albert Bandura (1977), refers to self-efficacy as the confidence a person has, and it involves personal beliefs regarding his or her ability to perform certain actions to achieve a goal. Self-efficacy influences an individual's ability to adapt to certain circumstances and emphasises the importance of persistence in challenging environments (Bandura 1977). Regarding students' self-efficacy in online environments, Wang et al. (2022) emphasise that it allows for student-centred learning opportunities and similarly requires student engagement and commitment in their learning, thus being self-directed. Some factors

that may promote successful online learning are responsible learning, technical abilities, self-esteem, students' attitudes and self-efficacy (Bahçekapili & Karaman 2020).

In terms of BBP, scholars claim that self-efficacy perceptions are crucial in programming tasks (see Öztuzcu, Öztürk & Mısırlı 2022). Ramazanoğlu (2021) found that when students actively engaged in coding activities associated with digital microworlds, their opinion of their self-efficacy regarding their CT skills improved, and their concerns about computers decreased. In addition, students found BBP environments simple because of the use of block-based codes, the drag-and-drop gestures and the simplicity of language browsing (Weintrop & Wilensky 2015). Block-based programming enables students to learn programming principles effectively by breaking them down into sections and organising them logically (Kraleva, Kraleev & Kostadinova 2019).

Kraleva et al. (2019) further argue that BBP gives students a sense of accomplishment and boosts their level of confidence. Scholars claim that the benefits of BBP, which include ease of use, motivation to learn and the ability to develop programming skills, enable students to be satisfied with their academic success (Erol & Kurt 2017; Marcelino et al. 2018; Papadakis et al. 2019; Yukselturk & Altiok 2017). On the other hand, Adsay et al. (2020) found that students' evaluations of their self-efficacy concerning BBP were low, while their levels of Science, Technology, Engineering and Mathematics (STEM) and CT proficiency were moderate when their self-efficacy observations were related to BBP and CT skills. Therefore, students' self-efficacy levels concerning BBP were decisive in how they perceived their self-efficacy concerning CT skills.

■ Block-based programming and self-directed learning

The accelerated and inspiring technological developments require guidance regarding responsibility and 'identity within the 4IR' (Penprase 2018, p. 222). Consequently, curricula must be responsive and allow for concurrent skill development. Penprase (2018) argues that adaptability and SDL are central to the required skills for the 4IR. In other words, students are expected to adapt to change, be responsible and develop skills accordingly to be relevant for the future. Olivier (2022, p. 37) emphasises the importance of equipping students with skills to be prepared for a 'dynamic educational context', using various modalities of learning and developing SDL abilities. These abilities are essential to function in the 4IR. Schwab (2016, p. 97) emphasises that the 4IR impacts in various ways on individuals in terms of

'not only changing what we do but also who we are'. In the first chapter of this book (cf. Chapter 1), SDL refers to an individual's ability to set specific goals, identify particular learning needs, and direct and evaluate their learning processes (Knowles 1975). Robinson and Persky (2020) mention that students who engage in SDL establish goals, decide how progress will be evaluated, plan the sequence and structure of activities, select relevant resources, and get the necessary feedback. Self-directed learning features, such as being goal-driven, curious, taking responsibility for tasks, having initiative, being independent, having self-confidence and having self-efficacy, are crucial for a complex and challenging world (Guglielmino 2013; Knowles 1975).

Block-based programming environments encourage SDL through experimentation and group work (Maloney et al. 2010). In addition, SDL assists students in promoting their CT skills in BBP environments and provides supportive tools to develop 21st-century capabilities (Fadhillah, Budiyo & Hatta 2023; Zhou et al. 2022). Block-based programming also helps students to be creative and develop their capacity for solving challenging problems (Hu, Chen & Su 2021; Wei et al. 2021). Digital microworlds positively influence students' understanding of their own learning (Ferrer-Mico, Prats-Fernández & Redo-Sanchez 2012). The self-checking and self-debugging strategies related to CT help students enhance their learning through unplugged coding activities (Threekunprapa & Yasri 2020). Moreover, these strategies encourage the development of CT, which contributes to addressing open-ended real-world problems.

■ Methodology

A generic qualitative methodology was employed in this chapter. This methodology was suitable as it focused on students' experiences and reflections regarding their introduction to BBP and CT. The ability to construct their knowledge highlighted the importance of constructionist microworlds as relevant to this research.

■ Study context

One cohort of 33 Postgraduate Certificate in Education (PGCE) distance learning students enrolled, of whom 20 consented to participate. Students were required to have a qualification comprising computer courses and programming on at least second-year level. The research was approved by the Faculty of Education Ethics Committee and the University Research Data Gatekeeper Committee (RGDC). All activities were performed on the

eFundi (Sakai) learning management system (LMS). The online e-guide comprised the following study units:

- Study Unit 1: Digital knowledge and skills in praxis
- Study Unit 2: Assessment in digital technology
- Study Unit 3: Mastering of the touch-typing technique
- Study Unit 4: Introduction to programming and robotics
- Study Unit 5: Database design
- Study Unit 6: Web design with HTML.

Although participants had completed some courses as part of their degree, this postgraduate course aimed at preparing pre-service students for the Senior Phase (Grades 7 to 9) and developing essential competencies as future digital technology teachers for the 4IR. This also involved didactics and the methodology for teaching and learning. Regarding Study Unit 4, students were introduced to the principles of CT and the MakeCode programming environment for micro:bit, such as buttons for programme execution, sound, shake, music, loops, logic, mathematics functions and variables.

■ Assessment of the assignment

The course involved continuous assessment and no examination was written. Students submitted assignments about each study unit. The programming and robotics study unit assignment was carried out individually and involved the following, as shown in Table 8.1. Students had to demonstrate sound mastery of programming skills, challenges and responsibilities using the MakeCode environment.

■ Data collection and analysis

Data collection consisted of evidence regarding individual students' activities such as screen prints of BBPs, short videos to show programme execution and students' reflective reports regarding their experiences on

TABLE 8.1: Assignment on programming and robotics.

-
1. Develop your own game by using microworlds such as micro:bit. Include coding aspects you did as part of activities 1 to 9 and apply them to the game. Submit (a) the block coding/programme as well as (b) a short video of the output.
 2. Write a reflective report (1½ to 2 pages) referring to your thinking, challenges and responsibilities involved in the game you developed. Give several examples. Also mention how you addressed the challenges and problems.
 3. Compile a lesson plan and apply active teaching-learning strategies to facilitate the learning of coding and robotics. Convert the Word document to a PDF document and submit it on time.
-

Source: First author's own work.

Key: PDF, portable document format.

BBP and digital microworlds. The data were manually coded. Descriptive or attribute coding was used to analyse the data (see Saldaña 2016). This coding method assisted the authors in organising the data, identifying patterns, facilitating the discussion on the data and condensing the data, among others. The findings are outlined in the next section.

■ Findings

Integrated findings from students' programmes, videos and reflections are presented in Table 8.2, Table 8.3, Table 8.4 and Table 8.5.

TABLE 8.2: Selected responses regarding students' skill development with block-based programming (BBP).

Theme 1: Skill development with BBP
'Creating a game require critical thinking and problem solving [...] also increase my coding aspects and skills' (P1, gender undisclosed, date unknown).
'I made sure that the game performs all its functions and those players don't experience any errors [...] the blocks move in the right directions and do not clash making it different to move around' (P10, gender undisclosed, date unknown).
'Working with logic and loops, inserting LEDs, adding music and inserting a text box was the most fun part of my game [...]' (P14, gender undisclosed, date unknown).
'It was easy to declare variables and use them but the use of <i>for loop and if statements</i> was a big challenge. I had to watch some videos' (P24, gender undisclosed, date unknown).
'I really struggled to come up with an idea for a game but eventually settled on something educational [...], fun and evoke critical thinking. I had to separate the logic conditionals from the "while" loops. It is really satisfying seeing a game you developed come to life' (P30, gender undisclosed, date unknown).
'I also found it challenging with limited inputs [...] I overcome this by adding in a random function' (P33, gender undisclosed, date unknown).

Source: First author's own work.

Key: BBP, block-based programming; LED, light-emitting diode.

TABLE 8.3: Selected responses regarding students' self-efficacy.

Theme 2: Development of self-efficacy
'I had no motivation to start at all [...] I felt anxious about this assignment [...] Then I just started reading and doing coding [...] my idea changed after a few online tutorials [...] Visual representation, for me personally, is good [...] rather than coding in a normal coding language like C#.' (P2, gender undisclosed, date unknown)
'Microbit is a totally new platform for me and initially I was sceptical and had anxiety attacks [...] I then started to enquire over the internet and I found interesting information.' (P14, gender undisclosed, date unknown)
'It all looked a little too complicated [...] Luckily the scaffolding of activities based on different aspects of micro:bit helped to ease some of the confusion.' (P30, gender undisclosed, date unknown)
'I was afraid of it [assignment] and thought it's very complicated. But once I started (with the help of videos and micro:bit tutorials) it was actually easily to pick up. I realised it is indeed (very) fun to code.' (P33, gender undisclosed, date unknown)

Source: First author's own work.

TABLE 8.4: Selected responses regarding students' experiences and challenges.

Theme 3: Experiences and challenges with BBP
'The activities were so challenging [...] using logic, loops and mathematical functions. When creating a game I got exposed to many features in the MakeCoke blocks.' (P1, gender undisclosed, date unknown)
'You must think incredibly carefully as to the output and functionality of the game' '[Initially] I found it difficult to code with the blocks [...] I found the coding framework very interesting and good to work with pupils in schools.' (P2, gender undisclosed, date unknown)
'I was however excited to see how the block coding interface worked, wondering whether it would make coding more accessible to a younger audience so that they could concentrate on the ideas behind programming not getting possibly tripped up by syntax.' (P5, gender undisclosed, date unknown)
'My other concern was that [...] micro:bit coding seemed to be more event-driven based on the input of pushing the A or B buttons etc.' (P5, gender undisclosed, date unknown)
'Thinking about a creative problem formulation on developing a programme using micro:bit [...] was a challenge because I had to think out of the box and come up with a different angle of focus'. (P8, gender undisclosed, date unknown)
'Overall, this was a wonderful experience, I think that I would love to teach robotics someday when I become a teacher.' (P29, gender undisclosed, date unknown)

Source: First author's own work.

TABLE 8.5: Selected responses regarding students' self-directed learning abilities.

Theme 4: Development of self-directed learning abilities
'There were difficulties but I went back to the tutorial [...] I became motivated and continue developing with a positive mindset.' (P1, gender undisclosed, date unknown)
'I had to take the responsibility for rewriting the code and restructure my initial planning when I started to create the game [...] I had to work through various videos and coding with the tutorials online to get a better understanding to make sense of it. When I finally started doing it on my own, there was light at the end of the tunnel [...] By involving games in the learning, the learners become more actively involved and give their inputs.' (P2, gender undisclosed, date unknown)
'I approached this assignment with a confidence [...] I see understanding and experiencing the event-driven paradigm as an area for growth.' (P5, gender undisclosed, date unknown)
'The thinking, brainstorming, and comparing different kinds of ideas became interesting [...] having to compile deeper understanding [...] create a problem formulation creatively [...] and I have accomplished my responsibilities even though I encountered challenges in the process.' (P8, gender undisclosed, date unknown)
'[T]he more I practiced, the more knowledge I got and the more confidence I developed [...] it kept on showing errors and forced me to start the function over and over again until it was perfect [...] if I had this kind of exposure during my high school years I could have been one of the best computer scientists in varsity.' (P14, gender undisclosed, date unknown)
'I carefully worked through my code over and over to figure out where the problems were [...] Now the error message was gone [...] It was very satisfying to figure it out and to see the game playing out as I wanted.' (P33, gender undisclosed, date unknown)

Source: First author's own work.

The quotes are reproduced verbatim and without any language editing. The following themes emerged from the data:

- skill development with BBP
- development of self-efficacy
- experiences and challenges with BBP
- development of SDL abilities.

As indicated in Table 8.2, students developed several programming skills such as working with loops, declaring variables and applying logical thinking while working with micro:bit.

Regardless of students' negative feelings, they were interested and enjoyed the gaming task (Table 8.3). Some responses relating to their experiences are outlined in Table 8.4.

Participants were exposed to several features of BBP, e.g., students were introduced to logic, iterative statements and mathematical functions in the BBP environment to solve problems. Although the students encountered several difficulties, they gained a deeper understanding of the programming environment.

The students were required to develop a game comprising various activities such as addressing certain objectives, executing the BBP code and demonstrating sound mastery of the programming concepts. Participants planned this activity with a clear goal in mind, approached it with confidence and searched for relevant resources. Such activities are associated with the qualities of a self-directed learner where students manage their thinking processes.

■ Discussion of the findings

The first question explored the *skills that were developed through BBP*. Although students initially experienced some challenges, they acquired certain skills while developing their own game (Theme 1). For example, they required critical thinking and problem-solving, increased their coding abilities (P1), worked with logic and loops, used LEDs and added some music to make the game more interesting. Such skills assisted students to analyse problems, critically discuss possible solutions and make decisions about the best solution. Consequently, participants were challenged to apply high-order thinking and construct new knowledge. For example, one student had to add the random function to ensure the game would work as expected (P33) and students had to declare variables for additional functionality in the programming environment (P24).

Although students were not expected to know different types of micro:bit errors (hardware errors and programme access errors), debugging and error prevention (P10) were essential, for example, to ensure that the blocks move in the right directions on the grid and do not clash. Another student mentioned, 'I had to separate the logic conditionals from the "while" loops. [T]he game quiz worked as intended. It is really satisfying seeing a game you developed come to life' (P30). These findings echo the views of Dhakulkar and Olivier (2021) and Da Silva (2020), as they

emphasise that digital microworlds have intellectual and personal value, such as enhancing real-world problem-solving, CT and innovation.

In terms of the second research question, some interesting findings regarding pre-service teachers' views on their *self-efficacy with BBP* emerged. Initially, most students were sceptical about their abilities to develop a game in micro:bit (Theme 2). They needed more time to master the coding (P1), were confused (P14) and experienced the assignment as complicated (P30); some students were not motivated while others struggled considerably with BBP, and yet others felt anxious about the assignment (P2, P14). Moreover, participants had a busy schedule (P1, P14) and were unfamiliar with the programming environment (Theme 3). As Bahçekapili and Karaman (2020) noted, working in an online learning environment was difficult for students. Some students struggled with technical competence and were concerned. Self-efficacy influences students' views regarding their abilities, challenging tasks and motivation to complete tasks (Bandura 1977). For three weeks, students developed certain skills and their views regarding their self-efficacy changed. Some examples are:

- 'I felt depressed' vs 'I found interesting information' (P14).
- '[I]t can be difficult' vs 'strengthen your resolve and learn to be flexible [...] not aiming for perfection' (P27).
- '[T]here is no way I will be able to do this' vs 'Luckily the scaffolding of activities [...] helped to ease some of the confusion' (P30).
- 'The game needs to be easy to play and understand with a clear goal in mind' (P2).
- 'I approached this assignment with confidence' (P5).

Regardless of participants' responses about their self-efficacy, it was evident that they required specific skills to develop their games and block-based coding, for example, persistence and critical thinking (Table 8.5). These findings emphasise scholars' views that coding offers great experiences and develops confidence in programming activities (Erol & Kurt 2017; Marcelino et al. 2018; Papadakis et al. 2019; Yukselturk & Altıok 2017). The findings also support Kraveva et al.'s (2019) views that BBP gives students a sense of accomplishment and boosts their level of confidence, self-perceived achievements, development of certain capabilities and motivation in learning.

Finally, we investigated how the *incorporation of microworlds encouraged the development of SDL*. Considering the attributes of self-directed learners such as persistence and the ability to develop essential skills for the 4IR, some examples emerged. Students found relevant resources and tutorials, recalled previous knowledge, became motivated and 'continue[d] developing

with a positive mindset' (P1). They also took responsibility for the game, changed the initial planning and gained 'a better understanding' (P2). In the age of the 4IR, graduate students must be lifelong and self-directed learners capable of managing their own learning processes. Some students approached the assignment with confidence and identified some gaps and areas for growth (P5) (a characteristic of an SDL learner) (Table 8.5). The gaming task opened for constructing new knowledge, a deeper understanding and persistence in completing the task (P8). Students also appreciated the fact that practising makes it easier to complete the game:

'[T]he more I practiced, the more knowledge I got and the more confidence I developed [...] if I had this kind of exposure during my high school years I could have been one of the best computer scientists in varsity.' (P14)

Participant 29 emphasised persisting and refused to be defeated.

The findings revealed that most participants believed playing the game was highly motivating and improved their understanding of BBP. These findings align with scholars who assert that BBP helps students be creative and develop the capacity for solving challenging problems (Hu et al. 2021; Wei et al. 2021). Self-directed learners are more proficient and independent, can think of novel solutions to problems and see things from new angles. Moreover, findings indicated that programming tasks helped students to construct new knowledge, to be persistent in developing their own game and to develop SDL skills. This finding agrees with Ferrer-Mico et al. (2012), who claim that digital microworlds positively influence students' understanding of their learning process. Furthermore, participants' responses highlight the importance of taking responsibility for learning, being goal-driven, planning activities, constructing knowledge and developing confidence regarding the incorporation of microworlds to promote their SDL skills. Some recommendations are outlined below.

■ Recommendations

Based on this study, the following recommendations were made:

- *Teaching and learning*: Detailed planning of activities and scaffolding of students' learning are essential when learning BBP in online environments. Furthermore, time management is essential to succeed, and the lecturer needs to set clear deadlines in this regard. Educational institutions should invest in incorporating digital microworlds and BBP into teacher training programmes with the aim of preparing them for the development of essential abilities for the 4IR.
- *Self-efficacy and SDL*: Promoting BBP as a learning tool is vital as it may scaffold the enhancement of self-efficacy in digital microworlds.

Considering the characteristics of an SDL learner, such as curiosity and persistence, the use of BBP offers opportunities for the development of SDL skills in pre-service teachers.

- *Future research:* Integration of BBP in several subjects may be followed with the use of more advanced programming activities with the use of physical robots such as LEGO Mindstorms EV3.

■ Conclusion

This chapter highlights the implementation of BBP within education to be a catalyst for cultivating essential skill development and self-efficacy in digital microworlds. Although education students initially encountered several challenges, such as confusion and anxiety, their views on self-efficacy changed, and they developed certain skills. The ability to systematically address complex problems is an essential skill and BBP has emerged as a means of nurturing such skill development.

Moreover, pre-service teachers' self-directed abilities were enhanced. Students adapted and took ownership of their learning by actively seeking relevant resources, engaging in independent research and employing appropriate strategies to overcome obstacles. The development of these abilities embodies the essence of SDL, equipping students with crucial skills to navigate the challenging and dynamic landscape of the digital age. Consequently, integrating BBP into pre-service teacher training offers a promising way to foster critical skills, self-efficacy and SDL. One limitation is that only one cohort of 20 students participated. Future research should consider follow-up activities that involve more challenging tasks to solve real-world problems and provide for education students to enhance skill development using BBP.

In closing, as we transform from traditional learning classrooms to alternative learning environments, the link between these pedagogical advancements and the successive chapter, 'From classroom to home: Unleashing the power of self-directed learning in homeschooling', becomes apparent. The learning journey from structured educational settings to SDL echoes a paradigm alteration in teaching and learning, accentuating the need to empower students and learners beyond traditional teaching and learning restrictions.

■ Ethical clearance number

The ethical clearance number for this study is NWU-01029-21-A2.

From classroom to home: Unleashing the power of self-directed learning in homeschooling⁹

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■ Abstract

As citizens, we are all, to some extent, involved in education, meaning that, by implication, we carry specific responsibilities. These responsibilities

9. This chapter is based on M Scheepers 2023, Exploring parents' self-directed learning skills for meaningful home-school facilitation, submitted for fulfilment of the Master of Education (MEd thesis) in Curriculum Studies, North-West University, Potchefstroom Campus, with supervisor Prof. C du Toit-Brits and co-supervisor Dr JH Blignaut.

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include, among others, providing guidance on the best possible ways to manage and address the impact of COVID-19, homeschooling and the future of education. Some parents chose to enrol their children¹⁰ in a homeschooling curriculum to take advantage of the benefits and to respond directly to the crisis created by the COVID-19 pandemic. Consequently, self-directed learning (SDL) has become a vital source of inspiration, with many learners¹¹ being schooled at home instead of being educated under the guidance of a professionally qualified educator. Self-directed learning can be described as generating an encounter that emboldens individuals (parents as educators or facilitators, and learners¹²) to make decisions and conclusions concerning the abilities learners want to acquire regarding subject knowledge. On the one hand, SDL may be seen primarily in the experiential setting, for example, when learners encounter something unfamiliar, they must discover suitable learning sources. On the other hand, SDL can also be experienced in co-curricular learning actions as learners explore areas of curiosity. Although SDL may be used in both educational and co-curricular contexts, the abilities required for SDL should be provided and developed in the didactic component of the curriculum. Fostering SDL in learners from a young age may enable them to build SDL skills that would add value to any education setting, including the homeschool setting, over time. Nevertheless, when learners had to stay home during the COVID-19 pandemic, they needed guidance from their parents to continue their educational journeys. The authors of this chapter believe that one cannot refrain from reflecting on and exploring the importance and value of implementing SDL in a homeschool environment, which is vital to the guidance and support of learners in their educational journeys.

■ Introduction

While the preceding chapter (Chapter 8) discussed integrating block-based programming and robotics to facilitate SDL in a formal educational context, this chapter (Chapter 9) extends this discussion to the homeschooling environment, showcasing how self-directed learning (SDL) can be a valuable and effective approach to alternative settings. Both chapters (Chapter 8 and Chapter 9) underline the significance of enabling learners to control their learning process, whether in a traditional classroom or a homeschooling setup. The link between these chapters is a seamless

10. Children in this chapter refer to the children as learners who are homeschooled by their parents.

11. The term learners refer to '... a pupil or a student at any early learning site, [or a] school ...' (SACE, 2023).

12. For this chapter, the focus is only on parents as teachers or facilitators, and learning in the homeschool learning environment.

transition from exploring SDL in the context of educational technology to its application in alternative educational settings.

Knowles (1975) sees SDL as a process by which learners learn to be accountable for their learning by identifying gaps and searching for ways to achieve their educational goals with or without the help of others. Many learners are homeschooled temporarily or indefinitely, making it vital for parents to adopt SDL practices in their homeschool facilitation. By doing so, parents can nurture the learning interests of their children and foster excitement in the learning process (Kern 2020; Thomas & Rodgers 2020). Hence, SDL is an essential tool in the homeschooling environment. Therefore, to understand the potential advantages of SDL, for parents, acting as homeschool facilitators, and homeschool learners, it is crucial to appreciate the rationale for introducing SDL and the methods by which it may be included in the homeschool learning environment.

This conceptual chapter examined why SDL is important in homeschool learning and how parents view SDL as a facilitator. Illuminated in this chapter is the importance of SDL and how it compliments homeschooling. Moreover, the authors posit that the home, as an educational setting, should provide a secure and conducive atmosphere for learners to cultivate SDL skills. These skills are crucial in enabling learners to assume additional responsibilities, such as engaging in sports activities or effectively reprioritising curriculum objectives. The underlying notion is that the responsibility for organising and implementing the educational process should rest with homeschooled learners themselves rather than their parents.

Homeschooled learners should be active learners, not just passive recipients of knowledge from their ‘teacher’. Active learning is imperative, as homeschooling promotes SDL and equips learners with 21st-century SDL skills (cf. Ricci 2009). However, parents must teach learners independence and self-direction (Wai-Cook 2020). Thus, a parent’s duty as a homeschool facilitator goes beyond curriculum delivery. As homeschool facilitators, parents should help their children master skills and become self-directed, responsible learners (Mifsud & Day 2022; Wai-Cook 2020).

From the above, we see many parallels between the goals of SDL and homeschooling, even though homeschooling has been around longer. Learning and instruction should centre on why SDL homeschooling matters in the context of contemporary educational models. Learning at home requires the learner to be self-directed and self-motivated, with the student taking the initiative to set objectives and complete assignments. The chapter’s main aim is to emphasise the significance of SDL in the context of homeschooling, explicitly concerning how parents understand SDL in their role as homeschool facilitators. The chapter also highlights how

parents, as facilitators, can effectively implement SDL to enhance their children's learning experiences and overall development.

■ The nature of self-directed learning

Self-directed learning represents a dynamic and empowering educational approach wherein individuals take control of their learning journeys by setting goals, identifying resources and autonomously navigating their educational paths, thereby transcending traditional pedagogical methods (Du Toit-Brits & Van Zyl 2017a). This paradigm shift in learning promotes greater ownership and accountability and fosters lifelong learning skills, adaptability and a more profound sense of personal fulfilment. To fully understand the origins and progress of SDL, we must first understand the core of this revolutionary approach to education.

The origins of SDL may be traced back to philosophical ideals by John Locke and Jean-Jacques Rousseau, who highlighted the prominence of personal independence in the learning process (Collier 2022). Nonetheless, SDL began to gain prominence in the 20th century (Collier 2022). At this stage, Malcolm Knowles pioneered the central role of SDL by articulating its principles and theories, specifically in adult education (Collier 2022). That said, as time passed, SDL has been adopted in various educational settings such as formal classrooms, online courses, workplace training programmes and homeschooling environments. Therefore, understanding the historical context of SDL is vital to realising how it has evolved into a widely accepted and effective educational approach today.

■ Overview of the history of self-directed learning

Elements of SDL have been evident in the works of prominent historians and scholars such as Socrates, Aristotle, Plato, Alexander the Great, Julius Caesar, Desiderius Erasmus and René Descartes (Bourke & Loveridge 2018; Du Toit-Brits 2015). The lack of formal education institutions in colonial America necessitated SDL. However, only about 150 years ago, the United States began recognising SDL and its significance. Over the past three decades, SDL's significance and scholarly exploitation have increased tremendously, classifying learners into groups representing goal-oriented, activity-oriented and learning-oriented individuals. Self-directed learning is premised on the idea that learners can initiate and direct their learning, leveraging their experiences as valuable resources (Curran et al. 2019). Adult learners, in particular, tend to be task-problem-oriented, driven by internal motivations such as curiosity and self-esteem, among others (Curran et al. 2019).

Historically, SDL has evolved to emphasise four key factors: learning readiness, a conducive learning environment, appropriate learning strategies and outcomes assessment (Nasri, Halim & Abd Talib 2020). Cultivating intrinsic motivation is crucial for effective SDL (Du Toit-Brits & Van Zyl 2017a). In recent years, SDL has gained prominence in education (cf. Loeng 2020). The theory suggests that with support and incentives, individuals can enhance their self-directedness and autonomy (cf. Brandt 2020a; Loeng 2020). Implementing SDL aims to enhance the overall quality of life (cf. Grover 2015; Safapour, Kermanshachi & Teneja 2019; Stebbins 2017) and livelihood development (Din, Haron & Rashid 2016). Self-directed learning benefits learners by enhancing interpersonal skills and critical thinking abilities, helping them overcome obstacles (Taylor 2001). Homeschooled learners need confidence in various tasks for success in the workforce. Effective learning requires tailored opportunities, feedback and clear instructions (Taylor 2001). Fostering SDL in learning environments requires a clear understanding of its components. A delineation of SDL is essential for effective implementation within homeschool settings. Understanding SDL involves goal setting, motivation, evaluation, resource selection and role definition.

■ Exploring the essence of self-directed learning

This chapter adopts Michael Knowles's 1975 theory of SDL, which is highly regarded in adult education (Marsick & Watkins 2001). This framework emphasises the importance of motivation and self-regulation in all learning environments, particularly those involving adults (Brookfield 2015; Knowles, Holton & Swanson 2014; Merriam & Bierema 2014). Knowles's perspective recognises that adult learners¹³ have unique attributes and needs distinct from adolescents¹⁴ (Knowles et al. 2014). Unlike younger learners, adults are primarily motivated by practical factors like career advancement or personal development (Knowles et al. 2014). Also, this study embraces Knowles's SDL theory to explore the significance of motivation and self-regulation in adult learning, recognising the distinct nature of their educational motivations and goals (Knowles et al. 2014).

Adult learners bring valuable experience and knowledge to their education, offering an opportunity to enhance their learning outcomes (Hiemstra & Sisco 2016). Knowles's framework underscores the importance

13. Adult learners are people who have assumed societally grownup duties (e.g., worker, husband, parent, citizen) and who see themselves as autonomous agents in their own lives (Knowles 1984).

14. 'Adolescence is the phase of life between childhood and adulthood, from ages 10 to 19. It is a unique stage of human development and an important time for laying the foundations of good health' (WHO 2023).

of SDL, empowering learners to customise their education to suit their unique needs (Knowles et al. 2014). While initially aimed at adult learners, SDL principles are relevant in today's rapidly changing educational landscape. In the 21st century, learners must be self-directed, independent and adaptable. Assuming responsibility for learning, identifying needs and utilising resources are vital for personal and professional growth. Self-directed learning enables active engagement and purposeful pursuit of educational goals, shifting learners from passive recipients to active participants in their learning journey. Learning to think critically, solve problems and make sound decisions are all abilities that may help self-directed learners succeed in today's complex environment (cf. Tekkol & Demirel 2018). Self-directed learning also promotes lifelong learning, as individuals acquire the skills and mindset to continue learning beyond formal educational settings (cf. Du Toit-Brits 2019). The implication here can be that SDL fosters a mindset and skillset that support lifelong learning, adaptability, empowerment and diverse learning experiences, ultimately equipping individuals to thrive in an ever-changing world.

Based on the above-mentioned details and the arguments presented in the preceding paragraphs, it can be inferred that SDL can enable people to effectively adjust and flourish in diverse environments within a dynamic society characterised by the continuous evolution of knowledge and information (cf. Guglielmino 2013; Nasri et al. 2020; Tekkol & Demirel 2018). Furthermore, SDL fosters a mindset of curiosity, exploration and continuous growth. In the current education landscape characterised by rapid change, SDL is essential for learners because educators need to prepare learners for their future - a future that cannot be predicted (Guglielmino 2013). Research highlights that SDL is a prevalent notion in contemporary learning frameworks and is, in general, acknowledged as vital for successful educational experiences in a fast-changing world (cf. Du Toit-Brits 2015; Guglielmino 2013; Mishra, Fahnoe & Henriksen 2013). This statement is also supported by Cazan and Schiopica (2014) and Mulube and Jooste (2014), who view SDL as the primary goal of education, including the idea that participation in learning is encouraged through the implementation of SDL. In addition to being exposed to SDL in the classroom through SDL activities, learners need to witness how others (parents and instructors) use these skills. Therefore, dedicating a section to illuminate these SDL skills is imperative.

■ Self-directed learning skills

Self-directed learning skills are crucial for active engagement, autonomy and lifelong learning in modern education (Curran et al. 2019). As the conventional educational paradigm moves towards a more learner-centred

approach, SDL skills emerge as a critical asset for success in both academic and professional activities. This introductory investigation delves into the varied areas of SDL skills (Du Toit-Brits & Blignaut 2019).

By mounting SDL skills, learners can be supported to attain their learning aims and engage in learning opportunities, even outside the classroom (Tredoux 2012). Doing so can lead to individuals' career achievement and economic growth (Mulube & Jooste 2014). The purpose of education is not to coach learners for assessments but to establish responsible and self-directed citizens who can benefit their community, economy and country. The following SDL skills (see Figure 9.1) are necessary for a self-directed learner, as identified by Barrett (2014), Du Toit-Brits and Van Zyl (2017b), Guglielmino (1977), Guglielmino (2013) and Samson (2013):

As seen in Figure 9.1, SDL is a vital component of education, and teachers or facilitators play a crucial role in assisting learners in developing SDL skills. In addition to the cognitive skills required for SDL, the emotional aspects of learning must also be considered (Schonert-Reichl 2017). Motivation is essential, as SDL can be emotionally draining for learners transitioning from traditional teacher-centred models (Schonert-Reichl 2017). Without proper motivation and guidance, learners may struggle to take responsibility for their learning (Ausburn 2002; Li Ping 2010; Schonert-Reichl 2017). Exposure to various SDL skills is essential for learners to



Source: Scheepers (2023, p. 25).

Key: SDL, self-directed learning.

FIGURE 9.1: Self-directed learning skills.

effectively engage in SDL (Hawkins 2018). Adjustment is a key requirement for success in an SDL environment, as learners may face challenges such as loss of motivation, interest, direction and understanding (Armstrong 2010). Maintaining attention and focus on challenging tasks is another SDL skill (Loeng 2020), but learners often feel frustrated and confused when introduced to SDL skills (Hawkins 2018). Therefore, facilitators must prepare learners for SDL by explaining expectations and requirements (Armstrong 2010). They should also convey the value of SDL and help learners progress through different stages of self-direction (Hawkins 2018; Li Ping 2010). Innovative teaching methods like role-playing, storytelling and gamification can aid this process.

Self-directed learning skills are crucial in the rapidly changing educational landscape, fostering intellectual independence, meta-cognition and flexibility. When learners and teachers recognise these benefits, they are more likely to internalise SDL strategies and apply them in various aspects of life. Furthermore, SDL promotes peer cooperation, enabling learners to participate in group discussions, peer-assisted learning and collaborative projects (Blignaut & Du Toit-Brits 2022). Facilitators who effectively convey the importance of SDL contribute to comprehensive educational experiences that produce self-directed, adaptive learners who excel in social interactions. In addition, not all learners possess SDL skills, which implies that learners need guidance to develop such skills (Egizii 2015; Lai, Gardner & Law 2013). Researchers suggest that SDL skills can be developed with proper support and facilitation (Lai et al. 2013; Tredoux 2012). Facilitators need to break down SDL skills and guide learners in their application. This support and guidance are crucial for learners to embrace SDL effectively (Lai, Shum & Tian 2014).

■ Importance of the development of self-directed learners

Self-directed learning is a fundamental aspect of education (Cazan & Schiopica 2014), and it should inspire and enhance classroom learning and participation (Mulube & Jooste 2014). Developing SDL skills in learners is seen to help them achieve their learning objectives and engage in lifelong learning opportunities (Du Toit-Brits & Van Zyl 2017b; Tredoux 2012). Furthermore, it is argued that providing learners with SDL skills can lead to economic growth and career advancement (Mulube & Jooste 2014). Self-directed learning skills encompass critical thinking, problem-solving, flexibility, communication and personal responsibility (Du Toit-Brits & Van Zyl 2017b; Kan'an & Osman 2015), highlighting the need to shift from a knowledge-centric to a skills-centric educational paradigm.

The SDL skills mentioned above relate to self-directed learners and the importance of creating opportunities to acquire these skills in the learning environment (Du Toit-Brits 2015; Du Toit-Brits & Van Zyl 2017b). Learning how to use SDL gives learners more options for approaching and overcoming academic obstacles (Du Toit-Brits & Van Zyl 2017a). However, it is acknowledged that SDL is not suitable for everyone; some learners require structure and guidance (Egizii 2015). Given the critical role of SDL skills in fostering lifelong learning and adaptability, it is vital to explore how SDL skills can be effectively nurtured within the homeschooling environment. Such an exploration is vital as it can shed light on the personalised learning of a homeschooled child, the essential skills they develop, how they adapt to change and how lifelong learning is promoted, among others.

■ Unlocking the power of self-directed learning in homeschool environments

The home environment needs to be a safe learning environment for learners to learn and grow into self-directed individuals. This safe learning environment needs to be the 'home' where learners with SDL skills are cultivated. Learners engaging in SDL achieve better results than passive learners (Alamry & Karaali 2016; Hawkins 2018). Self-directed learning skills encourage learner voices in the 21st century. Listening to learners' voices and entrusting them with decisions about the nature of learning communities are essential (Du Toit-Brits & Blignaut 2019; Robinson & Adam 2020). As learners tackle and overcome challenges, they also prepare themselves to tackle and overcome problems that might arise in the future (Bull 2017). The proliferation of information and the fast advancement of technology provide significant hurdles for learners to stay abreast of current developments (Du Toit-Brits 2019).

Self-directed learning skills are crucial for engineers because of the short half-life of their knowledge, ranging from two to eight years (Wulf & Fisher 2002), and one may assume the same goes for other professions. Lifelong learning is necessary in all professions (including engineering) as discoveries are made daily (Guglielmino 2013). In today's technologically advanced era, all professions must keep up with current trends by implementing SDL skills (Nasri et al. 2020).

With the above information in mind, as authors, we believe that 'self' in the term 'self-directed learning' refers to an individual's mental skills and strengths, and it can further be assumed that 'self' may refer to the individual's attributes that enable them to apply SDL skills. According to Song and Hill (2007), a fundamental incompatibility exists between

Guglielmino's (1977) concept of SDL and the perspective put forward by Brockett and Hiemstra (1991), highlighting the personal nature as a skill. Self-directed learning entails several learner-specific skills, where the individual is primarily responsible for their learning (Loeng 2020). Egizii (2015, p. 1742) makes a critical point by arguing that not all people might find SDL interesting; therefore, Egizii cautions educators to be sensitive when they promote SDL skills among learners. Numerous skills described in the literature are associated with self-directed learners (Barrett 2014; Guglielmino 2013; Samson 2013) and are listed below. Like all processes, learners must develop skills to be self-directed learners. Gündüz and Selvi (2016) have identified the following skills, which develop in learners applying SDL skills, as being essential for the homeschooling system:

- Learners recognise their learning requirements, processes and outcomes (Gündüz & Selvi 2016). Homeschool learners do not have a formally trained educator to help them with their work. As a result, learners must recognise their learning needs and how they will handle the work that must be carried out.
- Learners propose their own learning goals (Gündüz & Selvi 2016). In homeschooling, learners must plan their own learning goals and see how they achieve these academic goals.
- Learners learn and apply effective time management, enabling them to properly complete tasks (Gündüz & Selvi 2016). If these learners have busy schedules, they might need to plan how to prioritise their academic goals.
- Learners develop the ability to organise effectively. For example, learners need to compile schedules to track the progress of their tasks and monitor when tasks must be completed so as not to get overwhelmed (Findley & Bulik 2011; Gündüz & Selvi 2016).
- Learners acquire specific human resource skills. For example, in homeschooling, learners need to know how to research a topic by applying different tools such as web searches, books, libraries and YouTube videos and by conducting interviews with skilled people so that they can complete their tasks to the best of their abilities (Gündüz & Selvi 2016; Jeong et al. 2018; Payne et al. 2013).
- Learners learn to apply different learning strategies (Gündüz & Selvi 2016). For example, in homeschooling, learners do not have the guidance of a fully accredited educator in determining learning strategies and they need to figure out which strategy would work best for them in a particular situation.
- Learners develop the skill to self-assess to ensure adequate, progressive learning (Gündüz & Selvi 2016; Hiemstra & Sisco 2016).

As seen from the literature, Du Toit-Brits (2015, 2019) and Guglielmino (2013) all argue that SDL is a vital skill for all learners in the 21st century (especially in homeschool learning environments) for them to become independent individuals who can maturely adapt to an ever-changing society. Consequently, the implication for parents as homeschool facilitators, based on the information above, is to recognise the significance of SDL in the 21st century and take on a supportive role in fostering independence, adaptability and the development of critical skills in their children while also staying flexible and open to evolving educational methods and tools. Therefore, the following section delves deeper into homeschooling and the vital role of parents in such an educational environment. As parents are the primary facilitators of SDL in this environment, examining their role in the homeschooling educational experience is essential. Their guidance, support and participation are essential for creating an environment where children can become competent self-directed learners, enhancing the entire homeschooling experience.

■ The parent as facilitator in homeschooling

Learners who are being taught at home rely heavily on their parents to be actively involved in their education. In addition, this aspect, support to learners, is congruent with SDL in the sense that independence and active engagement in their educational journeys are prioritised. As an educational technique, SDL allows learners to assume responsibility for their learning, including goal setting and conducting independent research on numerous topics of interest. That said, the parent as facilitator forms part of the unique connection between the parent's engagement and independent learning, which has special significance. In addition, teamwork between a parent and a learner (their child) serves as the basis for independence epitomised by effectively incorporating SDL into homeschooling practices. As educators, a parent provides a conducive learning environment where they guide their children and offer them a variety of resources in their learning journeys. Parents who do this motivate their children to be autonomous and aid in their development of skills such as thinking analytically and managing themselves. Parents may assist learners in becoming self-directed by establishing a solid foundation for SDL.

Consequently, the connection between parental engagement in homeschooling and SDL is conceptual and tangible in a real-world application. Parents often modify and customise the curriculum to suit their child's unique learning requirements and areas of interest, delivering a personalised and captivating educational encounter. The technique aligns

with the praxis component of SDL,¹⁵ whereby integrating theory and practice facilitates an efficient learning experience. Doing so requires parents to continuously evaluate or reflect on their teaching and learning practices to ascertain if they need to adapt their instructional approaches and materials as necessary. Such reflective practices may assist parents in fostering a flexible educational setting sensitive to the learners' changing requirements.

Given all that has been mentioned so far, parents' involvement in homeschooling can contribute to developing SDL skills in children (cf. Gray & Riley 2013; Wai-Cook 2020). By actively participating in joint endeavours and engaging in scholarly activities, parents and learners can cultivate a passion for acquiring information. Parents also need to serve as SDL facilitators, showing academic behaviours and emphasising the importance of ongoing education. This contact helps homeschooled learners acquire subject-specific knowledge and the skills needed for independent and scholarly information retrieval.

Parental involvement is crucial for a child's education, offering various benefits for their development and academic success. Research shows that when parents actively participate in their children's learning, it enhances their confidence, attitude and academic achievement across different subjects, as well as their behaviour and social adjustment (Mamacos 2020; Roy & Giraldo-García 2018; Sepulveda-Esconar & Morrison 2020).

The focus of this section is on the significant role of parents in the provision of homeschooling educational experiences for their children. This role cannot be overstated, as the active engagement of a parent in their child's learning process offers them numerous opportunities to develop and grow into independent beings (Đurišić & Bunijevac 2017). We argue that a parent can nurture the confidence and motivation of a child if they are actively participating in their learning; this fosters a positive outlook on learning and influences their success across all subjects they take.

Active engagement as parental involvement greatly impacts a child concerning their adjustment to how they behave and act socially. That said, a parent so actively involved in their homeschooled child's learning increases discipline and overall positive behaviour (Đurišić & Bunijevac 2017). By offering guidance, outlining expectations and reaffirming fundamental values, parents may profoundly affect their children's

15. In the context of SDL, the concept of 'praxis' pertains to the tangible implementation of information and skills learned via the learning process. The educational approach significantly emphasises the amalgamation of theoretical knowledge and practical application. Learners are not just focused on acquiring information and skills but are also actively engaged in applying them within real-world contexts. This active application serves to enhance their comprehension and foster the development of their expertise (Knowles et al. 2014).

psychological and social growth (Đurišić & Bunijevac 2017). In essence, the parent through their involvement establishes a supportive environment that promotes the ability of their child to adjust and develop socially. Hence, this chapter emphasises the necessity of parents' SDL skills in facilitating their children in their homeschooling journey (cf. Wai-Cook 2020). In today's educational landscape, where homeschooling has become increasingly prevalent, parents' role as facilitators of learning is more critical than ever.

Therefore, parents' SDL skills can be crucial to their children's education (cf. Wai-Cook 2020). They can identify their children's learning needs, set appropriate goals and design engaging learning experiences. They can also evaluate their children's progress and make necessary adjustments. Beyond academic tasks, parents can create a nurturing learning environment, establish effective routines and promote a love for learning. This active involvement strengthens the parent-child bond and fosters shared responsibility for educational success.

However, it is essential to remember that recognising a parent's involvement in their child's education is a dynamic process that evolves. As children grow and develop, the nature of parental involvement may change. Parents need to adapt their approaches to match their children's evolvment and promote their growing independence. Doing so necessitates parents to observe their child, be flexible and adapt learning according to what they observe, communicate effectively, provide positive reinforcement and set boundaries, which are all aspects that can be realised through a parent's SDL skills (cf. Gray & Riley 2013; Wai-Cook 2020). Having established the critical role of parents in facilitating SDL within homeschooling necessitates exploring the specific opportunities that such parental involvement offers to enhance learners' educational experiences.

■ Opportunities that parental involvement offers to learners' homeschool educational experience

Parental participation in their children's schools plays a crucial role in their academic and social-emotional development, a fact recognised both locally and internationally (Lara & Saracostti 2019; Maluleke 2014). Bronfenbrenner's ecological theory supports this notion by highlighting the positive impact of reciprocal interactions between families and schools on a learner's socio-emotional and cognitive development (Louw & Louw 2014).

Parental involvement can significantly affect children's self-esteem and academic achievement, as evidenced by Garbacz et al. (2017). Numerous

academic researchers have explored the correlation between learners' academic achievement and parents' involvement, consistently finding a positive correlation (Pérez Sánchez, Betancort Montesinos & Carbrera Rodríguez 2013; Tárraga, García & Reyes 2017). Parents actively engaging in their children's educational journey can profoundly impact their academic performance, improving grades and overall educational outcomes.

While parental involvement has several advantages, it is essential to acknowledge and address the existing challenges that can undermine these benefits if not adequately considered. These challenges may include time constraints caused by work or other responsibilities, language or cultural barriers, lack of awareness about the importance of parental involvement and inadequate support systems to facilitate parental engagement. These challenges might pose challenges for learners in the homeschooling environment. In the following section, attention is given to some challenges that learners may encounter with SDL in their homeschooling educational experiences.

■ Challenges learners face in homeschooling underpinned by self-directed learning

The authors believe SDL is pivotal in cultivating autonomy and promoting active engagement from parents and learners. Despite the apparent advantages of SDL, implementing SDL in homeschooling poses challenges like curriculum design and maintaining self-discipline without traditional classroom structures (cf. Gray & Riley 2013; Pachai et al. 2016). In contrast to conventional educational settings, where educators are responsible for designing and organising the curriculum, parents who choose homeschooling assume this responsibility. Achieving this shift requires a nuanced equilibrium between establishing a framework and permitting adaptability, a task that might be challenging. Learners may encounter challenges in discerning appropriate learning resources, establishing attainable objectives and sustaining a cohesive learning progression. The lack of a uniform curriculum may result in deficiencies in knowledge, skills and values, impeding a well-rounded educational encounter. As a result, implementing SDL in homeschooling can be challenging for learners. Without knowledgeable instructors and peer contact, learners may struggle to apply theoretical knowledge in practical ways, leading to a disconnect between academic and real-world domains.

One notable challenge that learners encounter within homeschooling is the academic dimension of SDL. The challenge implies that some learners may find it difficult to adapt to the level of independence and self-discipline required for successful homeschooling, particularly in the academic aspect

of their education. To interact with academic disciplines successfully and purposefully, it is essential to possess the means to access a diverse array of information and perspectives. Nevertheless, those educated at home may have limitations regarding their ability to use specialised libraries and labs or get guidance from knowledgeable mentors. The restricted availability might hinder the extent and scope of their academic involvement. Moreover, the lack of peer dialogues and debates may impede the process of acquiring critical thinking skills and the capacity to question one's ideas, both of which are essential aspects of the scholarly mindset.

One common challenge is the tendency for parents to push their children to develop SDL skills faster than they are ready to master them (cf. Gray & Riley 2013; Martarelli et al. 2021). It is essential to recognise that SDL skills take time to develop; rushing the process can be counterproductive (Guglielmino 2013). Another challenge is maintaining self-discipline in homeschooling (cf. Martarelli et al. 2021). Without self-discipline, hobbies, TV, social media, games, sports and family responsibilities can easily distract learners. These distractions make it hard for learners to stay focused and engaged. Without social interaction and support, their productivity, consistency, self-discipline and motivation can be negatively impacted.

The social aspect of traditional schooling, such as peer interactions and teacher encouragement (absent in the homeschooling environment), can significantly contribute to learners' motivation and engagement (Guglielmino 2013). If that is true for traditional schooling, learners in a homeschooling context may need alternative ways to stay motivated and seek support from their facilitators, parents or online communities. The lack of constructive acknowledgement and reward can also undermine learners' motivation and desire to take responsibility for their learning process and performance (Guglielmino 2013). In traditional schooling, learners often receive feedback and recognition for their efforts, which helps to reinforce their motivation. Finding effective ways to provide constructive feedback and meaningful rewards to keep learners motivated and engaged in a homeschooling environment becomes essential. Effective ways parents could include implementing strategies such as providing a personalised learning experience, clear communication, positive reinforcement, various rewards, timely and continuous feedback, and celebrating milestones, among others.

In addition, maintaining focus and concentration can be a challenge for learners. In the absence of a structured classroom setting, mind-wandering and distractions can easily lead to losing focus on the main task (Pachai et al. 2016). Learners need to develop effective strategies (such as time management, mindfulness and stress management) and strategies for

managing their resources (such as minimising distractions and organising study materials) to enhance their concentration skills and create a conducive learning environment that minimises distractions. This statement implies that the mentioned strategies are crucial in the learning process for effective learning to take place – after all, effective learning is not only about the content but also about the strategies they employ to learn. More consideration should be given to the setting in which learning takes place; learners need to be able to concentrate on the activity at hand if they are to learn anything. Additionally, the statement highlights the importance of a conducive learning environment free from distractions, indicating that the physical and mental space plays a role in learning outcomes. The statement also highlights personal responsibility in that learners have a certain degree of responsibility in developing these strategies. For strategies such as time management, stress management and organising study materials to develop, parents, as homeschool facilitators, can consider an explicit instruction approach to teach their children explicitly, such as setting goals, managing stress, staying motivated and building a growth mindset. For instance, they could introduce mindfulness exercises or goal-setting activities into the curriculum. Furthermore, they can book online time management workshops for the learners they teach and actively engage in environmental adaptations. The implication is that homeschool parents can help to create a conducive learning environment by organising classroom spaces to minimise distractions, incorporating noise-cancelling technologies or suggesting specific study locations within the homeschool environment.

Homeschoolers face many challenges, including curriculum execution, practical application, scholarly pursuits, isolation and motivation. Parents and educators must work together to solve these problems. Self-directed learning implementation in homeschooling may be improved by providing resources, assistance and social interaction to help students and parents overcome these problems and thrive in school. Self-directed learning skills may help homeschoolers overcome these issues and enhance their experiences. Praxis in SDL applies learned information and abilities, emphasising theory and practice, where learners can study and use real-world environments to expand their competence and knowledge.

■ **The significance of self-directed learning in homeschooling: Fostering lifelong learning habits and empowering learners**

Self-directed learning is critical to homeschooling success because it allows learners to control their learning and shape their curriculum. In addition, learners are empowered through SDL to engage in curriculum

design and implementation in homeschooling settings, where their parents guide the learning process. Active involvement of learners in this manner promotes independence and ownership because learners can study subjects that interest them, select the resources they want to use to do so and set goals that fit in with their learning styles. Overall, SDL plays a significant role in creating a personalised and relevant learning experience for homeschoolers.

Self-directed learning in terms of homeschooling is crucial for translating theoretical concepts into real-world scenarios while developing the skills to think critically during problem-solving activities. Self-directed learning promotes hands-on experiences, experiments and projects, resulting in a more in-depth grasp of subjects. Furthermore, SDL encourages the exploration of multiple materials and views, enabling learners to dig deeply into topics of interest and research and critically interact with academic information. Self-directed learning nurtures intellectual curiosity and the capacity for autonomous thinking in learners. Therefore, homeschooled learners may investigate, analyse and deeply interact with academic information while gaining a broad grasp of themes through research and intellectual conversations. It can be deduced that SDL encourages intellectual curiosity (cf. Dweck 2006), challenging preconceptions and independent thinking (cf. Reinders 2010). Therefore, SDL in the context of homeschooling plays a significant role in cultivating enduring learning behaviours, such as effective time management, intrinsic motivation and the capacity to adapt to various circumstances. These talents provide inherent value that extends beyond formal schooling, enhancing people's ability to adapt and thrive in an ever-evolving global landscape.

From the discussion above, the authors believe that SDL supports the development of enduring learning habits, which may include a strong sense of responsibility for their education, effective time management, staying motivated and prioritisation. These skills extend beyond formal education, enabling individuals to adapt to new challenges, continuously acquire knowledge and remain engaged with personal growth throughout their lives. The habits cultivated through SDL contribute to learners' resilience and adaptability in a rapidly changing world.

The Global Student Network (GSN) believes that SDL works for homeschool parents because the method can be shaped into a teaching and learning method that reflects their belief systems and the unique learning style(s) of their child(ren) (GSN 2021). Moreover, by providing homeschooled learners with chances to engage in critical thinking and develop SDL skills, they are effectively motivated to assume responsibility for their education and demonstrate accountability (GSN). In addition, the GSN asserts that SDL directly engages homeschool learners in the learning

process, allowing them to develop research, scheduling, creativity, goal setting and communication skills, to mention but a few (GSN).

Finally, SDL also aids in establishing an SDL awareness, which may positively impact learners' ability to adjust to the rapidly changing context in which they are finishing their education in the 21st century. It also encourages learners to have positive attitudes towards learning, curiosity and self-confidence (Bryce 2019). It is also important to remember that learners who take charge of their own learning will have a firm grasp on the following skills: self-awareness, goal setting (both overt and covert), resource acquisition and evaluation (Ayyildiz & Tarhan 2015). In addition, self-control, self-sufficiency and self-regulation are related to SDL (Ayyildiz & Tarhan 2015). Therefore, self-control, external and internal motivation, self-regulation and success during learning activities and experiences are necessary for learners who continuously engage in SDL to develop their skills to function autonomously (Ayyildiz & Tarhan 2015).

Parents whose children are transitioning to SDL sometimes express that it is a new way of life, not just a new educational approach (Szalay 2020). Learners must develop various homeschool skills, as seen in the preceding sections. Homeschooling allows learners to customise their education into personalised education and learn at their own pace (Szalay 2020). As a result, learners must have SDL skills to navigate through their homeschool learning journey, which emphasises the importance of parents also possessing SDL skills, as they need to help the learners, through facilitation, foster SDL in their own lives (Wai-Cook 2020).

Considering the discussion on SDL's profound influence on homeschooling and lifelong learning habits, it becomes evident that this approach is a teaching method and a way of life for both learners and parents. That said, with a clear understanding of SDL's importance in homeschooling and contemporary education, let us explore how SDL can be effectively integrated into educational systems to prepare learners for an ever-changing world.

■ Self-directed learning and its relevance to contemporary education and homeschooling

Now that we have highlighted SDL, followed by discussions on the role of parents and learning in homeschooling, it is safe to say that SDL is not a solitary learning experience or learning in isolation (Bull 2017). In the 21st century, SDL is receiving much attention in learning frameworks and is regarded as a relevant concept for learning experiences in an ever-changing world (Du Toit-Brits 2015; Guglielmino 2013; Mishra et al. 2013). In addition,

among other goals, SDL is regarded as crucial in education and serves as a motivating component of learning (Cazan & Schiopica 2014; Mulube & Jooste 2014). Self-directed learning skill development can help learners achieve their goals and opportunities outside formal education (Tredoux 2012), contributing to personal career success and economic growth (Mulube & Jooste 2014). As is seen from the research conducted for this chapter, SDL is necessary for a thriving homeschooling environment because it provides more opportunities for learners to accept ownership of their learning. Homeschooling empowers learners to take charge of their education and connects them with other people, resources and communities worldwide (Bull 2017).

In homeschooling, SDL can be seen as a process of parents or facilitators guiding their learners to be more independent, which, in turn, can help the learners in the homeschooling environment to gain an appreciation for learning, as they have to take up accountability and the initiative for their learning and should also be able to research topics to get a better understanding of the work at hand (Schoonwinkel 2020). Some overlapping similarities between homeschooling and SDL involve learners' ability to set goals for themselves, select their materials and resources to achieve their personal goals, and create and implement plans to reach them (Pickert 2012). In addition, SDL develops learners' career readiness skills, as learners need to apply time management to their routines and take responsibility for their decisions (Pickert 2012). In other words, there is a focus on readiness and preparedness for the world of work or life after their formal school years. The Department of Basic Education (DBE) determines the content of the school curriculum (Curriculum Assessment Policy Statements [CAPS]). What the DBE determines includes (Ayyildiz & Tarhan 2015):

- how learners learn
- how many learners should already have learned, and how many still need to learn
- where their difficulties will be
- how educators and learners need to concentrate on the lesson
- when and from whom they, as learners, can seek assistance during a lesson, and what the lesson outcomes should be
- how learners and educators need to grasp the aims and objectives of the learning processes.

Even though the school curriculum makes place for SDL, the outline of what the DBE determines can be seen as a limitation to implementing SDL in the school curriculum. In addition, learners must control their learning experiences in the homeschooling environment to quickly transfer what they have learned in today's technology-driven world with constant change (Ayyildiz & Tarhan 2015).

■ Recommendations for enhancing self-directed learning skills in homeschooling

This chapter shows that SDL is imperative to a successful homeschool learning experience. Here are some recommendations on how parents can improve their SDL skills in homeschooling:

- Parents may use a community of practice (CoP) to stay informed about current educational trends, ensuring that their children get a high-quality education. Membership of a CoP allows parents to remain updated on the latest modern educational practices, ensuring that their children enjoy relevant learning experiences. Books, online courses, webinars and seminars are all great options for parents who want to improve their teaching skills, knowledge of the subject matter and philosophy of education.
- Parents who join a CoP may learn from the insights of other CoP members and get support by being involved in such a group. Learning from other CoP members will allow them to grow as teachers and provide more educational options for their children.
- Accountability is another benefit of being part of a CoP. Parents can stay motivated and focused on their educational objectives by sharing their progress and goals with others. Parents reflecting on their learning and engaging in self-care activities can help identify strengths and weaknesses, refining their approach to homeschooling and personal growth.
- Prioritise self-care activities to maintain physical, mental and emotional well-being during homeschooling. Being healthy is crucial for the quality of life and facilitating learners effectively. Unhealthy parents may hinder their ability to facilitate homeschooling, affecting their ability to support learners effectively.
- Embracing lifelong learning allows parents to continue their education and explore new interests alongside their children, fostering a culture of curiosity and growth.
- Providing clear and concise definitions of SDL is essential for parents and facilitators in homeschooling. Offering SDL skills workshops can provide hands-on training and guidance on mastering SDL skills, facilitating effective homeschooling.
- Creating courses on SDL implementation for parents to attend can introduce SDL to them and guide them in implementing SDL effectively. Encouragement of SDL-supporting technologies like the Internet and practical gadgets may also improve homeschooling facilitation.

Having reached the end of the chapter, we propose that parents can enhance their SDL skills and create optimal learning environments for their

children by implementing the above recommendations. In addition, SDL serves as a transformative force, allowing learners to embrace lifelong learning and take ownership of it.

■ Conclusion

Self-directed learning is seen as more than just an educational approach; it is a transformative way of life. People are inspired to trace their paths and embrace autonomy in today's society owing to the rapid availability of new career prospects. Self-directed learning symbolises a cultural change towards curiosity and a quest for knowledge.

The research has continuously stressed SDL's critical role in building learners' responsibility and independence throughout the learning process (Mahlaba 2020). It is critical for homeschooling parents to ensure that their children have the required abilities to become effective self-directed learners, which is possible through creating a suitable learning environment. Creating study environments that foster the development of personal and cognitive skills is fundamental to nurturing self-directed learners (Bhat, Rajashekar & Kamath 2015). Parents can create educational environments that enable their children to assume responsibility for their learning, make well-informed decisions and engage in self-reflection. In these situations, necessary abilities are prioritised, including critical thinking, problem-solving, self-discipline and time management.

In addition to the points above, the authors underline the significance of parents' involvement in their child's education and recommend that parents improve SDL skills to lead and assist their children successfully. By modelling self-directed behaviours and providing guidance and resources, parents can empower their children to assume responsibility for their learning and become motivated learners. Self-directed learning surpasses traditional education by promoting individual power and independence. Homeschooling facilitates the cultivation of self-directed learners through the promotion of autonomy, critical thinking skills development and the fostering of self-reflection. Parents with SDL skills may significantly impact equipping their children with the necessary tools for achieving success in an evolving context. In the next chapter, we look at how the principles of SDL apply to the chemistry classroom and pre-service teacher education, expanding our understanding of the role of self-directed learning in education.

■ Ethical clearance number

The ethical clearance number for this study is NWU-00258-22-A2.

Enhancing self-directed learning: Integrating the Rationality Index of Plant Use and scientific principles in pre-service Chemistry teachers' training¹⁶

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■ Abstract

Poor Chemistry performance may be attributed to various poor teaching practices at the school level. Indigenous knowledge (IK) might provide an avenue to effectively engage pre-service teachers and school learners alike in Chemistry teaching and learning. Therefore, teacher training facilities like higher education institutions must include resources and exemplify effective methods for pre-service teachers to successfully incorporate IK into their Chemistry teaching. One proven effective tool is the Rationality Index of Plant Use (RIPU). The RIPU tool also uses a heuristic to discriminate between tenets of science, IK and pseudoscience to promote deep Chemistry learning. Using RIPU in a problem-based learning setting seemed to sensitise pre-service teachers to self-directed learning by requiring them to diagnose their learning needs, formulate intermediate goals and use the appropriate resources to gather the required knowledge while promoting ownership of and engagement in learning.

■ Introduction

The preceding chapter (Chapter 9) delved into the exploration of self-directed learning (SDL) within the framework of homeschooling during the COVID-19 pandemic. Conversely, this chapter (Chapter 10) explored SDL in Chemistry education by integrating targeted resources, such as the Rationality Index of Plant Use (RIPU) in a problem-based learning (PBL) setting. This approach aimed to create a more nuanced understanding of scientific principles among pre-service Chemistry teachers. Both of these chapters highlight the importance of SDL in different educational settings and provide valuable perspectives on its practical use.

Current work skills prioritise cultivating individuals characterised as lifelong learners, proficient in critical and creative thinking, and adept at problem-solving (Saxe, Mahmoud & Razavinia 2022). Consequently, higher education institutions (HEIs) are responsible for producing graduates who possess these 21st-century competencies (Markandan, Osman & Halim 2022). In the South African context, a substantial proportion of pre-service

Chemistry teachers come from educational backgrounds characterised by suboptimal teaching practices, resulting in a pervasive underperformance in the field of science, as shown by various assessment frameworks such as the Trends in International Mathematics and Science Study (TIMSS) (TIMSS 2019). According to the TIMSS report, the achievement scores in eight countries, including South Africa, showed a concerning decline. In 2019, South Africa scored 374 points, significantly lower than Russia's 567 points, Japan's 593 points and South Korea's 600 points. The deteriorating performance in achievement scores raises cause for concern. Indigenous knowledge (IK) may offer a promising avenue for effectively engaging pre-service teachers and school learners in Chemistry education (Kibirige & Van Rooyen 2010). In addition, IK can serve as a vehicle to contextualise the fundamental characteristics (tenets) of science. Incorporating contextualised content into the curriculum equips pre-service teachers and learners to evolve into scientifically literate citizens and discerning consumers instead of mere memorisers of information.

Despite IK's educational advantages, Widdowson and Howard (2008) lamented the inadequate integration of IK into Chemistry education, often perceived as pseudoscience within the South African HEI environment. Therefore, teacher training facilities like HEIs must include resources and exemplify effective methods for pre-service teachers to incorporate IK into their Chemistry teaching. De Beer's (2020) RPU is a notable tool that has demonstrated effectiveness as it serves as a heuristic to differentiate between the tenets of science, IK and pseudoscience which in turn could promote deep Chemistry learning (De Beer & Wyk 2022, p. 488). Regardless of RPU's roots in ethnobotany, it can be used as an instructional tool in the Chemistry classroom while following the principles of PBL. To Loyens et al. (2015), PBL is seen as a teaching and learning strategy that facilitates critical argument analysis, promotes a deep understanding of the content, and aims at activating prior knowledge.

The relationship between the tenets of IK and the tenets of science in a PBL setting provides a fascinating intersection, highlighting the diversity of human understanding of the natural world. While these knowledge systems (IK & science) have developed through distinct cultural contexts and methodologies, they also share commonalities and potential for mutual enrichment while engaging pre-service teachers in Chemistry teaching and learning. Furthermore, several SDL competencies, such as improved problem-solving, time management and research skills, were enhanced by engaging pre-service teachers in PBL to investigate IK and science concepts. Several scholars have established links between PBL and SDL (Ali et al. 2023; Golightly 2019; Senocak, Taskesenligil & Sozibilir 2007).

To add to the literature on the links between PBL and SDL, the research question for this chapter was: *How does utilising the Rationality Index of Plant Use enhance pre-service teachers' self-directed learning of indigenous knowledge in the Chemistry classroom?*

■ Literature review

The constructs Chemistry teaching, IK, RPU, as well as the science concepts of the nature of science (NOS), IK and pseudoscience (in this order) are critically reviewed in this section.

■ Chemistry teaching

The Curriculum Assessment Policy Statement (CAPS) states that:

Physical Sciences investigate physical and chemical phenomena. This is carried out through scientific inquiry, application of scientific models, theories and laws to explain and predict events in the physical environment. (Department of Basic Education [DBE] 2011, p. 8)

A concise differentiation between the Chemistry and Physics component of Physical Sciences is provided, namely that Physics 'deals with matter and energy and their interactions', whereas Chemistry 'deals with the composition, structure, and properties of substances and with the transformations that they undergo' (DBE 2011, p. 8). Chemistry consists of qualitative (related to conceptual understanding) and quantitative (related to calculations) aspects, which must be taught comprehensively through diverse teaching and learning strategies (Chua & Karpudewan 2019). Unfortunately, attaining such ideals remains unrealised in secondary education in South Africa, as evidenced by the 2019 TIMSS report (TIMSS 2019). Apart from the decline in achievement scores, a more worrisome finding is that only 36% of learners boast the basic scientific knowledge and skills for their age level (TIMSS). Consequently, the South African national performance for Grade 12 Chemistry, as assessed in the 2022 National Senior Certificate Paper 2, averaged a mere 49% (DBE 2023). This figure reflects a disconcerting overall pass rate in the final examination that evaluates the Chemistry component within the broader Physical Sciences subject. The examination results underscore a substantial challenge in secondary education. Delving deeper into the potential factors contributing to this trend reveals a multifaceted landscape, which has been extensively explored and elucidated in various academic studies. The insights derived from Aris, Salleh and Ismail's (2020) comprehensive study are of particular significance.

Aris et al. (2020) conducted a study that examined the many obstacles that impact academic achievement within the domain of Chemistry.

The researchers discovered various challenges that pupils encounter that impede their academic advancement. One highlighted main concern is the widespread adoption of teacher-centred instructional methods. Aris et al. argue that this conventional methodology tends to restrict student involvement and impede the development of critical thinking skills. Additionally, they observed a deficiency in crucial resources and instructional materials, which may hinder the educational process. Aris et al. further identified a lack of creative teaching and learning practices while analysing the educational scene. The need to implement more dynamic methodologies that cultivate creativity and problem-solving abilities in learners was underscored. Furthermore, the researchers expressed reservations about the efficacy and precision of continuous assessment practices. The absence of real-world, authentic scenarios and challenges in the classroom was another important finding in their research. According to Aris and his colleagues, if these challenges are omitted from the curriculum, there might be a disconnect between learners' theoretical knowledge and their practical application, impairing their comprehension and memorisation of the material.

Additionally, Aris et al. (2020) provided insight into student motivation and interest, revealing that in some instances, these factors were discovered to be very deficient. According to their explanation, an absence of motivation may have a substantial impact on the learning process and may be a contributing factor to subpar academic achievement. Furthermore, they observed that some learners had insufficient readiness for the learning process, a phenomenon they hypothesised may be ascribed to reasons such as poor previous educational experiences or personal situations. In brief, the research conducted by Aris and his colleagues revealed an intricate network of elements contributing to subpar academic achievement in Chemistry. The results of their study underscored the need for an instructional strategy, such as SDL (in this domain) that prioritises the needs of learners, provides enough resources and fosters innovation. The above-mentioned challenges typify the learners who contributed to the overall pass percentage of 49% in Paper 2 of the Physical Science examination after their studies at the secondary school level. The same learners then proceeded on various career paths at HEIs. Students who become trainee teachers are referred to as 'pre-service teachers' in this chapter.

Thus, pre-service teachers enter HEIs from a background riddled with challenges, and the possibility exists that these pre-service teachers might model the same poor teaching practices in their classrooms. The pre-service teachers referred to in this chapter are enrolled in Physical Sciences at HEIs in South Africa. One Chemistry module of the Physical Sciences for Education qualification was selected for this chapter. This Chemistry

module is aligned with school-based outcomes regarding understanding matter, material and chemical change (DBE 2011). In addition to the content knowledge, the pre-service teachers also study the didactical components of the selected module. The didactics section relates to how the content knowledge of the module should be taught. Thus, how science content is produced and validated should be understood by pre-service teachers so that they would be able to teach the content well. A thorough understanding of how science is produced and validated leads to tenets of the NOS, which are also juxtaposed and related to tenets of IK. The constructs NOS and IK are part of this module and are studied by pre-service teachers who take this module. The operationalisation of these two constructs is explicated in the sections below. According to Kibirige and Van Rooyen (2010), IK might be a powerful instructional tool in the Chemistry classroom. They also contend that IK might provide an avenue to explore prior knowledge of pre-service teachers and school learners so that effective instructional scaffolding can unfold. This assumption was also taken in the conceptualisation of this chapter to establish how utilising RIPU may enhance pre-service teachers' SDL of IK.

■ Indigenous knowledge

Indigenous knowledge – often referred to as ‘traditional wisdom’ – represents a wealth of insights deeply intertwined with the lives and experiences of communities. As Kibirige and Van Rooyen (2010) define it, IK emerges from the practical engagement of people with their environments during daily existence. Embedded within these rituals lies a crucial metaphysical dimension that carries elements of magic and mysticism, as De Beer and Van Wyk (2022) noted. This metaphysical component adds a layer of significance to IK, infusing it with a sense of wonder and reverence. What sets IK apart from other knowledge systems are its distinctive attributes, as outlined by Kibirige and Van Rooyen.

Firstly, IK is profoundly local and firmly rooted in its specific community and cultural traditions). This knowledge cannot be plucked from its origin without losing its essence and significance (Kibirige & Van Rooyen 2010, p. 237). The same authors highlight that IK is often implied rather than explicitly stated. It resides in the unspoken – understood through actions, customs and subtle nuances – making it an integral but implicit part of everyday life. The transmission of IK is a dynamic process, passed down through generations, not through textbooks or lectures but through imitation, demonstration and storytelling. Indigenous knowledge is a living narrative, evolving with each retelling. Unlike theoretical knowledge systems, which may rely on abstract concepts, IK is grounded in experience and is shaped and refined over countless generations through direct

engagement with the world, embodying the wisdom of lived realities. Lastly, Kibirige and Van Rooyen (2010, p. 237) contend that IK is not static; it is in a perpetual state of transformation. As communities change and adapt to new challenges and opportunities, so does their IK evolve – a reflection of the ongoing interplay between people and their environments. Thus, IK is a living, breathing testament to the deep connection between communities and their surroundings. Interestingly, the participants who participated in this study came from different communities and were expected to teach learners in different communities. Thus, the infusion of IK during the teaching and learning process is necessary, as promulgated by the current curriculum document.

Indigenous knowledge was introduced to the school curriculum documents in 2001 and 2002 as part of the post-apartheid curriculum reform (Naidoo 2010). The Physical Sciences CAPS document is underpinned by IK serving as a guiding principle in the current curriculum: 'Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution' (DBE 2011, p. 5).

More specifically, the inclusion of IK in the Senior and Further Education and Training (FET) Phase CAPS document validates IK as a knowledge system in science teaching by stating:

Indigenous knowledge is knowledge that communities have held, used or are still using; this knowledge has been passed on through generations and has been a source of many innovations and developments including scientific developments. Some concepts found in Indigenous Knowledge Systems lend themselves to explanation using the scientific method while other concepts do not; this is still knowledge. (DBE 2011, p. 8)

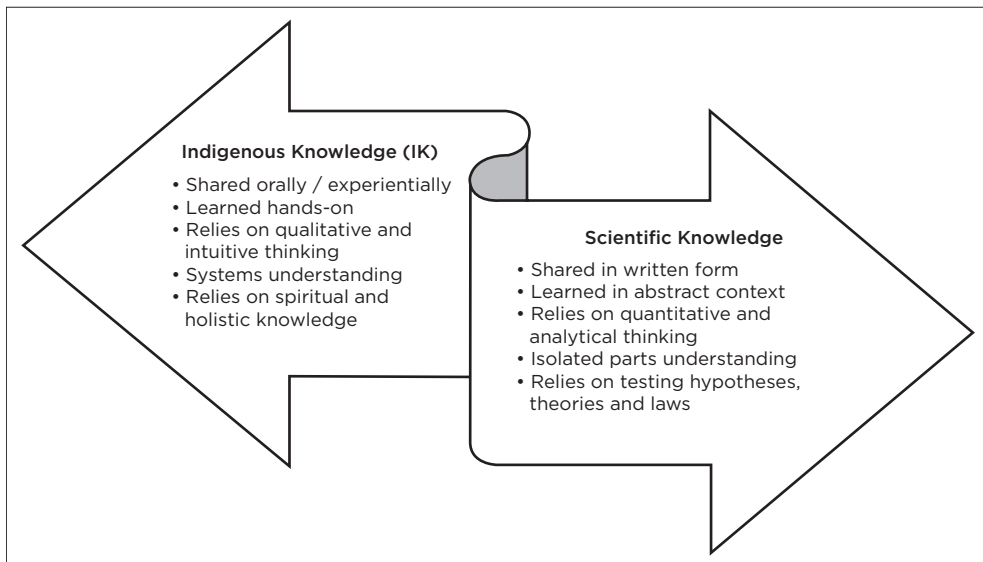
Utilising CAPS as a guiding policy document to plan all teaching and learning activities, teachers and pre-service teachers must infuse IK with the proposed teaching and learning strategies, teaching methods and examples. Regrettably, the links between IK and Chemistry content are not made clear in this document, and teachers and pre-service teachers without a nuanced understanding of IK may be unable to accommodate learners from diverse backgrounds and cultures (Naidoo 2010). In the worst-case scenario, uninformed teachers may even dismiss learner conceptions based on IK as scientific misconceptions. Thus, the absence or inappropriate accommodation of IK in curricula could have significant consequences for some learners (Kibirige & Van Rooyen 2010). For example, they may experience conflict between their existing knowledge and the knowledge presented in Chemistry curricula (Kibirige & Van Rooyen 2010). Sometimes, learners must cross over from IK to Chemistry knowledge or abandon IK (which is inextricably linked to their culture and beliefs) to accommodate

Chemistry knowledge (Kibirige & Van Rooyen 2010). Such learners could face an epistemological crisis in the Chemistry classroom. Figure 10.1 overviews epistemological differences between IK and (Western) scientific knowledge.

In addition to the epistemological crisis learners might experience, Kibirige and Van Rooyen (2010) contended that further problems could include learner disengagement and teacher challenges in conducting proper baseline and formative assessments. These challenges may lead to poor Chemistry performance. On the contrary, several scholars (De Beer & Van Wyk 2022; Kibirige & Van Rooyen 2010; Srikantaiah 2005) indicated that the effective integration of IK (also referred to as contextualised content) could pose the following benefits for instruction:

- making Chemistry concepts less foreign and more familiar to holders of IK
- promoting positive attitudes towards Chemistry in the classroom
- improved instructional praxis, as the new knowledge can be assimilated better if the teacher is aware of prior learner beliefs
- real-life relevance of Chemistry concepts would promote a more profound understanding.

Many countries – including Australia, India and the United States – have realised the need to include IK to contextualise content in the teaching and learning of science concepts in their science curricula (Kanika et al. 2019;



Source: Adapted from De Beer and Van Wyk (2022) and Kibirige and Van Rooyen (2010).
Key: IK, indigenous knowledge.

FIGURE 10.1: Epistemological differences between indigenous knowledge and Western science.

Pangemanan 2020; Tytler & Hobbs 2011). This approach – also referred to as the incorporationist approach by Naidoo (2010) – views IK as an instructional tool that provides a pathway for learners from diverse backgrounds to access (Western) science and more effectively engage with science concepts. Naidoo (2010, p. 219) concluded that contextualised content ‘ensured that learners were not robbed of the necessary concepts and skills to survive in an increasingly global world’. Contextualised content allows learners to become scientifically literate citizens and critical consumers instead of individuals only memorising facts. Despite all the instructional benefits listed, the *status quo* remains that IK is not effectively integrated with Chemistry education and is still perceived as a ‘junk science’ (Widdowson & Howard 2008, p. 242). It is also the view of Jacobs (2015) that there is resistance among practising teachers towards the integration of IK into their teaching practices. This resistance stems from the perception that IK is not evaluated in the exit-level examinations and is rooted in the belief that their teacher training is primarily focused on (Western) scientific knowledge. Therefore, it is of the utmost importance that teacher training facilities, such as HEIs, incorporate tools and model good practices for pre-service teachers to effectively accommodate IK in the Chemistry classroom. One tool that may prove to be effective is RIPU developed by De Beer (2020).

■ Rationality Index of Plant Use

Studies of ethnobotany by De Beer (2020) resulted in the culmination of RIPU – a user-friendly tool to rationalise and validate the medicinal use of certain herbs and plants. The Rationality Index of Plant Use is a heuristic tool comprising questions that result in the overall statistic measure validating or debunking plants’ reasonable and logical use for medicinal purposes. To exemplify the value and use of RIPU, we provide the example of the African potato (*Hypoxis hemerocallidea*), also called *inkomfe* (isiXulu) or *lotsane* (Sesotho), which is commonly used as a tonic in IK to treat a malnourished person (Van Wyk & Gericke 2018).

After selecting the medicinal plant from any IK system, the user must engage with scientific literature and scholarly databases such as Google Scholar, SciFinder or Scopus. According to De Beer (2020), an initial search of the plant’s botanical name, *Hypoxis hemerocallidea*, serves as a starting point for RIPU. The overall number of hits based on the initial search just using the botanical name can be recorded (2,140 results on Google Scholar), and subsequent searches can be carried out by adding more specific keywords to the botanical name such as ‘medicinal use’ (1,890 results on Google Scholar), ‘in vivo’ (907 results on Google Scholar) and ‘in vitro’ (1,260 results on Google Scholar). The search results can then be used to answer

five questions with subsections, as indicated in Table 10.1. Furthermore, the user would then briefly read through some scholarly articles to identify confirmed hypotheses in high-quality journals and discover how in vitro and in vivo experiments were conducted (De Beer 2020).

De Beer (2020) continued to develop an easily quantifiable scale, which can be totalled to 30 marks on the tool interface. The total is divided by 30, resulting in a RIPU scale value ranging from 0.0 to 1.0. Low values (e.g. 0.2) correlate with a lack of scientific evidence to support the medicinal use of

TABLE 10.1: An example of a partially completed RIPU tool.

Item in RIPU questionnaire	Discussion	Score
1. Number of original anecdotes recorded on the plant and its use(s)		4
1.1 How many original anecdotes have been published?		
None = 0		
One or two only = 1		
Three to ten = 2		
Eleven to twenty = 3		
More than twenty = 4		
1.2 Were these anecdotes published in accredited, peer-reviewed publications?		2
No, they were published in grey/low-impact journals = 1		
Yes, they were published in respected peer-reviewed publications = 2		
1.3 How many unpublished anecdotes have been recorded?		3
One to ten = 1		
Eleven to twenty = 2		
More than twenty = 3		
2. Is there a workable (plausible) hypothesis for the plant's use(s)?		4
No = 0. It is possible to speculate on the merit of the plant use = 1		
The hypothesis is unpublished (or published in grey literature) = 2		
The hypothesis is published in low-impact journals = 3		
The hypothesis is published in high-quality journals, but there are still unanswered questions = 4		
Confirmed hypothesis, published in high-quality journals = 5		
3. Chemical evidence		5
The chemistry is unknown = 0		
Little is known about its chemistry = 1		
The chemistry is known, but irrelevant to its use = 1		
The chemistry is known and is related to its use = 3		
The chemistry is very well recorded and clearly linked to its specific use; there is no doubt about its effectiveness = 5		

Table 10.1 continues on the next page→

TABLE 10.1 (cont.): An example of a partially completed RIPU tool.

Item in RIPU questionnaire	Discussion	Score
4. In vitro evidence for the plant use (pre-clinical tests)		3
No in vitro tests have been conducted = 0		
Little or doubtful in vitro testing was conducted = 1		
Some in vitro testing supports the specific plant use = 2		
Extensive in vitro testing has been conducted, with varied results, or results indicating limited effectiveness = 3		
There is good evidence of rigorous in vitro testing that supports the plant use = 5		
5. In vivo evidence for the plant use		4
No in vivo testing has been conducted = 0		
Some evidence of in vivo testing in animals = 1		
Good evidence of in vivo testing in animals = 2		
Some evidence of in vivo testing in humans = 3		
Sufficient evidence of in vivo testing in humans, with either mixed results, or indicating limited effectiveness = 4		
Very good evidence of in vivo testing in humans, indicating the efficacy of the plant use = 6		
Total		21/30
RIPU index: (Total divided by 30)		0.7

Source: Adapted from De Beer (2020).

Key: RIPU, Rationality Index of Plant Use.

the plant, whereas high values (e.g. 0.9) would indicate sufficient scientific evidence to support the medicinal uses of the plant. De Beer and Van Wyk (2022) stated that an intermediate score of 0.4 to 0.6 would require more research on the medicinal plant's chemistry.

As is clear from Table 10.1, the total RIPU index was 0.7, which is considered an intermediate to a high score. This score indicated the limited efficacy of *Hypoxis hemerocallidea* and more research may be needed on the medicinal use thereof. A more comprehensive use of the tool (as was required of the pre-service teachers in the intervention) would require the user to summarise and record findings and proof from the scholarly articles in the discussion section of the table (we omitted this in Table 10.1 for brevity). We concur with De Beer and Van Wyk (2022) that this tool is not limited to ethnobotany but can be a powerful instructional tool in the educational setting to engage pre-service teachers and learners. Also, using this tool would impose a substantial cognitive burden on learners and pre-service teachers. Consequently, we affirm that active involvement with the RIPU tool in the classroom environment is *sine qua non* for SDL. Pre-service teachers would be encouraged to assess learning requirements and develop

learning objectives before utilising the RPU tool. Utilising suitable scholarly databases would facilitate the acquisition of knowledge by pre-service teachers regarding the selected medicinal plant by improving understanding of *in vitro* and *in vivo* experimentation in scholarly texts, as well as the chemistry about the plant's active ingredient and drawing conclusions based on evidence (De Beer & Van Wyk 2022). Such an approach not only reflects the authentic realm of scientific enquiry but also has the potential to foster an engaging SDL experience in Chemistry.

De Beer's (2020) RPU tool was only recently introduced in education and teacher training; thus, empirical evidence related to its efficacy and the challenges related to its implementation are sparse. Early research efforts reported by De Beer and Van Wyk (2022) show possible teaching-learning gains for pre-service teachers. Preliminary findings from focus group interviews conducted after a RPU workshop with practising science teachers concurred with the task's complexity and its potential to promote SDL, as expressed earlier. Furthermore, the focus group data reiterated that the RPU tool might promote active learning involvement and enhanced creativity while promoting cultural diversity and respect for IK (in a cooperative learning environment). De Beer and Van Wyk advocate that engaging with IK through the RPU tool provides a vehicle for exploring important science concepts such as the tenets (characteristics) of science, the tenets of IK and how both science and IK differ from pseudoscience.

■ The science concepts: The nature of science, indigenous knowledge and pseudoscience

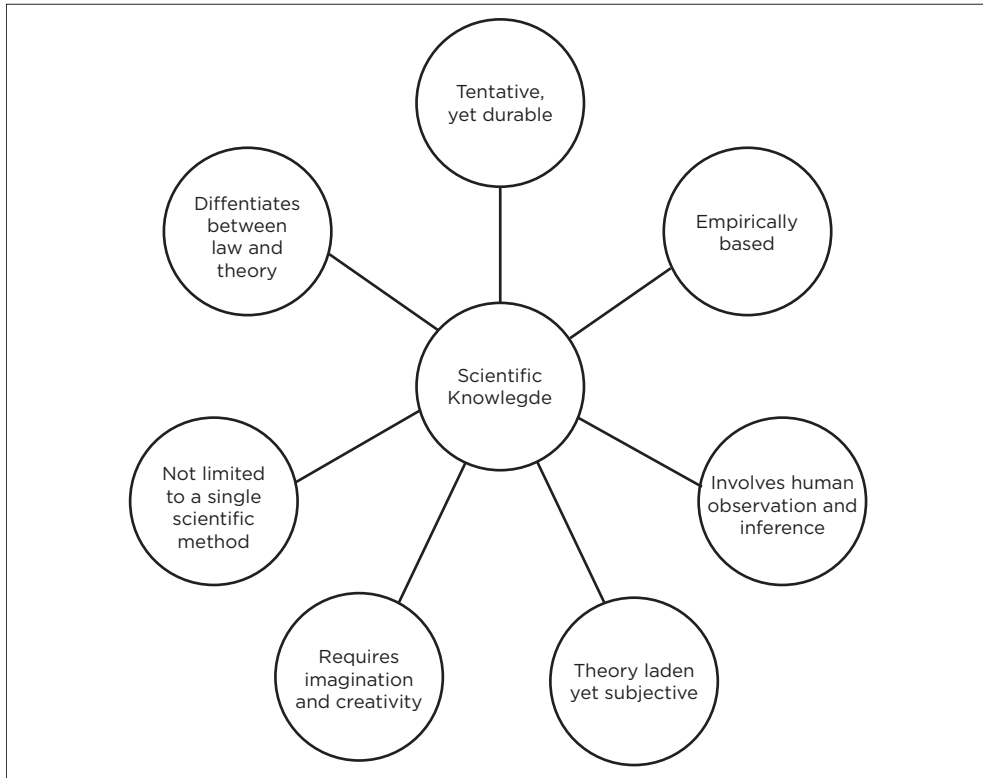
Vhurumuku (2010) contends that international trends in science education focus on the process of science approach, which recognises that science encompasses more than just facts, laws and theories. This approach acknowledges the importance of human activities when engaging with the process of science and so positively contributes to the development of scientific literacy of learners (Cronje, De Beer & Ankiewicz 2015). Scholars agree that by frequently engaging with the process of science, certain common characteristics of science emerge. These so-called characteristics are called the NOS (Cronje et al. 2015; Vhurumuku 2010). Interestingly, many of these characteristics of science overlap with the nature of IK but differ from the attributes of pseudoscience (De Beer & Van Wyk 2022). In the following subsections, the NOS, the nature of IK and the nature of pseudoscience are discussed to better define and differentiate between them.

■ The nature of science

The NOS is a dynamic and multifaceted construct influenced by the philosophy, history and sociology of science (Chanetsa & Ramnarain 2023). Cronje et al. (2015) contend that no single definition exists to define the construct NOS, but because of frequent engagement with science and scientific enquiries, certain characteristics of science emerge consistently. These characteristics of science constitute the NOS. According to Chanetsa and Ramnarain, there are two schools of thought regarding the NOS: the consensus view (CV) and the reconceptualised family resemblance approach (RFN). Below, we provide a brief overview of the evolution of the CV from the 1990s to the RFN in 2016.

According to the CV, the NOS was expressed only in epistemological and sociological dimensions. This view explored science as a mode of thought and a means of understanding the natural world. Additionally, it examined how the values and beliefs of the scientific community influenced the advancement of scientific knowledge (Lederman 1992 as cited in Chanetsa & Ramnarain 2023). This understanding led to the NOS being summarised by seven characteristics of science (tenets of science), represented in Figure 10.2.

According to Chanetsa and Ramnarain (2023), scholars have identified several limitations in conceptualising the NOS, specifically concerning its historical and philosophical dimensions, as expressed by the CV. To this effect, scholars such as Irzik and Nola (2014) proposed a conceptual framework to address these limitations (i.e. the FRA). The FRA offered a comprehensive perspective on NOS by incorporating diverse philosophical perspectives and organising scientific knowledge into four distinct categories, as Irzik and Nola suggested. The categories included the following: science as a systematic process of enquiry; the objectives and principles underlying scientific endeavours; the methodologies and rules employed in scientific investigations; and the body of knowledge generated through scientific enquiry. These categories were enhanced to accommodate the specific needs of various branches of science, allowing for greater subject specificity. Chanetsa and Ramnarain (2023) exemplified the more holistic nature of the FRA by explaining that all sciences 'will make use of science process skills such as collecting data and making inferences', but some sciences will have to exclude non-subject specific science processes – such as experimenting – which does not apply to Astrophysics. The CV did not provide for such differentiation and subject specificity. In subsequent years, the FRA continued to evolve through the work of scholars Dagher and Eduran in 2016. Chanetsa and Ramnarain explained that the work of Dagher and Eduran expanded the four categories of Irzik



Source: Adapted from Chanetsa and Ramnarain (2023) and Vhurumuku (2010).

FIGURE 10.2: The tenets of science, according to the consensus view.

and Nola to include social organisations and interactions, political power struggles and financial systems. The newly expanded FRA was coined by the RFN, providing a more nuanced and inclusive framework for understanding the NOS, as shown in Table 10.2.

As is clear from Table 10.2, the RFN acknowledges the multifaceted and ever-evolving nature of scientific knowledge and methodologies and carries significant ramifications for science education, interdisciplinary cooperation and ethical deliberations among scientific community members (Chanetsa & Ramnarain 2023).

We acknowledge and appreciate the RFN approach for its holistic nature; however, for this chapter, the RFN framework would add too much complexity concerning the constructs already mentioned. Therefore, for this chapter, the CV of the NOS was utilised. In addition to the seven characteristics of NOS identified in Figure 10.2, our selected CV framework added two more specific characteristics under the ‘methods and methodological rules’ proposed by Irzik and Nola (2014): a reductionist

TABLE 10.2: The categories and description of the reconceptualised family resemblance approach (RFN) of the nature of science (NOS).

Category of RFN	Description of category
Aims and values	Central cognitive and epistemic outcomes of science, e.g. accuracy and objectivity Central societal, cultural and political values, e.g. honesty and applicability to human needs
Methods	Techniques (manipulative or non-manipulative) underpinning scientific investigations
Scientific practices	Epistemic and cognitive practices required to generate scientific knowledge
Scientific knowledge	The outcomes of scientific enquiry in the form of scientific explanations, models, laws and theories
Social certification and dissemination	The social mechanism of peer reviewing, peer evaluating and validating scientific knowledge
Scientific ethos	The guiding principles and norms scientists employ in their professional interaction with colleagues
Professional activities	The way scientists engage in professional settings and/or conferences
Social organisations and interactions	The arrangement of science in academic and research institutions
Financial systems	The funding of and other financial dimensions related to science
Political power structures	The underlying power dynamics between scientific communities and cultures

Source: Adapted from Chanetsa and Ramnarain (2023).

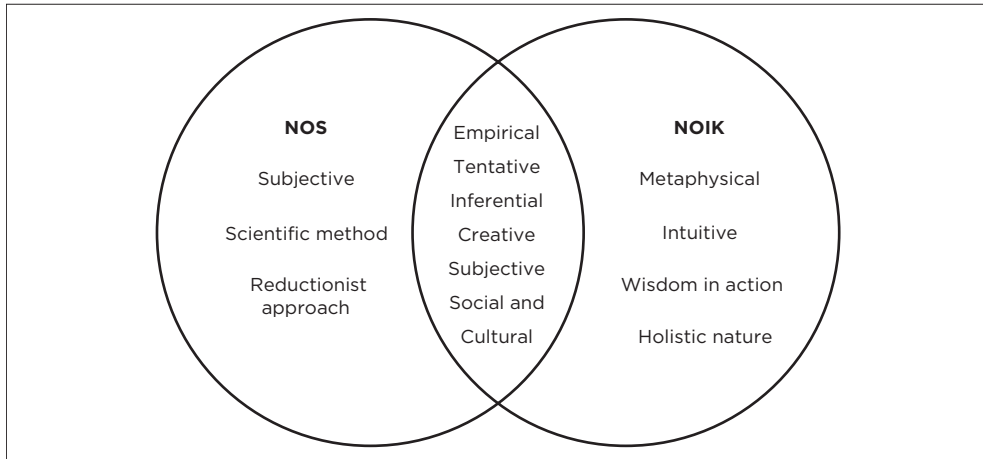
Key: RFN, reconceptualised family resemblance approach; NOS, nature of science.

approach and social and cultural embeddedness. Cronje et al. (2015) explain that the reductionist approach refers to complex problems broken down into smaller parts for analysis; social and cultural embeddedness refers to the universally applicable scientific laws and theories; and science can be generated at a specific place. This CV of NOS enabled us to compare the tenets of science with those of IK more effectively, as recommended by scholars (Cronje et al. 2015).

■ The nature of indigenous knowledge

Earlier, IK as a knowledge system was discussed in detail. Like science, IK also has distinguishing tenets (characteristics). However, many of the tenets of IK overlap with the tenets of science. Figure 10.3 offers an overview of the shared and opposing tenets of the nature of indigenous knowledge (NOIK) and the NOS.

As Figure 10.3 shows, the tenets that comprise the NOIK include both empirical and metaphysical contexts, which implies that nature is real, can be fully or partly tested and 'the universe is orderly, metaphysical and partly predictable' (Cronje et al. 2015, p. 323). Contrary to the NOS, the NOIK relies on wisdom in action, implying that IK is generated by hands-on, trial-and-error engagement with daily life rather than laboratory testing by



Source: Adapted from Cronje et al. (2015).

Key: NOS, nature of science; NOIK, nature of indigenous knowledge.

FIGURE 10.3: A graphical illustration depicting the intersection between the nature of science (NOS) and the nature of indigenous knowledge (NOIK).

engaging with the scientific method, as in the NOS (Cronje et al. 2015). Indigenous knowledge solves problems holistically, ignoring the boundaries of the metaphysical world (Cronje et al. 2015). Per implication, IK is an amalgamation of knowledge systems, which includes science, religion, psychology and other fields. Therefore, this holistic problem-solving nature of IK is difficult to reconcile with the parts-of-the-whole problem-solving method in the NOS. The NOS tends to rely on a reductionist problem-solving approach where complex problems are broken down into smaller, manageable parts for analysis (De Beer 2023). Similar to the NOS, the NOIK is tentative, which implies that IK withstood the test of time but is subject to change as traditions are changeable, transformative and ever evolving (De Beer 2023).

As argued by Cronje et al. (2015), it is important to realise how the characteristics of the NOIK correspond to the characteristics of the NOS, not to determine which knowledge system is superior, but rather to effectively integrate IK in the Chemistry classroom. Table 10.3 represents all the main characteristics of the NOIK and how they relate to the characteristics of the NOS for ease of reference.

The shared tenets of science and IK pose a conundrum - the shared tenets validate the inclusion of IK in curricula, yet the fundamental differences between the two constructs pose challenges for inclusion. Hodson (2009) warns that care should be taken to 'include anything and everything in the curriculum under the banner of science'. Consequently, the RIPU scale does not accommodate the metaphysical (i.e. immeasurable)

TABLE 10.3: The tenets of the nature of indigenous knowledge (NOIK) and its relation to the tenets of the nature of science (NOS).

Nature of indigenous knowledge (NOIK)	Nature of science (NOS)
Empirical and metaphysical: In needs-based experimentation, nature is real and observable, and the universe is orderly, metaphysical and partly predictable.	Empirical: Nature is observable, orderly, predictable and testable.
Tentative: IK is fluid and transformative; although it withstood the test of time, it is subject to change as culture changes.	Tentative: All can challenge science; depending on the validity of new discoveries, science is subject to change.
Inferential yet intuitive: Events have natural and supernatural (unnatural) causes. The metaphysical dimensions are important.	Inferential: All events have natural causes. There is a difference between observations and deductions made from observations (inferences).
Creative and mythical: Human creativity, myths and metaphors, and imagination contribute to different ways of knowing.	Creative: Human creativity and imagination play a role in discovering and interpreting scientific knowledge.
Subjective: Indigenous epistemology is intertwined with cosmology, spirituality and culture.	Subjective: Scientists try to be objective but cannot be separated from human nature, prior knowledge and beliefs.
Social and cultural: Indigenous knowledge is profoundly local, rooted in culture and affected by historical-political contexts.	Social and cultural: Science is a human endeavour influenced by the social and cultural contexts, which impacts the objectivity of scientists.
Wisdom in action: New ideas are tested in the 'laboratory of survival'. Daily life contexts to explain the why and what behind observed phenomena. Ceremonies and repetition reinforce ideas and aid retention.	Scientific method(s): Causal and logical scientific laws, theories and scientific enquiry explain why and what happens behind observed phenomena. Various methods and problem-solving theories are applied in laboratory contexts.
Holistic approach: Indigenous knowledge is an amalgamation of science, religion and philosophy. Problems are solved with no regard for metaphysical boundaries.	Reductionist approach: Complex scientific problems are broken into smaller, manageable parts for analysis.

Source: Adapted from Cronje et al. (2015) and De Beer (2023).

Key: NOIK, nature of indigenous knowledge; NOS, nature of science; IK, indigenous knowledge.

component of IK to ensure effective science learning and mitigates the challenge of including IK in the curriculum. However, the shared tenets of science and IK differ significantly from the tenets of pseudoscience.

■ The nature of pseudoscience

As the prefix 'pseudo' suggests not genuine or fake, pseudoscience can be succinctly defined as an imitation of science; it mimics scientific activity without conforming to the rigour, norms and standards fundamental to

science (De Beer & Van Wyk 2022). At initial observation, it may seem that IK and pseudoscience share few similarities, given their distinct origins regarding worldviews and methodologies. However, several intriguing parallels emerge when examining the underlying tenets of these two frameworks. Both IK and pseudoscience frequently challenge the established norms of mainstream scientific paradigms. Indigenous knowledge is firmly grounded in traditional wisdom, local customs and oral traditions, challenging the dominant authority of Western scientific dogma (Cronje et al. 2015). Similarly, pseudoscience often presents itself as a dissenting voice, questioning the consensus of established scientific principles, as shown by Pavić's (2013) study. In addition, it is worth noting that both IK and pseudoscience share a common tendency to prioritise experiential and anecdotal evidence as legitimate sources of information (De Beer & Van Wyk 2022). This inclination starkly contrasts the rigorous empirical tenets of science (De Beer 2023). The correlation between IK and pseudoscience frameworks underscores the significance of cultural context in influencing beliefs and the intricate interaction between tradition, belief systems and empirical evidence in human understanding of the natural world. Pavić lists the following as the most prevalent tenets of pseudoscience:

- vague and unfalsifiable claims
- selective presentation of empirical evidence (confirming evidence selected while contradicting or falsifying evidence is ignored)
- selection of unreliable data by being over-reliant on anecdotal evidence.

De Beer and Van Wyk (2022) underscore that less rigorous or pseudoscientific practices are often disguised as science using scientific terminology. They also contend that it is of the utmost importance for pre-service science (including Chemistry) teachers and learners to be able to discriminate between science, IK and pseudoscience. The RIPU tool is best used as a heuristic to develop a more nuanced understanding between the tenets of science, IK and pseudoscience, respectively, and should ideally be presented to learners (also pre-service teachers) in a PBL activity (De Beer & Van Wyk 2022).

■ Problem-based learning

To Loyens et al. (2015), PBL is succinctly seen as a teaching and learning strategy that facilitates critical argument analysis, promoting deep understanding of the content and activating prior knowledge. This chapter adopted the definition of PBL suggested by Sameuls, Sebatana and Dudu (2023, p. 93), who defined PBL as 'inquiry-based teaching and learning pedagogy that develops the learners' conceptual understanding of the content and SDL through the exploration of an authentic content-based problem'. Thus, by engaging pre-service teachers' PBL through the RIPU

tool, SDL is *sine qua non*. During PBL implementation, pre-service teachers work together to plan and discuss the solutions through a seven-step method listed by Bilbao et al. (2018):

- Step 1: Exploring the PBL problem and defining concepts in the problem
- Step 2: Delineating and defining the problem by identifying facts
- Step 3: Analysing the problem to generate hypotheses
- Step 4: Looking for explanations and identifying gaps
- Step 5: Engaging in SDL by formulating learning objectives or issues
- Step 6: Searching and applying new information
- Step 7: Evaluation and preparing a report that addresses the stated problem.

In this chapter, PBL was operationalised as an enquiry that develops learners' conceptual understanding of the content and SDL through exploring an authentic content-based problem.

■ Self-directed learning

Introducing open-ended, real-life situations, for example, makes it an important teaching and learning method in a Chemistry classroom because it permits learners' engagement and participation rather than simply acquiring information through direct instruction. In a study performed by Golightly (2019), the author maintains that the problems during PBL activities can develop critical thinking skills and learning autonomy and several SDL skills, including selecting and applying resources required for learning and pre-service teachers taking ownership of the learning process (Sameuls et al. 2023). As argued by several scholars (Ali et al. 2023; Golightly 2019; Senocak et al. 2007), this study acknowledged the enhancement of SDL because of PBL implementation in a classroom setting. As seen in Chapters 1, 2 and 9, SDL is a process of showing independence, motivation and confidence such that an individual is aware of what is required to be successful in learning or working. This chapter also sees the relationship between SDL and PBL in the following aspects:

- *Autonomy and ownership*: Both approaches emphasise learner autonomy. In SDL, pre-service teachers can set their learning goals and take control of their learning journey; similarly, in PBL, pre-service teachers take ownership of solving complex problems driving their learning process (Loyens, Magda & Rikers 2008).
- *Engagement and motivation*: Both SDL and PBL can increase engagement and motivation, according to Loyens et al. (2008). When pre-service teachers have agency in their learning (SDL) and work on real-world problems (PBL), they often find the learning experience more meaningful and relevant.

- *Problem-solving and critical thinking:* Problem-solving skills are developed by using PBL in pre-service teacher education (Sameuls et al. 2023). This approach allows individuals to engage with and solve complex problems. Similarly, SDL serves as a valuable complement by allowing pre-service teachers to delve deeply into solutions and select pathways congruent with their strengths and interests.
- *Collaboration and communication:* PBL involves collaborative group work, enhancing communication and teamwork skills (Sameuls et al. 2023). Similarly, SDL also involves peer interactions, allowing pre-service teachers to share insights and collaborate more informally.
- *Research skills:* PBL requires pre-service teachers to research and gather information to address the problem (Loyens et al. 2008). This relates well to SDL which requires pre-service teachers to explore additional resources and delve deeper into related subjects.
- *Lifelong learning:* Both approaches foster the development of skills that can be applied in contexts beyond the traditional classroom setting. Self-directed learning fosters a sense of accountability for continuous learning, whereas PBL equips learners with problem-solving abilities applicable to diverse real-life situations (Sameuls et al. 2023).

We conclude that these approaches (SDL and PBL) can be combined to create a comprehensive learning environment. For example, in a PBL scenario, learners can engage in SDL to research background information before addressing the problem. Conversely, an SDL project can culminate in a PBL activity where learners collaboratively tackle a real-world issue related to their chosen topic. Ultimately, the relationship between SDL and PBL highlights the importance of active engagement, student autonomy, critical thinking and the application of knowledge to real-life situations. Integrating these approaches can result in a well-rounded educational experience that prepares learners for the complexities of the modern world.

In this chapter, the PBL intervention using the RIPU tool was presented to pre-service teachers by linking the problem to IK as a vehicle to explore the tenets of science and pseudoscience. The methodology section discusses the activity (or intervention) in more detail. Our literature found that no similar studies were performed in Chemistry teaching, but several related studies investigated the interrelated notions of PBL, SDL and science concepts (IK, NOS and pseudoscience) as described above.

■ Review of related studies

A study titled 'Teachers' affective development during an IK professional teacher intervention with in-service Life Sciences and Natural Sciences teachers' was conducted by Jackson, De Beer and White (2016) in the

North-West Province, South Africa. In their research, Jackson et al. (2016) used Engeström's third-generation cultural-historical activity theory (CHAT) as a theoretical framework to examine the factors that facilitate or impede affective development in the pedagogy of IK. The results of their study revealed a notable enhancement of the participants' favourable disposition towards IK after the intervention. The findings suggest that following intervention, teachers show a greater level of motivation and interest in instructing IK. Nevertheless, the data also revealed that the provision of ongoing professional development, specifically within communities of practice, is imperative to support teachers' development of pedagogical content knowledge.

Valdez and Bungihan (2019) conducted a study in the Philippines to examine the efficacy of the PBL approach in improving the problem-solving abilities of Grade 9 learners in Chemistry within a public high school setting. The data obtained from a sample of 96 learners were analysed using a descriptive-comparative and pretest-posttest experimental design. This analysis yielded the following findings: there was an inadequate level of problem-solving skills observed both before and after the implementation of the non-PBL approach. However, there was a noticeable improvement in problem-solving abilities after the learners were exposed to the PBL approach. The utilisation of PBL in the instruction of Chemistry concepts to Grade 9 learners demonstrated a higher level of effectiveness compared to the non-PBL approach.

Baynes (2016) conducted a study in the field of participatory action research (PAR) to investigate the perspectives of teachers on the integration of IK into the Science Curriculum of Australia. In this chapter, Baynes (p. 80) considered the 'attitudes and beliefs of a group of secondary school science teachers to the current imperative to include IK and perspectives in classroom practice'. Similar to PBL discussed in this chapter, the PAR process described by Baynes facilitated the participants' cultivation of personal and intellectual involvement before their implementation of IK in education settings. According to the research conducted by Baynes, the acknowledgement of various perspectives and aspirations in science education, such as IK, necessitated a commitment of teachers' time and a readiness to engage with epistemological challenges. The teachers in the study encountered significant obstacles in the past because of their limited cultural knowledge and apprehension about potentially offending cultural norms. Although the individuals expressed empathy towards the integration of IK and had reservations about promoting social justice through education, understanding their teaching environments and perspectives on science necessitated grappling with epistemological obstacles. The preceding studies' results informed the formulation of themes aimed at identifying conflicts within activity systems with CHAT.

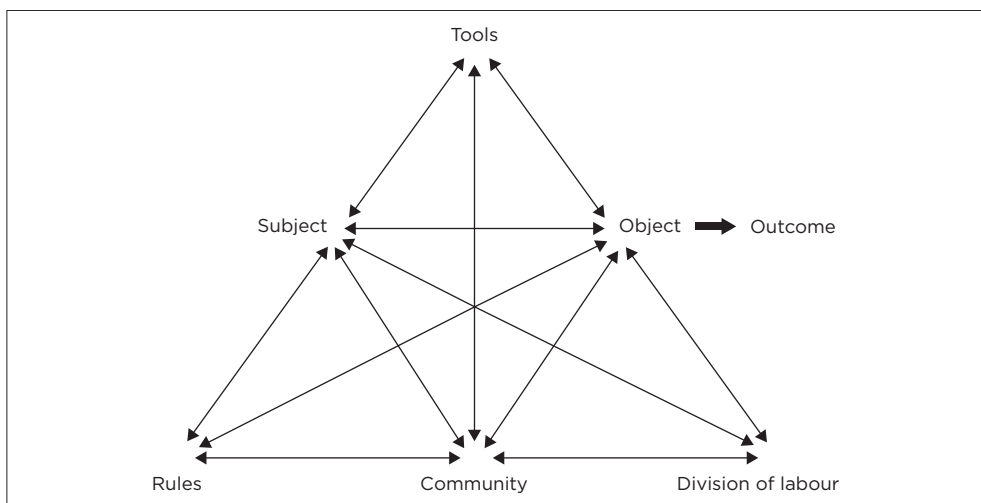
■ Theoretical framework

Cultural Historical Activity Theory was considered a valuable theoretical framework for comprehensively understanding the intricate dynamics of teaching and learning chemistry within a classroom, mainly when including IK. According to Gewurtz et al. (2016), the utilisation of a single theoretical framework in a PBL study may not adequately address the multifaceted nature of the subject matter. To pre-empt this challenge, the present study was informed by Vygotsky's (1978) zone of proximal development (ZPD) as an additional theoretical framework. The theoretical framework of CHAT can be traced back to the early contributions of Vygotsky (1978) and has been further developed by influential scholars such as Engeström (1987) and Leont'ev (1978). The ZPD is a prominent concept formulated by Lev Vygotsky within the framework of social constructivism (Taber 2020). According to Morris (2020), the concept of SDL is grounded in the theoretical framework of constructivism. The concept of SDL holds significant importance within the context of PBL, as highlighted by Silen and Uhlin (2008). According to Vygotsky (1978, p. 86), the ZPD can be defined as the discrepancy between an individual's current level of development, as assessed through independent problem-solving, and their potential level of development, as determined by problem-solving with the guidance of an adult or in collaboration with peers who possess greater capabilities. The concept of the ZPD encompasses two key elements. The first element pertains to a genetic explanation rooted in the origins and progression of learning. The second element focuses on the significance of social interaction in the development of knowledge, with particular emphasis on the influential role of a more knowledgeable individual (Wertsch 1979).

According to Podolefsky, Moore and Perkins (2013), the ZPD places greater emphasis on an individual's competence when engaged in small group settings compared to working alone. This is supported by Yu and Hu (2016), who suggest that learners' cognitive abilities are expanded through participation in novel, engaging and challenging learning activities. In addition, Vygotsky (1978) posited that the ZPD involves the potential of a learner to eventually attain independent mastery of a given task. Vygotsky underscores the significance of engaging in interactions with individuals such as friends, family members, teachers and peers in constructing knowledge and fostering cognitive development. According to Vygotsky's seminal work in 1978, individuals from whom we acquire knowledge are referred to as 'most knowledgeable others'. Furthermore, Vygotsky posited that learning through social interaction takes place within the ZPD of an individual. McPherson-Bester (2019) postulated that a ZPD professional development programme facilitates the establishment of linkages between

theoretical concepts and practical applications for teachers. This chapter focuses on the examination of Vygotsky's concept of the ZPD in relation to Chemistry pre-service teachers. These individuals participated in an intervention where they were provided guidance by more proficient peers (who were also researchers) to assist them in effectively utilising the RIPU tool for their SDL. The aim was to facilitate the connection between chemistry principles and their IK. Figure 10.4 illustrates the utilisation of CHAT as the theoretical framework that formed the foundation of this study.

The utilisation of CHAT in research endeavours that aim to understand the intricacies of real-world scenarios involves the application of a specific language and a collection of frameworks. These tools facilitate the interpretation and analysis of observations, interviews and other data collection methods, including open-ended questionnaires (Gedera & Williams 2013). The utilisation of the activity theory framework in research involves the examination of activity as the fundamental unit of analysis. Activity, in this context, is characterised by the dynamic interplay between the subject and object, encapsulating the question of 'who is engaged in what action and for what purpose' (Vygotsky 1978). Cultural-historical activity theory is a comprehensive theoretical framework that has been widely employed, particularly in heterogeneous societies like South Africa, to provide valuable perspectives on the systemic elements and conflicts that impact the achievement of particular educational goals. This framework has been recognised for its strength and versatility (De Beer 2019; Igira &



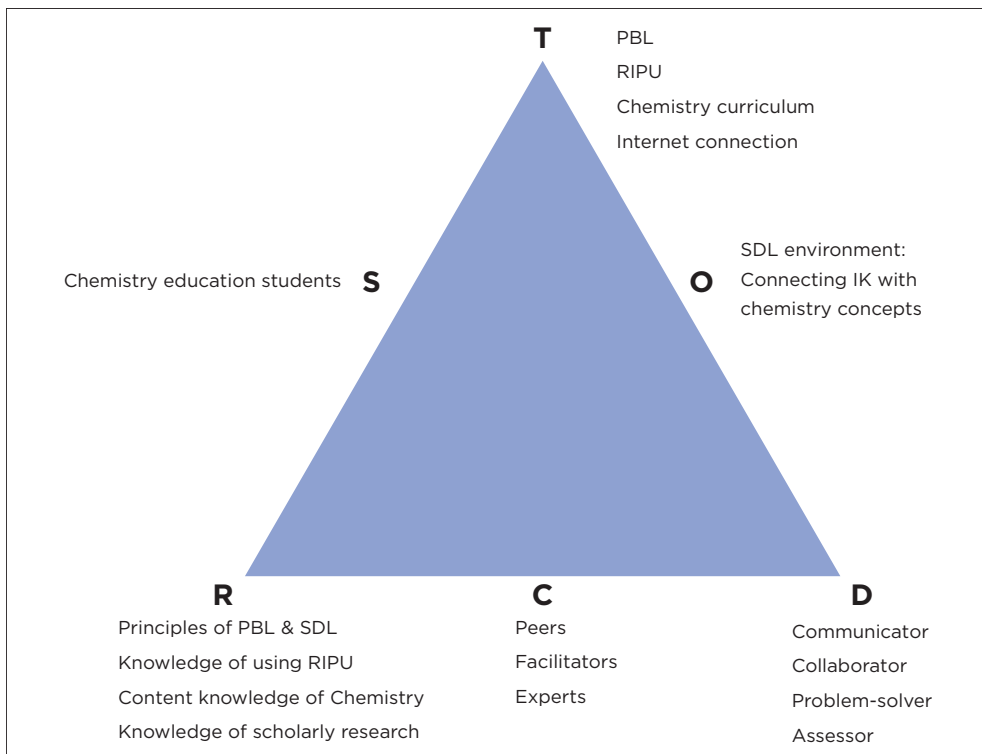
Source: Adapted from Engeström (1987).

FIGURE 10.4: Activity theory framework.

Gregory 2009). The CHAT framework examines the dynamics of teaching and learning in the classroom through a comprehensive lens, encompassing various aspects such as the social construction of knowledge by learners and the utilisation of tools to support learning, as discussed by De Beer (2019) and Mentz and De Beer (2021). The third-generation CHAT model, as utilised in this study, is illustrated in Figure 10.5.

As depicted in Figure 10.5, each abbreviation is linked to an important concept:

- R = Rules are described in detail under the methodology section
- C = Community refers to lecturer(s), peers (other Chemistry pre-service teachers) and learners' communities
- D = Division of labour refers to the roles of pre-service teachers to provide their known cultural practices, engage in scholarly searches related to IK, complete the RIPU tool and the lecturer(s) as facilitators and assessors of learning



Source: Adapted from Mentz and De Beer (2021).

Key: PBL, problem-based learning; RIPU, Rationality Index of Plant Use; SDL, self-directed learning (SDL); IK, indigenous knowledge.

FIGURE 10.5: Applied third-generation cultural-historical activity theory.

- S = Subject refers to the pre-service teachers exposed to 'Tools' and 'Rules' at the focal point between the two
- O = Objective of this study is for the learners to learn Chemistry concepts (the tenets of science, IK, pseudoscience) using IK as a vehicle in a PBL environment (using the RPU tool), thus because of 'Tools' and 'Division of labour'.

The theoretical framework employed in this chapter is CHAT, which utilises an SDL environment. Within such an environment, learners can establish connections between IK and Chemistry concepts, thereby engaging in an activity system. According to Collier (2022), SDL is posited as a transformative educational approach accessible to learners of all backgrounds. One distinguishing characteristic of SDL in comparison to other pedagogical approaches is its emphasis on placing the 'self' (the learner or pre-service teacher) at the forefront of the learning process. The learner assumes agency in their own learning process. Batiibwe (2019) posits that CHAT offers insights into the ways in which technology can facilitate instructional practices that promote transformative learning. Based on an analysis of the aforementioned sources, it can be deduced that the intersection of CHAT and SDL is evident when considering the impact of social and cultural factors on the development of autonomous learning. In this instance, learner autonomy can be conceptualised as the capacity of a learner to exhibit self-motivation and assume responsibility for their own educational pursuits. In such an SDL environment as envisaged by Knowles (1975), pre-service teachers must scrutinise their own learning needs, set their learning goals, identify the resources required to complete the tasks at hand and evaluate the outcomes of the set task. A contradiction of control exists between the traditional way of direct teaching and an SDL environment. In the former, learners are provided with answers to their questions; in the latter, learners are equipped with skills that allow them to answer questions surrounding the activity or concepts. This theoretical framework is observed clearly in this chapter's research methodology, where learners are provided with tools and rules to work within their small communities in class on various roles (see Figure 10.2), thus showing how theory informs practice.

As is shown in this chapter, CHAT makes clear how cultural tools and societal norms shape this zone, elucidating the impact of social interactions and cultural contexts on the developmental trajectory within the ZPD. Cultural-historical activity theory enhances ZPD by emphasising the social, historical and cultural dimensions that intricately shape the learning process. Furthermore, CHAT and SDL intersect through the lens of social and cultural influences on learning autonomy. Cultural-historical activity theory highlights the role of social interactions and cultural context in shaping cognition and learning. Self-directed learning, conversely,

emphasises the individual's ability to guide their learning. The connection lies in how cultural and societal factors mould an individual's capacity for self-direction, setting the parameters of what is considered 'self-directed' within a given cultural framework. Cultural-historical activity theory offers a critical perspective on how cultural norms, tools and social environments influence the extent and nature of SDL, enriching the understanding of autonomous learning processes described in this chapter's research methods.

■ Methodology

According to McMillan and Schumacher (2010), the concept of research methodology is characterised by its systematic and purposeful nature, as it is carefully designed to generate data pertaining to a specific research problem. The specific procedures or techniques used to identify, select, process and analyse information about how utilising RIPU enhances pre-service teachers' SDL of IK in the Chemistry classroom are elucidated in this section. The methodology section of this study addresses two primary questions: What methods were employed to collect or generate the data? What methods were employed for the analysis? In answering these two main questions, this methodology section allows the reader to evaluate this chapter's overall validity and reliability critically. This methodology section describes the research design, site selection and sampling, the data generation tools and analysis, and the intervention that pertains to this chapter.

■ Research design

To comprehensively address the broad research question posed by this chapter, it was deemed advantageous to use a qualitative single-case study methodology grounded in exploratory principles and guided by a pragmatic perspective. According to Yin (2009), there are several advantages of using this design; among them is that as researchers, we could observe one case directly and relate it to the theoretical part (as described above); we got the data directly from the case and analysed it. Similarly, we could provide a rich and detailed description of the case as we explored this new or complex issue by testing our assumptions when conceptualising the study, as reported earlier. As researchers, we were aware of some disadvantages of a single case study, such as that it may not be generalisable to other cases, may be influenced by researcher bias and may be difficult to replicate. However, as Gustafsson (2017) states, using a case study provides illustrative possibilities that enhance the validity and reliability of

the findings, and this outweighs the stated disadvantages. The aim was not to generalise to other cases and to reduce bias by applying trustworthiness strategies to address the posed research question in more detail.

■ Site selection, sampling technique and sample

Convenience sampling was utilised in this study, as it was conducted in one HEI in South Africa because of its geographical proximity and accessibility to the researchers. It is important to note that this study is part of a bigger project. For the sake of convenience, this HEI is referred to as African University (AU). African University is diverse, with pre-service teachers from 11 cultural practices and has three campuses offering Chemistry education. Each campus has an average of 40 Chemistry Education first-year students enrolled in the Bachelor of Education programme. Only two of the three campuses consented to participate in the research. Only two out of the three campuses participated because the colleague teaching the Chemistry module on one of the campuses declined participation in the study. The colleague is also not part of the research group. For ethical reasons pertaining to consent, this excluded the third campus. Approximately 80 student-teachers consented to participate in the bigger project. One campus, Campus East, utilised the RPU tool to look at over-the-counter colloidal silver as an alternative medication. The other campus, referred to as Campus West, utilised the RPU tool to look at the use of indigenous plants in their communities. Campus East is in a suburban area, while Campus West is in a rural village. For the results and findings reported in this chapter, Campus West was chosen because this chapter focuses more on IK. Furthermore, only one group of five participants from Campus West was purposively selected for further in-depth discussions for the purpose of the chapter. Thus, the sample of this study consisted of five participants. This group was chosen because it scored a RPU index of 0.7.

■ Data collection instruments

Data were collected using the following three instruments:

- an open-ended questionnaire (pre- and post-intervention)
- the Views of the Nature of Science (VNOS) questionnaire (Abd-El-Khalick, Bell & Lederman 1998) pre- and post-intervention
- Views of the Nature of Indigenous Knowledge (VNOIK) questionnaire (Cronje et al. 2015) pre- and post-intervention.

The three mentioned data collection methods have been piloted several times and used in various studies (e.g. Cronje et al. 2015; De Beer & Van Wyk 2011; Gravett et al. 2017; Sebotsa, De Beer & Kriek 2019). These studies included participants from the same context and environment, and the instruments were deemed valid in this study, as they were used previously in similar contexts with participants from the same background. In addition, the analysis artefacts (the pre-service teachers' completed tasks, namely, the RIPU tool) provided insight into the pre-service teachers' process and experience of the PBL task. The open-ended questionnaire had about 14 open-ended questions. Those questions included 'How can indigenous knowledge best be incorporated in the science classroom?' and 'What are the tenets (characteristics) of indigenous knowledge?' The VNOS questionnaire had seven open-ended questions related to the tenets of the science (see Figure 10.2). An example of those questions is:

Scientists perform experiments/investigations when trying to solve problems. Besides planning and designing these experiments/investigations, do scientists use their creativity and imagination during and after data collection? Please explain your answer and provide examples if appropriate. (Abd-El-Khalick et al. 1998, p. 434)

The VNOIK questionnaire consisted of 10 open-ended questions related to the tenets of IK. An example of those questions is:

Hoodia gordinii is a plant used by Khoi-San hunters to suppress their hunger and thirst when they went on hunting expeditions. How do you think the Khoi-San people know this plant has these properties? (Cronje et al. 2015, p. 326)

■ Intervention

An 'effective learner instructional intervention should include early detection of problems in academic performance, strategies to help learners develop better approaches for academic success and facilitation of self-directed learning' (Othman et al. 2016, p. 1). Instructional interventions focus on giving students an active role in problem-solving (Niu, Behar-Horenstein & Garvan 2013). In this chapter, an instructional intervention using the RIPU tool was conducted in four workshops; each workshop lasted approximately 1.5 hours. During the instructional intervention, PBL was implemented. Pre-service teacher participants were grouped into eight groups of five members each. This PBL scenario was related to one study unit of the Chemistry module titled *Science as Human Endeavour*. In this study unit, pre-service teachers are expected to analyse the nature of Chemistry by referring to the points of contact of Chemistry with the other natural sciences; list and discuss the tenets of NOS, IK and pseudoscience; define concepts such as quantitative, qualitative, hypothesis, law and theory; criticise their worldview based on ethical issue; discuss the reasons

why natural sciences are practised and the moral dilemmas (e.g. risk analysis) that go along with this; and use and apply the scientific method. Thus, the PBL activity depicted in Table 10.4 was used as an instructional method to achieve the above-listed outcomes.

During the first workshop, the pre-service teachers were presented with the problem, as depicted in Table 10.4. In addition, one of the authors provided the participants with a brief overview and instructions on using the RIPU tool and scholarly (Google Scholar, Scopus and SciFinder) databases. In their collaborative PBL groups, the participants had to select one medicinal plant from IK to study using the RIPU tool. In the remaining three workshops, the pre-service teachers worked in their collaborative PBL groups to complete the scholarly searches, read the introduction, do the data analysis and draw conclusions from the articles/ anecdotes they found, and summarise their findings before completing the RIPU tool. During the fourth and final workshop, the PBL groups gave feedback on the overall RIPU index for their chosen plant, commented on the in vitro and in vivo evidence and gave general feedback on their experience. It is important to note that the one PBL group of pre-service teachers selected to study the *Moringa oleifera* (horseradish or drumstick tree), which is widely used for treating malnutrition in sick people. While using the RIPU tool for *Moringa oleifera* as a group, the pre-service teachers scored 21 out of 30, resulting in the RIPU index of 0.7. It is noteworthy to highlight that the in vivo evidence for the use of *Moringa oleifera* was the highest. This chapter focuses on disseminating the findings of this group.

TABLE 10.4: Problem-based learning scenario and task.

In South Africa, the Black African population is in the majority and constitutes 81% of the total population (Statistics South Africa 2021). Most Black Africans rely heavily on African traditional IK for their health conditions for various reasons; it might be because of the economy or cost of living (as most people are unemployed and do not have income), being too traditional (trusting African medicine over Western or scientific medicine), etc. This has both positive and negative impacts on the livelihood of Black Africans. The problem that might come with IK is misconceptions surrounding the uses of various plants. In Chemistry 1, you discussed some of the misconceptions about science. Some of the beliefs and uses of some plants may be the result of misconceptions. In your PBL groups, you are required to discuss, research and report whether you support or are against the following plants and their uses: Pumpkin seeds (dried) eaten by African men for increasing fertility; Tshuku-ya-poo (*Hypoxis hemerocallidea*) - treatment of diabetes, pain reliever for abdominal pains in older women, and burning body fat; *Moringa oleifera* (horseradish or drumstick tree) - treatment of malnutrition on a sickly person and used as organic manure for crops; Phate ya ngaka (*Helichrysum caespitium*) - treatment of skin conditions such as rash or eczema and candidiasis; Tlhonya (*Elephantorrhiza burkei* Benth) - Albinism treatment; Lemon fruits for alkalisating the body - reduces acid caused by fizzy drinks in the body; Moselesele shrub (*Dichrostachys cinerea* or sickle bush) - cures cancer; and Mokgalo tree (*Ziziphus mucronata* or Buffalo thorn) - cures boils.

Therefore, you are required to choose one plant and use a Rationality Index of Plant Use (RIPU) heuristic to support your argument in your PBL groups.

Source: Original work of first author (Mothale Judicial Sebatana).

Key: IK, indigenous knowledge; PBL, problem-based learning; RIPU, Rationality Index of Plant Use.

■ Data analysis

The VNOIK and VNOS questionnaire data were analysed by means of the method explained by Abd-El-Khalick et al. (1998) and Cronje et al. (2015), respectively, and grading rubrics were used to characterise the pre-service teachers' views on the tenets of science and IK as naïve, partially informed, or informed views. Each pre-service teacher was allocated a weighting for their responses for the VNOIK and VNOS items in the questionnaire, respectively, as one of the following:

- an uninformed or naïve view (UI/N), scored 0 points
- a partially informed or transitional view (PI/T), scored 1 point
- an informed view (I), scored 2 points.

Saldaña's (2009) coding technique distorts emerging findings from the artefacts (student tasks) and open-ended questionnaires. Finally, third-generation CHAT was utilised to interpret the data and determine what factors promote or impede the conceptual development process of the NOS, IK and pseudoscience. Mentz and De Beer (2019) described CHAT as a 'flexible meta-theoretical framework that can assist the researcher in interpreting data from complex settings or activity systems and to distil the finer nuances from the data'. Cultural-historical activity theory analysis further focused on how the learning task promoted SDL and what the student teachers' experiences were in this regard.

■ Ethical considerations

Ethics is an important aspect and process in any social sciences and humanities research. The relevant Research Ethics Committee of the AU granted ethical clearance for this study in line with the ethical guidelines, thus allowing us to conduct the study. The participants were asked to complete an informed consent form. They were assured that they would remain anonymous throughout the study and that the findings would be handled with confidentiality. The participants were informed that their participation was voluntary and that early withdrawal from the study would not be penalised. All written responses, such as questionnaires, will be kept safe, ensuring confidentiality, in a locked cupboard at the AU for a minimum of five years as per ethical requirements of the University and shall then be disposed of.

■ Positionality

Positionality is the practice of a researcher delineating his or her position concerning the study, with the implication that this position may influence aspects of the study, such as the data collected or how it is interpreted. (Qin 2016, p. 1)

In adherence to Holmes' (2020) principles of positionality, this chapter adhered to the commonly recognised practice of situating the researcher(s) within three key domains: the subject of enquiry; the participants involved in the research; and the broader context and procedural aspects of the research. Regarding the subject under investigation, there is a dearth of studies that have utilised RIPU as a practical guide for the teaching and learning of tenets of science in the Chemistry classroom while following the principles of PBL, and this study intended to address the gap. Massoud (2022) views positionality as a statement in a research article that may enhance the validity of its empirical data and its theoretical contribution. Our social-historical-political location in this study was that we were the lecturers teaching pre-service teachers in the referred module, which could have influenced our orientations, potentially impacting researcher bias or subjectivity in the study's outcomes. To ameliorate this threat, independent individuals were requested to administer the data generation instruments to avoid power relations because we had a direct relationship with the participants. After data generation, we met again to discuss a data analysis process. To eliminate bias during data analysis, each researcher analysed the data set from each pre-service teacher using the grading rubric scores for the VNOS and VNOIK instruments. We then met, compared their scoring and discussed until a consensus was reached on the rubric scores. The same procedure was also followed in the interpretation of the results and the drawing of conclusions as to what the data might mean. In this way, bias and subjectivity, which could have negatively impacted the study's outcome, were eliminated.

■ Findings and discussion

This section presents and discusses the findings from the research and addresses the research question. The discussion on each data collection instrument is presented separately.

■ Views on the nature of indigenous knowledge

The pre- and post-intervention VNOIK questionnaire results are summarised in Table 10.5 using the coding guidelines developed by Cronje et al. (2015).

The results summarised in Table 10.6 indicate that none of the pre-service teachers had an initial uninformed view of IK; all the pre-service teachers had a partially informed view overall. After the PBL RIPU tool activity, 80% of the pre-service teachers had a partially informed view, while 20% had an overall informed view of IK.

TABLE 10.5: Coded results on the views of the nature of indigenous knowledge (VNOIK) questionnaire before and after the problem-based learning Rationality Index of Plant Use (RIPU) tool activity on *Moringa oleifera*.

Participant	Q1 Pre/ Post	Q2 Pre/ Post	Q3 Pre/ Post	Q4 Pre/ Post	Q5 Pre/ Post	Q6 Pre/ Post	Q7 Pre/ Post	Q8 Pre/ Post	Q9 Pre/ Post	Q10 Pre/ Post	Overall score Pre/Post
O1	PI/PI	UI/UI	UI/I	PI/I	UI/PI	PI/UI	I/PI	I/I	I/I	PI/I	
Weighting	1/1	0/0	0/2	1/2	0/1	1/0	2/1	2/2	2/2	1/2	1.0/1.3
O2	UI/PI	UI/UI	I/I	PI/I	PI/I	PI/PI	I/I	PI/I	PI/PI	PI/UI	
Weighting	0/1	0/0	2/2	1/2	1/2	1/1	2/2	1/2	1/1	1/0	1.0/1.3
O3	UI/PI	UI/UI	I/I	UI/PI	PI/I	PI/UI	PI/PI	PI/PI	PI/I	NA/I	
Weighting	0/1	0/0	2/2	0/1	1/2	1/0	1/1	1/1	1/2	NA/1	0.7/1
O4	PI/PI	UI/I	PI/I	PI/PI	UI/PI	PI/PI	PI/PI	PI/I	PI/I	UI/I	
Weighting	1/1	0/2	1/2	1/1	0/1	1/1	1/1	1/2	1/2	0/2	0.7/1.5
O5	I/I	U/U	PI/PI	PI/PI	PI/PI	U/I	I/I	PI/I	U/PI	PI/U	
Weighting	2/2	0/0	1/1	1/1	1/1	0/2	2/2	1/2	0/1	1/0	0.9/1.3

Source: Original work of first author (Mothale Judicial Sebatana).

Key: Q, question; NA, not answered; UI, uninformed view (0); PI, partially informed view (1); I, informed view (2).

TABLE 10.6: The average percentages of participants' views of the nature of indigenous knowledge (VNOIK) before and after the problem-based learning Rationality Index of Plant Use (RIPU) tool activity on *Moringa oleifera*.

View of IK	VNOIK pre-intervention	VNOIK post-intervention	Percentage points change
UI	0%	0%	0% =
PI	100%	80%	20% <
I	0	20%	20% >

Source: Original data collected from the project.

Key: IK, indigenous knowledge; VNOIK, views of the nature of indigenous knowledge; UI, uninformed view; PI, partially informed view; I, informed view.

Some attractive tenets of IK to report on include:

Only 40% of the participants had an uninformed view of IK before intervention, but after intervention, all the participants had partially informed or informed views on what IK is (Q1). Before the intervention, none of the participants realised that IK was empirically based (Q2); 20% realised the empirical tenet connected to IK after the intervention. Only 20% of participants did not recognise that IK practitioners make inferences (Q3). However, all pre-service teachers at least partially/fully recognised the holistic nature of IK (Q7). It is noteworthy to comment on the solid metaphysical connection made or experienced by the pre-service teachers, as all the pre-service teachers recognised the role of myths in IK. (Cronje et al. 2015, p. 326) (The questions [Q1, Q2, Q3 and Q7] are found in the VNOIK questionnaire.)

■ Views of the nature of science

The results of the pre- and post-intervention VNOS questionnaire are summarised in Table 10.7 using the coding proposed by Abd-El-Khalick et al. (1998) and the same coding rating grid proposed for VNOIK to ease the interpretation of results.

TABLE 10.7: Coded results on the views of the nature of science (VNOS) questionnaire before and after the problem-based learning Rationality Index of Plant Use (RIPU) tool activity on *Moringa oleifera*.

Participant	Q1 Pre/ Post	Q2 Pre/ Post	Q3 Pre/ Post	Q4 Pre/ Post	Q5 Pre/ Post	Q6 Pre/ Post	Q7 Pre/ Post	Overall score Pre/Post
O1	N/N	N/T	T/T	N/I	N/I	T/T	N/T	
Weighting	0/0	0/1	1/1	0/2	0/2	1/1	0/1	0.3/1.1
O2	N/T	N/N	N/T	T/T	N/T	N/T	N/T	
Weighting	0/1	0/0	0/1	1/1	0/1	0/1	0/1	0.1/0.9
O3	T/I	N/T	T/T	T/I	T/T	T/T	N/N	
Weighting	1/2	0/1	1/1	1/2	1/1	1/1	0/0	0.7/1.1
O4	I/I	N/N	T/I	I/I	T/I	N/T	T/T	
Weighting	2/2	0/0	1/2	2/2	1/2	0/1	1/1	1.0/1.4
O5	N/T	N/T	N/I	T/T	N/T	N/T	T/N	
Weighting	0/1	0/1	0/2	1/1	0/1	0/1	1/0	0.7/1.0

Source: Original data collected from the project.

Key: Q, question; N, naïve view (0); T, transitional view (1); I, informed view (2).

Table 10.8 shows that 40% of the pre-service teachers had an overall naïve view and 60% had a transitional view of the NOS pre-intervention, whereas all the pre-service teachers had a transitional view after intervention. Quite concerning is that all the pre-service teachers had the naïve view that atomic structure was observed with microscopes; after intervention, 60% of participants had a transitional view, noting that scientists ‘performed experiments to know about the nature of the atom’ (Pre-service teacher 1, undisclosed as non-applicable information, 16 April 2022). It is noteworthy to report the common misconception related to scientific law and scientific theory where 40% of the pre-service teachers had naïve views and 60% transitional views before intervention. Conceptions like ‘evolution is just theory is a scientific belief without proof’ (Pre-service teacher 2, undisclosed as non-applicable information, 16 April 2022) indicate the erroneous concepts regarding nature and the relationship between a scientific theory and scientific law.

A comparison between VNOIK (Table 10.6) and VNOS (Table 10.8) seems to indicate a better general understanding of the nature and tenets of IK than the nature and tenets of science. This might be because of cultural factors and possible tensions that could arise between activity systems after the analysis of the open-ended questionnaires and RIPU tool artefacts. The following exciting tensions between activity systems were reported: VNOS – VNOIK – Open-Ended Questionnaire – Artefacts. Third-generation CHAT was utilised to interpret the data and determine promoting or impeding factors. The following tensions between activity systems were identified during the analysis:

TABLE 10.8: The average percentages of participants' views of the nature of science (VNOS) before and after the problem-based learning Rationality Index of Plant Use (RIPU) tool activity on *Moringa oleifera*.

View of NOS	VNOS pre-intervention	VNOS post-intervention	Percentage points change
Naïve view	40%	0%	40% <
Transitional view	60%	100%	40% >
Informed view	0	0%	0% =

Source: Original data collected from the project.

Key: NOS, nature of science; VNOS, views of the nature of science.

■ Tension 1: Tools (views of the nature of indigenous knowledge & views of the nature of science) – Community (cultural) – Rules (knowledge of chemistry concepts)

Most pre-service teachers viewed IK and science taught in a classroom as two discrete entities. As a result, in their responses on whether IK should be included in the school science curricula, most believed it was not a good idea. For pre-service teacher 2, this tension seems to be an impeding factor. The participant seemed torn between his/her embedded culture and the scientific facts taught to him/her. On the one hand, the participant strongly believed in the metaphysical and mystical tenets of IK as 'spiritual realm', 'witchcraft' and 'rituals' featured in many answers. On the other hand, the participant stated that IK could not be tested or experimented on, as it was solely 'obtained (knowledge) in the spiritual realm', but 'science is based on tested facts' (Pre-service teacher 2, undisclosed as non-applicable information, 16 April 2022). The participant seemed to view IK and science as two insoluble worlds; he/she had to choose between IK and Chemistry (science) as knowledge systems. The participant could not see the overlap in the tenets of IK and NOS and seemed trapped between an old world (IK) and a new world (science). The participant motivated the world is in the 21st century, therefore, practices, including IK, are becoming irrelevant. These situations remind the researchers of the epistemological crisis that could result from insufficient integration of IK in the classroom (De Beer & Van Wyk 2022; Kibirige & Van Rooyen 2010; Srikantiah 2005). Figure 10.6 shows pre-service teacher 2's response, which may justify why this participant did not see IK as science.

The response in Figure 10.6 shows that some pre-service teachers associated science with laboratories, thus ignoring the empirical tenet of IK. Interestingly, for some pre-service teachers, the same activity system had a positive effect. Responses before the instructional intervention show that they saw IK and science as more similar than different entities, as suggested by pre-service teacher 4. Figure 10.7 shows pre-service 4's verbatim responses.

2. Practitioners of indigenous knowledge (e.g., elders, herbalists, traditional healers) observe nature to generate knowledge. Do they do experiments and tests in order to verify or validate this knowledge?
 - If yes, explain how they test or validate their knowledge
 - If no, explain why not

They don't do any experiment and test, The traditional healers doesn't have any laboratory where they will be able to measure the scale of medicine.

They only have knowledge from the historical elders that the medicine it's for particular decease.

Source: All the figures are screenshots from the responses of the pre-service teachers who partook in this project and are thus 'original work and data' that emanated from this project.

FIGURE 10.6: Pre-service teacher 2's verbatim response (Pre-service teacher 2, gender/race undisclosed as non-applicable information, 01 April 2022).

6. What are the similarities and differences between the natural sciences and indigenous knowledge systems?

Both natural sciences and indigenous knowledge systems focuses on nature a understanding of nature for able to discover new knowledge based on nature science and IKS

7. Should indigenous knowledge be included in the natural sciences / physical sciences curricula? Motivate your answer.

Yes it should be included for in the curricula because it will help learners to know more about nature and IKS outside the school.

Source: All the figures are screenshots from the responses of the pre-service teachers who partook in this project and are thus 'original work and data' that emanated from this project.

FIGURE 10.7: Pre-service teacher 4's verbatim responses (Pre-service teacher 4, undisclosed as non-applicable information, 16 April 2022).

Figure 10.7 shows that pre-service teacher 4 saw IK and science as two related entities focused on observing the natural world. Thus, the shared tenets between IK and science (empirical, inferential, creative, social and cultural) were more apparent to this pre-service teacher. Such an understanding of these related concepts (science and IK) warrants this pre-service teacher to include IK in the science curriculum, which could improve Chemistry teaching and learning praxis, as described by various scholars (De Beer & Van Wyk 2022; Kibirige & Van Rooyen 2010; Srikantiah 2005):

- making Chemistry concepts less alien and more familiar to holders of IK
- promoting positive attitudes towards Chemistry in the classroom
- better assimilation of knowledge as a prior knowledge system (IK) is recognised.

Pre-service teacher 4 believed that including IK in the science curriculum would give learners more knowledge of IK and science outside the classroom. This links to the notion of contextualised content of curricula

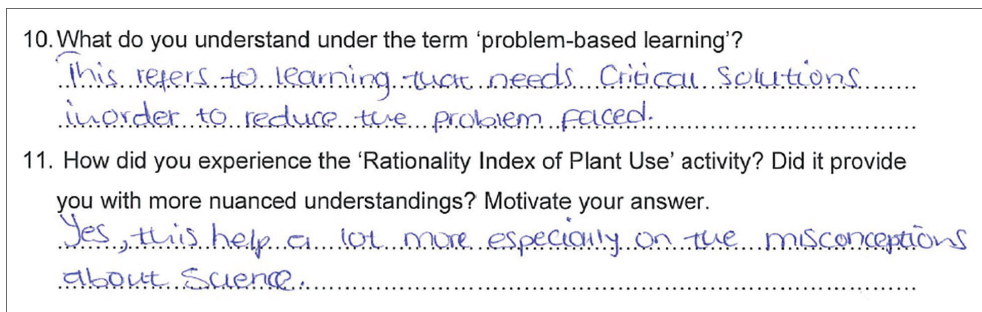
that allows learners to become scientifically literate citizens and critical consumers instead of individuals only memorising facts (DBE 2011; Kanika et al. 2019; Pangemanan 2020; Tytler & Hobbs 2011).

Another pre-service teacher's response correlated well with that of pre-service teacher 4. This participant stated that he would include IK in the school classroom 'because it gives you a better understanding of science' (Pre-service teacher 3, undisclosed as non-applicable information, 16 April 2022). However, the participant added that IK may also include metaphysical aspects that cannot be tested, indicating that the pre-service teacher has a more nuanced understanding of the similarities and differences between the tenets of NOIK and NOS (see Figure 10.3).

■ Tension 2: Tools (Rationality Index of Plant Use) - Rules (knowledge of problem-based learning) - Object (connect indigenous knowledge with chemistry concepts)

During the analysis of the PBL rules and using the RIPU tool, a promotive tension was noticed regarding the object/outcome. When asked about their understanding of PBL and the use of RIPU, pre-service teacher 1's response was (Figure 10.8):

The data shown in Figure 10.8 reveals that the pre-service teacher comprehensively understood PBL as a practical pedagogical approach. Pre-service teacher 1 used 'reduce' instead of 'solving' (Pre-service teacher 1, undisclosed as non-applicable information, 16 April 2022). This participant might have used the word 'reduce' in recognising that PBL problems are open-ended; therefore, one solution to the problem might not solve it



Source: All the figures are screenshots from the responses of the pre-service teachers who partook in this project and are thus 'original work and data' that emanated from this project.

FIGURE 10.8: Pre-service teacher 1's verbatim response to problem-based learning (Pre-service teacher 1, undisclosed as non-applicable information, 16 April 2022).

entirely. Furthermore, Figure 10.8 also shows pre-service teacher 1's response that using the RIPU tool during PBL may address some misconceptions about science. The analysis of the VNOS questionnaire (pre- and post-intervention) affirmed that most pre-service teachers themselves still hold misconceptions regarding the difference between a scientific theory and a scientific law. It can be inferred that the RIPU tool came in handy in identifying student misconceptions within the Chemistry classroom when PBL was used as a teaching strategy.

In addition, using the RIPU tool in PBL learning activities provided pre-service teacher 3 with insight into the real world of scientists (see Figure 10.9), as affirmed by De Beer and Van Wyk (2022).

■ Tension 3: Rules (principles of self-directed learning) – Tools (Rationality Index of Plant Use) – Object (self-directed learning environment)

The analysis of the RIPU tool and the object of connecting Chemistry concepts in an SDL environment highlighted the following promotive interactions. Although the intervention was not poised to investigate SDL *per se*, several SDL competencies were implied in the pre-service teachers' responses. Q3's word choice, for example, 'I came to realise...' (Pre-service teacher 3, undisclosed as non-applicable information, 16 April 2022) relates to the pre-service teacher taking ownership of learning. Q1 indicated that the most valuable aspect of RIPU was the activity 'I was able to collect and gather knowledge' (Pre-service teacher 3, undisclosed as non-applicable information, 16 April 2022). This pre-service teacher could diagnose his learning needs, formulate intermediate goals and use the appropriate resources to gather the required knowledge.

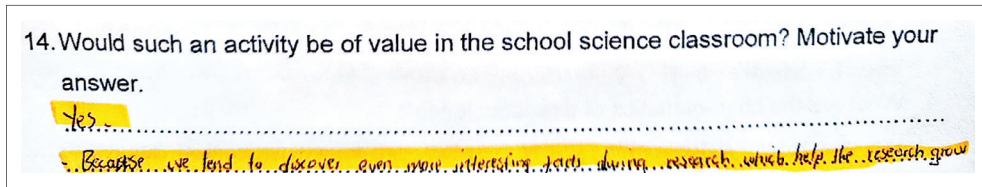
In addition, the same pre-service teacher indicated that the RIPU activity could be improved by 'find[ing] ways to increase activity'. Thus, relating to the reflection on and evaluation of the outcomes. These implied

12. Which aspects about the RIPU activity did you find particularly useful? Why?

In vitro evidence.....
 - because it shows the medical procedure, tests, and experiments based on the plant.....

Source: All the figures are screenshots from the responses of the pre-service teachers who partook in this project and are thus 'original work and data' that emanated from this project.

FIGURE 10.9: Pre-service teacher 3's verbatim response (Pre-service teacher 3, undisclosed as non-applicable information, 16 April 2022).



Source: All the figures are screenshots from the responses of the pre-service teachers who partook in this project and are thus 'original work and data' that emanated from this project.

FIGURE 10.10: Pre-service teacher 3's verbatim response (Pre-service teacher 3, undisclosed as non-applicable information, 16 April 2022).

skills – related to the most basic definition of SDL (Knowles 1975) – sensitised the pre-service teachers to SDL, as De Beer and Van Wyk (2022) anticipated.

Pre-service teacher 3's response in Figure 10.10 corroborates that the pre-service teachers were sensitised to SDL by referring to engagement and motivational affordances of both PBL and SDL, according to Loyens et al. (2008). In addition, the mention of research skills relates to the ability of pre-service teachers to 'identify human or material resources' (Knowles 1975, p. 18).

■ Recommendations from the study

The study found that pre-service teachers had difficulties with a nuanced understanding of both IK and the tenets of science, and they struggled to identify the common tenets of both constructs. In the problem-based and SDL environment, pre-service teachers (first-year university students) could benefit from more scaffolding of the learning tasks. As recommended by De Beer and Van Wyk (2022), possible scaffolds could include guidance in the use of scholarly and scientific databases; assisting the pre-service teachers to differentiate between the so-called grey and white literature; and providing clear examples to better distinguish between *in vitro* and *in vivo* experimentation. Furthermore, the PBL task could rather be integrated as project-based learning. Project-based learning, as defined by Sameuls et al. (2023), assumes better scaffolding than in PBL and affords more time for meaningful presentation of and reflection on findings. Such a process could therefore sensitise pre-service teachers better to the notion of SDL. A further recommendation is that the constructs of RIPU, IK and NOS should be included in all science modules to prepare future science teachers holistically so that they would be able to teach science with a clear idea of how science is generated and the link of science with learners' everyday experiences.

■ Recommendations for further research

Only one plant, the *Moringa oleifera* plant, was used in this study where pre-service Chemistry teachers made connections to science concepts. The recommendation emanating from this study is that more plants could be investigated and used for future studies. This study also had a sample of only five pre-service Chemistry teachers and the recommendation is that a larger sample of pre-service teachers can be used in future studies specialising in Chemistry and Natural Sciences, as IK does not relate to the subject Chemistry only. All teachers teaching most sciences face the dilemma of integrating IK into their classrooms. It is recommended that the interconnections of NOS and NOIK be explored in various contexts, different disciplines and school grade levels using the RPU tool as illustrated in this chapter. A mixed-methods approach using the qualitative tools described in this chapter and quantitative SDL tools are recommended for future research efforts. A mixed-methods approach may ensure a more rigorous understanding of how the SDL competencies of pre-service teachers are influenced by using the RPU tool in a PBL task to explore the tenets of science and IK. In such a study, it is recommended that the specific model proposed by Mentz and De Beer (2021) be used for CHAT as a research lens to provide a more nuanced understanding of the intervention and the effect thereof on pre-service teachers.

■ Conclusion

This study sought to answer the research question: How does utilising the RPU enhance pre-service teachers' SDL of IK in the Chemistry classroom? This question was answered by showing how five Chemistry pre-service teachers utilised the RPU rubric in a PBL classroom concerning IK of using the *Moringa oleifera* plant and making connections to science concepts. The analysis of the VNOIK and VNOS questionnaires showed a somewhat more nuanced understanding of both IK and the tenets of science. However, the pre-service teachers still struggled to identify the common tenets of these two constructs.

Third-generation CHAT, as used in this chapter, provided insight into possible impeding or promotive interactions during this PBL activity using the RPU tool. Failure to acknowledge the IK of pre-service teachers may result in an epistemological crisis, as one might feel bound to choose either IK or science as a knowledge system. Conversely, adequate acknowledgement of IK makes Chemistry concepts less alien, promotes motivation and engagement of pre-service teachers and helps with better

assimilation of new knowledge to prior knowledge structures. In addition, PBL learning activities using the RPU tool seem to assist pre-service teachers to identify scientific misconceptions, help understand the real-life relevance of Chemistry by reading about laboratory procedures and promote understanding of PBL as a teaching and learning strategy to use in their classrooms.

Finally, the RPU tool used in a PBL learning environment seemed to sensitise the pre-service teachers to the notion of SDL by requiring them to diagnose learning needs, formulate intermediate goals and use the appropriate resources to gather the required knowledge while promoting ownership of and engaging in learning.

■ Ethical clearance number

The ethical clearance number for this study is NWU-01015-21-A2.

Epilogue

As we conclude this wide-ranging exploration of self-directed learning (SDL) within the context of curriculum praxis and scholarship, we deem it necessary to reflect on the significant insights and contributions highlighted in this book. The collective efforts of the authors enriched our comprehension of SDL and its potential to transform education.

■ Summary of themes

Summarising the themes, it is evident that the editors and authors meticulously explored integrating SDL into curriculum development, emphasising the importance of active learning strategies and incorporating technology into teaching and learning to meet the growing demands of the educational landscape. Key themes of the book include:

- AI in Education with an emphasis on personalisation and enhancement of learning experiences promoting SDL
- innovative curriculum practices include strategies for embedding SDL into curricula to foster critical thinking, lifelong learning and increased student engagement
- empowering teachers where emphasis was placed on preparing future teachers with skills and methodologies they can use to facilitate SDL in their teaching and learning practices
- practical application and implementation of SDL are reflected through case studies and examples in higher and school education, specifically focusing on homeschooling, climate change education and integrating indigenous knowledge.

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■ Future directions

This book's discussions and critical findings pave the way for future research studies and educational practice. Primary areas for future exploration include:

- exploring AI-driven adaptive learning environments and their long-term influence on student and learner performance
- cross-, inter- and trans-disciplinary explorations of SDL at all educational levels
- examining the importance of educational policy in supporting and fostering SDL in formal and informal learning environments
- comprehensive professional development programme focused on SDL and innovative teaching practices.

■ Personal reflections

Putting this book together has been an exciting and challenging journey. As editors, we want to express our deep appreciation to the authors whose hard work and insightful commentary have enabled this book to come to fruition. Additionally, we are motivated by the idea that SDL can revolutionise education by giving students and learners more agency over their learning paths.

■ Impact and relevance

In the present era of rapidly evolving educational paradigms and rapid technological advancements, the importance of SDL is immeasurable. This book offers a comprehensive guide for educators, school principals, education managers and policymakers to establish flexible and captivating classrooms by implementing the strategies and methods outlined in its pages. By encouraging SDL, we can better equip students to navigate the intricacies of the 21st century and beyond.

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In closing, as editors, we hope this book will be indispensable for educators and researchers dedicated to advancing self-directed learning. As a collective, we can create educational experiences that are engaging, meaningful and transformative.

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Chapter 6

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Chapter 7

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Chapter 10

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This scholarly book provides an in-depth analysis of self-directed learning (SDL) within contexts of curriculum, praxis, and scholarship. The book presents original research from multiple authors, which provides diverse perspectives and methodologies for enhancing understanding of SDL.

The book primarily focuses on incorporating SDL into curriculum development and emphasises the significance of scholarly research in designing effective curricula. It explores the integration of technology in learning and adapts instructional strategies to meet the evolving demands of higher education and school environments. Inspired by constructivism, socio-constructivism, and context-based learning theories, the book presents practical strategies for educators.

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Some of the chapters are especially valuable to institutions that conduct teacher training and in-service training of teachers, where SDL could improve learners' and teachers' agency. The publication is a must-read for scholars and academics committed to achieving learning success through innovative and self-directed approaches.

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