On the Theory of Content Transformation in Education

The 3A Methodology for Analysing and Improving Teaching and Learning

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Chapter 1

Introduction

1 Introduction

Learning – as understood commonly – is a process that allows humans, animals, and some man-made systems (machines and virtual networks) to acquire new knowledge, attitudes, behaviours, etc. Teaching, on the other hand, is almost exclusively reserved to humans as it is understood as *intentional acting* with the aim to induce and support *learning*. When those who are teaching meet with those who are learning – in an educational setting – there is always some *matter* involved. There simply cannot not be. Teaching and learning cannot be *matterless*. Be it a simple historical fact such as the ending of WWII in 1945, a biochemical process such as photosynthesis, a skill such as throwing a ball or an attitude such as the rejection of xenophobic stereotypes, any such fragment of human knowledge and culture in the widest sense can be the focus of learning and teaching. In this book, they are referred to as *the content of education* or *educational content*.

This book is altogether centred around the idea of educational content as a phenomenon that bolts together teaching, learning, and human culture. In Chapters 3–5, we present and argue for a theoretical approach that explains how (educational) content is mediated socially and culturally. In order to do so, we introduce the idea of transformations of content to explain how content changes form upon entering different contexts and modalities. In Chapter 6, we outline a specific research methodology that stems from the theory of content transformation. Chapter 7 then serves as an illustration of how the methodology is used for the analysis of teaching and learning with specific emphasis on educational content. Before the explanation of the theory itself, the disciplinary context is outlined in Chapter 2 where we discuss various models of didactics as a theory of teaching and learning and suggest the idea of transdisciplinary didactics as a general framework for the ideas introduced in this book. This introductory chapter (Chapter 1) is here to present a number of basic theses that will be discussed and developed later throughout the following chapters and that help us understand what teaching and learning essentially are and how they can be analysed and improved.

We look to tackle Shulman's problem of "missing paradigm" not only in the limited context of curriculum but also with reference to epistemology and the theory of mind. We aim to devise a theoretical and methodological framework

for the research of educational practice that supports the quality of teaching and learning through the analysis of semantic-logical networks (S-L networks). Analyses of S-L networks help us investigate content transformations during teaching and learning, identify critical points, and discuss suggestions for improvement. Such research can identify instances of didactic excellence (elements of productive culture of teaching and learning) as well as flaws in the integrity of teaching and learning (didactic formalisms). To characterize these positive and negative aspects is to help teachers identify problems in teaching and learning, and eliminate them, and thus to improve them.

When teaching and learning take place, educational content is activated, i.e., it becomes *active content* that "maintains the causal power to transform mental operations" and generates a cognitive change in the learner (Fisherman, 2012, p. 163). Active content of sociocultural mediation can take two different forms: one is spontaneous mediation of the cultural content between people, and one is intentional and systematic teaching and learning. To focus on the first is to formulate theories and realize research that helps to generate knowledge about how active cultural content interacts with the human brain and affects experience. It is, however, the second that lies in the focus of our attention: the goal-directed, systematic education (typically in a school context). Here, all and any basic assumptions about the processes of social learning are confronted with a normative view of what it means to be educated and how education is achieved (Fisherman, 2012; Scheffler, 1995; Sheppard, 2001). In the background, we use the framework concept of *productive (constructivist) culture of teaching and learning*, which is seen as a normative ideal to which all attempts to improve teaching and learning are oriented. We are namely concerned with the areas of cognitive activation of students while working with content, clarity and structure of instruction, a supportive learning climate, and constructive work with mistakes.

Educational settings are created with the aim to generate cognitive changes in students thus enriching and developing their experience. *Active content* stems from the culture and through education is transformed into a student's knowledge of content. This transformation entails the fundamental problem of educational practice and theory that Dewey (1902/1990, p. 189, in Deng, 2007) saw as the *logical-psychological distinction* between the intersubjective existence of content in the culture and its subjective existence in the student's experience. Because of this, learning needs to be supported by teaching and educational practice needs to be supported by educational theory. Dewey's *logical-psychological distinction* manifests itself in the tension between student-oriented strategies in teaching and discipline-oriented ones. Sadly, empirical research often fails to recognize this contrast and researchers carry out studies in which – as Duit et al. (2012, p. 15) put it – "a balance between science orientation and orientation on student needs, interests, ideas and learning processes is missing".

In this book, we look for this balance in adopting the relational approach to content and its mediation. Here, content is seen holistically and dynamically

as the result of interactions between its *subjective*, *intersubjective*, and *objective* existence. The relational approach overcomes the contrast between student-oriented and content-oriented teaching strategies and puts emphasis on the co-dependence between the subjective (students') and intersubjective (cultural, disciplinary) perspective in teaching and learning. This co-dependence should be respected by any teacher that aims to mediate any content from any domain of the culture.

Challenges posed by the logical-psychological distinction are intensified by the disagreement between the discourse of the disciplines that provide the content of curriculum and the discourse of the domains of pedagogy and psychology that concentrate on students and their learning. These discourses differ on all levels including vocabulary, value systems, and degree of normativity. To overcome this disagreement, we propose a transdisciplinary approach and argue for it throughout this book. We build on the theories of intentionality and content transformation in the European tradition of didactics and the theory of active content that developed in the American tradition of philosophy of education. Following Shulman's notion of content as the missing paradigm and how this notion has been elaborated in European didactics we want to demonstrate possible mutual inspirations between the American and the European traditions of exploring the process of sociocultural mediation of content. In this way, we provide a wider context for explaining our approach presented in this book. Let us now summarize the contents of the following chapters.

1.1 Didactics as context – Didactics rediscovered (Chapter 2)

Shulman (1986) used the term *the missing paradigm* to draw attention to the elusive nature of content and introduced the concept of *pedagogical content knowledge* to refer to the unique "intersection between content and pedagogy". In the European discourse, the notion invited positive reactions as well as critical discussion; possibly due to the fact that similar ideas had been continuously addressed by the continental tradition of didactics. Duit et al. (2012, p. 16) note that "the Didaktik[1] tradition aims at a balance of key features of the science-oriented and student-oriented science education research". However, the term *didactics* is rarely used in the Anglo-Saxon discourse to refer to the specialized discipline (theory of teaching) and has negative connotations in English.[2] This may well be one of the reasons why Shulman called it the *missing* paradigm.

In continental Europe, didactics has a long tradition as a discipline subdivided into general didactics and a system of individual disciplinary didactics. As such, it has always naturally concentrated on the study of the (disciplinary and educational) content of teaching and learning; it is therefore to a certain degree equivalent to Shulman's approach. Kansanen (2009) notes that pedagogical content knowledge (PCK) and disciplinary didactics[3] are related concepts coming from different sources (traditions). Gudmundsdottir et al.

(1995, pp. 164–165) summarize that "pedagogical content knowledge is just fachdidaktik – the American way". They refer to the fact the Shulman's "intersection between content and pedagogy", which in the American context is considered a missing paradigm, is in fact a well-known and intensively studied phenomenon in the focus of disciplinary didactics in the European tradition.

Despite the commonalities between Shulman's conception and the European conception of didactics, there is an important difference between them. Bromme (1995, p. 208) has pointed it out: although Shulman's construct clarifies the specificity of teachers' content knowledge, it does not explicitly include the process of transforming the content of the discipline into the content of the school curriculum, i.e., into the school subject. Therefore, the PCK conception does not make use of the term *content transformation* at all. On account of that, however, what escapes from the attention of educational theory and research is the problem of mediation of cultural content – i.e., the very theoretical construct that calls for a balance between culture-oriented and student-oriented approaches and which is a fundamental prerequisite for the constitution of specific disciplines: disciplinary didactics. In the European tradition, disciplinary didactics are there to study the mediation of content as a set of content transformations between cultural disciplines (sciences, technologies, arts, etc.), curriculum, and the processes of teaching and learning. Therefore, their approach is more comprehensive compared to Shulman's construct and allows for both a deeper theoretical understanding of the processes of teaching and learning and a more effective practical application of theoretical and research findings.

The idea of disciplinary didactics assumes that there are differences between cultural domains that are projected onto educational domains as differences in how their content should be taught and learnt. "The claim is that in addition to general aspects of teaching and studying, school subjects differ according to their special characteristics, and this leads to pedagogical decisions that are of a subject-didaktik character" (Kansanen, 2009, p. 31). Disciplinary didactics have thus evolved as a combination of *general didactics* (see Chapter 2) with the specific content of a particular disciplinary field (to become didactics of mathematics, didactics of geography, didactics of foreign languages, etc.). Even though this approach springs from the differences between various disciplinary didactics, it is also possible to look beyond the differences to search for an integrated, transdisciplinary didactics. Kansanen (2009, p. 32) goes on to ask "whether it is possible to construct a general subject-matter didaktik that would be common to all subject matter. But what would then be its relation to general didaktik? This means there would be some aspects outside general didaktik which would be common enough to all content prior to the content-specific aspects". In this sense, and it is the idea represented in this book, didactics can be reconstituted as a transdisciplinary field that addresses the common topics of all disciplinary didactics (Slavík et al., 2016, p. 677; Slavík et al., 2017 in Czech).
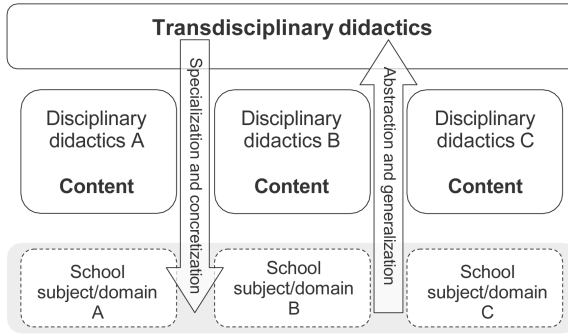
Figure 1.1 The relationship between disciplinary didactics and transdisciplinary didactics

Kansanen's idea of "general subject-matter didactics" therefore presupposes a transdisciplinary approach. It should be based on theoretical and methodological constructs that can be shared by all disciplinary didactics without the individual disciplines losing their specificity. This means that these constructs should be both general enough to cover all educational disciplines or subjects, and operational enough to allow for specification down to the level of disciplinary content. This requirement is visualized in Figure 1.1. It shows that the central concept that unites all disciplinary didactics is the notion of *content*. This is concretized in each disciplinary didactics by what students are supposed to learn in the respective school subject.

Beyond the term *content* itself, the core of this terminological system is the term *content transformation*: the movement of content between culture, teaching, and learning mediated by cultural instruments. A necessary condition for content transformation is the connection between three basic modes of content existence: *intersubjective*, *subjective*, and *objective*. Their distinction and the interpretation of their relations is the fundamental underpinning for clarifying and addressing the challenge posed by the *logical-psychological distinction* accompanying content transformations in teaching and learning. How content transforms during teaching and learning is the focus of the following chapter.

1.2   Content and its cultural mediation (Chapter 3)

Human culture develops through inventions and is sustained through education. Tomasello (1999, pp. 37–40) used the metaphor of a *ratchet* to argue that similarly to a pawl or a latch that disables the backward movement of a rotating wheel in a ratchet, new inventions and new knowledge are fixed in cultural artefacts and transmitted through social learning and so cannot be easily reversed or undone. In this way, the *content* of human culture is acquired, stabilized, and retained.

The development and sustaining of content depend on its *mediation* among people because cultural content exists only in the history of human community (content is *embedded* in cultural history) but survives only in the minds of individual people (content is *embodied*). Cultural mediation (explained by Vygotsky, 1978) is twofold: on the one hand, it is realized by *people*, but on the other hand, it requires *tools* or *instruments* (symbolic as well as material) that any cultural novice needs to master in order to become a successful and well-performing element of the culture.

The concept of *content mediation* presupposes three basic forms of content existence: (a) *intersubjective*, (b) *subjective*, and (c) *objective*. Intersubjective existence of content is anchored in cultural instruments and is assured through a consensus during communication and cooperation between individuals. Subjective existence of the content refers to the fact that individual minds are *aware* of the content in the form of perceptions, impressions, notions, ideas, conceptions, etc. that can be expressed through cultural instruments. Objective existence of content manifests itself in phenomena and as such, it is the prerequisite for its intersubjective grasping. All three of the forms of existence are interdependent and inaccessible individually: we refer to this idea as the *relational approach* to the content.

It is evident that content travels between the three forms of existence without losing its identity. For example, the expression $1 + 1 = 2$ is identical to the arrangement of beads on an abacus and with the respective mental operation. This type of semantic, logical, and operational equivalence between different types of existence of identical content is referred to as *isomorphism* and the change of the type of content existence is referred to as the *transformation of content* (Janík et al., 2020). It is on this very basic level of cultural content that we find the connection between teaching and learning: without transformations of content there could be no learning or teaching.

The term *content transformation* goes far beyond the mere process of translating discipline to curriculum. Content transformation is present wherever there is *mediation* of content: it is the general principle of *maintaining interpretative identity of content throughout conversions between the forms of its existence*. For example, the content of a sentence is the same whether written or spoken, and the content of the expression $3 + 3 + 3$ is identical to expressions $3 * 3$ and 3^2. Without a way to assess the identity of content throughout its various transformations, there would be no learning and no teaching: the teaching would have no means to communicate with the students about what and how well they learn. The identity of content when interpreted is never absolute; it depends on the circumstance: the art of interpretation resides in the ability to emphasize what is significant and to neglect what is marginal.

In the European continental tradition of didactics, transformation of disciplinary content to the content of curriculum and then to the processes of teaching and learning is historically a prominent object of interest. "It concerns the analytical process of transposing (or transforming) human knowledge (the cultural heritage) like domain-specific knowledge into knowledge

for schooling that contributes to the above formation (Bildung) of young people" (Duit et al., 2012, p. 16). As a research objective, this brings together researchers in transdisciplinary didactics with teachers because they deal with the practical issues of teaching and learning in the same way as teachers, who project and realize teaching activities, formulate curricular documents, write textbooks and devise other learning aids for students. The key question for researchers and teachers alike is how to mediate cultural content to students with their (specific) learning abilities and needs.

In the European discourse, there are different terms to refer to the transformation of content between the culture and the curriculum which reflect differences in theoretical perspectives: *didactic transposition* (transposition didactique, Chevaillard, 1981–1982), *educational reconstruction* (Duit et al., 2012), *didactic transformation of content* (didaktická tranformace obsahu, Brockmayerová-Fenclová et al., 2000), etc. The basic principles of educational mediation of cultural content however remain the same. Following the French tradition, Savelli (2016, p. 100) summarizes them in the following key elements:

1 the constant dialogue between knowledge and prevailing social practices and wise knowledge (addressed to the explanation of phenomena);
2 the occurrence of an external transposition concerning the knowledge to be taught which flows into the formal program; and
3 the occurrence of an internal transposition related to the teaching-learning process leading to the taught knowledge and to students' learning.

External content transformation is based on the specific ontology of the particular cultural domain and aims at the curricular programme; we therefore refer to it as *ontodidactic transformation* (Figure 1.2). Internal content
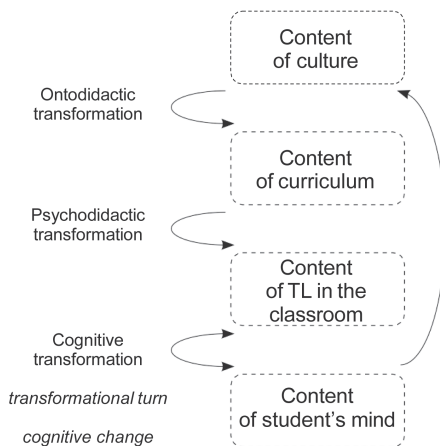

Figure 1.2 Three types of content transformation

transformation proceeds from the curricular programme to the learning possibilities and needs of specific students or types of students; we therefore refer to it as *psychodidactic transformation*. We refer to the subjective and socially determined process of learning, in which the student acquires the knowledge of content, as *cognitive transformation* (the content of culture becomes the content of an individual mind).[4] Cognitive transformation is related to cognitive changes brought about by active content (Fisherman, 2012, p. 163). Cognitive transformation differs from the previous two types of transformation in that it has the opposite direction – it does not step from culture, or cultural disciplines, to the subject, but from the subject towards the culture. The transition from teaching to learning can therefore be described as a *transformational turn* – a change in the transformational perspective. This makes the student's active, exploratory, and creative role in the process of teaching and learning stand out.

Any of these types of content transformation presents a complex of questions to be answered and problems to be solved. A solid didactic theory should nevertheless in all of them deal with a basic challenge of *two-dimensionality of facts* in education: every fact has an *ontological* dimension (what is to be taught and learnt) and an *epistemological* one (how particular content becomes the content of student's mind/experience).

1.3   Active content (Chapter 4)

In Section 2.4.2, we describe in more detail how current didactic theories deal with the challenge of *two-dimensionality of facts* and what remains unresolved. Here we will point out only one major shortcoming in how the construct of *content transformation* is used in both the various disciplinary didactics and general didactics: it is only used intuitively. So far, there has been no theoretical explanation that would provide sufficiently strong support for didactic analyses of the connections between the learning environment, the relevant content (what is to be taught and learnt), and the changes in the student's experience.

In our conception of transdisciplinary didactics, we seek to remedy this deficiency by elaborating a terminological system (a "language") that links the ontological and epistemological dimensions of didactic theory and research. Underlying this approach is the assumption that by linking teaching and learning, cultural content becomes "active content". Active content causes causal changes in mental operations (Fisherman, 2012, p. 163) that are usually called *cognitive changes*.[5] Cognitive changes take place in the epistemological dimension and accompany learning: they are transformations in the experience of individual people associated with the use of cultural instruments. However, cognitive changes are also a prerequisite for the development of human knowledge, as they can be the result of discoveries and creation projected into cultural development. These cognitive changes shape the history of culture and represent the development of knowledge in the ontological dimension.

This connection between cognitive changes in personal epistemology and cognitive changes in cultural history has its consequences for theory and research in transdisciplinary didactics.

The previous explanation should clarify the basic theoretical ground for the investigation of content transformations: two different forms can be distinguished in which cultural content exists. The distinction of the two forms is the root of Dewey's *logical-psychological distinction*:

- *epistemic operations with the content of subjective experience* (the subjective mode of content existence), and
- *cultural semantic-logical structures* (*S-L structures*) that base this experience in a socially shared context and its historical development (the intersubjective mode of content existence).

Concerning the S-L structures, it is essential for there to be any research on teaching and learning within transdisciplinary didactics to formulate two suppositions that help to bridge the *logical-psychological distinction*:

1 any content that we are aware of – or handle and reason about – can be analysed in the form of an S-L structure, and
2 any S-L structure is to a necessary extent at least partially identical in intersubjectively shared content (in concepts, symbols, patterns of action) and in the subjective grasp of this content.

If these two suppositions did not apply, there could be no public language or public world (cf. Searle, 2004, pp. 189–191). We use *language* to express S-L structures, to share and represent the world through them, so that we can communicate and cooperate with each other. This is common to all disciplines. The differences between them are due to the different relationships between the use of discipline-specific instruments, linguistic conceptualization, and the way the discipline approaches the world (i.e., how it extracts and elaborates discipline-specific content from it). It is these relationships that are the subject of teaching and learning, and thus the subject of didactic research.

The objects of research on teaching and learning are always real operations with certain content that can be analysed down to the level of S-L structures. These differ from one another in different disciplines in terms of content, i.e., the specificity of the instruments by which they are represented, but not in terms of general principles of structuring or transformation of content. This is evidenced by the fact that all S-L structures, regardless of the discipline, can be represented by graphs (concept maps) whose nodes are made up of concepts (denoting units of content) and whose lines correspond to meaning and logical relations. It follows that the qualitative cognitive changes caused by learning (the shift from phase n to phase $n + 1$) can be represented by graphs depicting the different phases of the learning process initiated by a learning task.

On this common basis, it is possible to analyse and explain the creation and operation of the learning environment in the classroom as a transformational content process, which can be represented by the *Deep Structure of Teaching and Learning Model*. The model allows for the juxtaposition of S-L structures derived from culture, or disciplines, and S-L structures interpreted from students' solving of learning tasks or from students' communication about content. The analysis of the correspondences and differences between them, together with the analysis of the qualities of the learning environment, guides the evaluation of the teaching and learning process and suggestions for its improvement. We believe that these theoretical assumptions are general enough to apply not only across different disciplines but also to different cultures of teaching and learning regardless of their social and cultural conditions.

Students' epistemic operations with content have traditionally been analysed by educational psychology since the work of Piaget, Vygotsky, and others. On the other hand, the development and elaboration of S-L cultural structures have been studied by various disciplines that provide educational content to school curriculum. Communication and cooperation between these different domains are never simple even though it is exactly from the relationship between cultural structures and epistemic operations that teaching and learning arise.

To sum up, transdisciplinary didactics (similarly to disciplinary didactics) operates on the intersection of these two domains and is therefore expected to build a system of theoretical constructs and a methodology for the research and interpretation of interrelationships between epistemic operations and cultural structures.

1.4   Cognitive changes (Chapter 5)

As explained above, by internalizing active content, causal changes in mental operations are induced (Fisherman, 2012, p. 163). These changes are generally referred to as cognitive changes. Fisherman's (2012, pp. 164, 166) definition of active content implies that cognitive changes are an attribute of active content: content that does not cause cognitive changes is not active content. On the basis of this fundamental thesis, three necessary and interrelated conditions can be derived for the action of active content on cognitive changes in content transformation: *content identity*, *knowledge increment*, and *experience reconstruction*. Not included in the cited Fisherman's paper, we suggest these conditions clarify and specify the construct of *active content* in the context of the theory of content transformations. They represent a claim to the normativity of the educational process in terms of the active content construct, as they are fundamental criteria for both the recognition of active content during transformations in teaching and learning and for the (normatively contingent) assessment of the quality of its impact on the student's experience.

Content identity – an "identifying" condition: the change must be recognizable as preserving the identity of the content in all three variants of its transformation mentioned above: cognitive, ontodidactic, and psychodidactic (knowing better about "the same").

Increment of knowledge – a "normative" condition: there is an educational benefit of the change caused by the active content: the increment of knowledge (knowing more…).

Reconstruction of experience – a "structural" condition: cognitive changes lead to a new ordering of experience (knowing differently…).

This type of conditioned experience change is generally called *relational change*. We use this term to highlight the dependence of cognitive change on cultural structures. Relational changes are the result of the causal action of the semantic-logical structure (S-L structure) of active content, which comes from culture, on the mental operations of individual subjects – i.e., learners. Relational changes are (in the most general sense) changes in the network of distinctions and cross-references between parts and wholes (typically in the acquisition of a new concept or a new skill). They are characterized by the fact that the transformation of the sub-elements of the content structure causes (often extensive) re-constructions in the whole network of meaning and logical connections (S-L network) arranged by the previous operations; the degree and quality of these re-constructions can be classified and scaled upon reflection.

With respect to the quality and quantity cognitive changes can be distinguished into types that represent different levels of re-construction in the S-L network of meaning and logical connections that constitute the particular content of experience. The thesis about the relationship between cognitive changes in personal epistemology and cognitive changes in cultural history provokes a genetic parallel: the key phases or components of cognitive changes in personal epistemology and cultural epistemology are identical (Garcia & Piaget, 1989; Kvasz, 2022; Piaget, 1970; Toeplitz, 1926/2015). Based on the study of cognitive changes in historical cultural development, Kvasz (2008, 2020, 2022) proposed to distinguish four main components of phases of cognitive changes that are applicable to teaching and learning: epistemic contact, the stabilization of epistemic contact (objectification), the extension of epistemic contact (re-presentation), and idealization of epistemic contact (idealization).

Kvasz (2022) strongly distinguishes the concept of epistemic contact from the forming of ordinary sensory experience. This distinction arises from the pivotal role of instrumental practice in the realm of science for the cognitive transformation of experience. According to Kvasz (2022), the interpretation of this transformation pertains to the human mind, but within the framework of cultural epistemology, its focus is not on the subjective mode of knowledge acquisition (as in psychology); rather, it concerns *objectified epistemic relationships between theories and reality* (Kvasz, 2022, p. 167).

We consider the most didactically sensitive initial point of memetic replication to be the stabilization of epistemic contact (objectification) (Kvasz, 2020, pp. 9–11; 2022, pp. 169–177). Objectation (objectification, reification) is understood as a "stabilizing contact with reality" through the instrumentalization of perception (Kvasz, 2020, p. 9; 2022, p. 169).[6] An example is the emergence of the rules of linear perspective in Renaissance painting, which is interpreted by Gombrich (1960/2002) with support in his schema theory. On the basis of objectation, the ability "to single out certain cognitive content, to isolate it, to hold it in consciousness, and to manipulate it in various ways" (Kvasz, 2020, p. 24) emerges and develops. In science, objectation is a prerequisite for the basic ontological distinction of "units of content" and a condition for the formulation of variables.

A significant cognitive enrichment of objectation is the next level of cognitive change: the extension of epistemic contact (re-presentation) (Kvasz, 2020, pp. 17–23; 2022, pp. 177–182). Re-presentation depends on the systematic development of instruments in a particular domain at the "seam" between the sense organs, the joint intentional action, and the world. Cognitive changes at the level of re-presentation are a condition for a gradual grasping of the "thinking of the field" – for understanding the specific ways of grasping and coping with the world that are characteristic of it. At the same time, the path opens up to expanding epistemic contact beyond sensory experience and eventually to idealization.

The most radical cognitive change in this conception is *idealization*. Idealization consists in "the creation of a new language, i.e., new rules of its syntax and semantics, which makes it possible to describe the world in a way that is consistent with the results of instrumental practice" (Kvasz, 2020, p. 10).[7] We believe that idealization in its pure form is reserved only for mathematics and, in close connection with it, also for physics or other exact disciplines of the natural sciences. Yet it is clear that all other disciplines that aspire to fulfil the demands of idealization must be culturally stabilized to some degree through semantic-logical structures in the schemata of their memetic equipment in order to replicate themselves. This is evidenced, for example, by Wellman's (1990) proposed criteria for evaluating the quality of any conceptualization: the criterion of *coherence* and the criterion of *a causal-explanatory framework*. The coherence criterion refers to the quality of the logical (inferential) structure of concepts, and the second criterion speaks to the explanatory power of the conceptualizing language. Both criteria seem to correspond to the claims of idealization in Kvasz's conception. Only at the level of idealization with recognized cultural value does one or another instrumental practice demonstrate sufficient cultural weight to survive in historical development and have the power to become part of the curriculum.

Chapters 3–5 show teaching and learning as a complex and intricate system. Such systems are in principle impossible to maintain or improve by random interventions. That is why any attempt to improve the quality of teaching and learning must begin with an analysis and assessment of classroom situations. This is the concern of Chapters 6 and 7.

1.5 Content-focused approach for improving teaching and learning: 3A methodology and case studies (Chapter 6)

Teachers are very well used to analysing teaching and learning as part of head teachers', school inspectors' or peer observation. In these instances, it is crucial that all these parties use the same language and analytical approaches. This is, however, not always the case. The discourses of different (even if closely related) professional communities may differ in terminology, perspectives, frameworks of reference, etc. To bridge these differences, we propose in this book a methodological approach to analysing teaching and learning – the 3A Methodology (M3A) – an approach that can be used by different actors interested in the quality of teaching and learning regardless of which professional community they belong to.

M3A refers to the three steps of which it consists:

- *Annotation* is a brief summary of the analysed situation; it documents its aims, content, and conditions.
- *Analysis* is a detailed look at the key aspects of the analysed situation from the perspective of quality assessment; pinpointed are those moments that should be improved or may on the other hand serve as examples of inspiring practice.
- *Alteration* is a suggested change in the situation, critically justified with regard to the integrity of teaching and learning (the coherence of aims, contents and the activities of teachers and students).

The idea behind the M3A is that quality in teaching and learning cannot be assessed based on "surface" observation, because many of the relevant didactic phenomena are only available through an in-depth analysis. The key theoretical tool for this analysis is the Deep Structure of Teaching and Learning Model (see Figure 1.3). The Deep Structure of Teaching and Learning Model
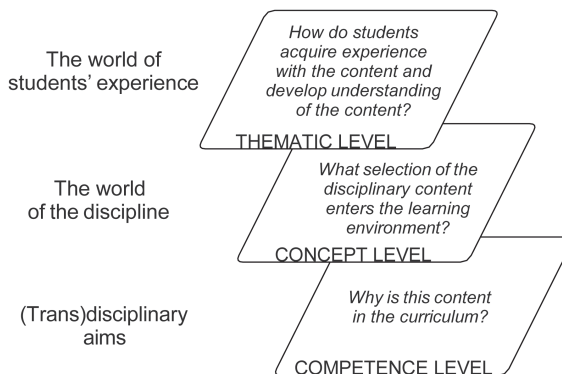

The world of students' experience — How do students acquire experience with the content and develop understanding of the content? — THEMATIC LEVEL

The world of the discipline — What selection of the disciplinary content enters the learning environment? — CONCEPT LEVEL

(Trans)disciplinary aims — Why is this content in the curriculum? — COMPETENCE LEVEL

Figure 1.3 Three levels of the Deep Structure of Teaching and Learning Model

serves as a fundamental underpinning for operationalizing the theoretical background for transdisciplinary didactics for research on teaching and learning and for supporting teacher development activities. A constitutive feature of the Deep Structure of Teaching and Learning Model is the linking of three basic levels of content transformations during teaching and learning. Each of these levels represents a specific way of dealing with content by teachers and/ or students.

The three levels of the Deep Structure of Teaching and Learning Model (Figure 1.3) are:

- the concept level (named after concepts as "units" of content) refers to educational content,
- the competence level (named after the most complex curricular aims) refers to educational aims and objectives,
- the thematic level (named after the way of thematization of cultural content) refers to the ways in which content is grasped in the learning environment.

It is a basic professional competence for teachers to maintain integrity of all three levels while teaching. A high level of integrity occurs when educational aims, content and the students' activity are in agreement. In the language of the Deep Structure of Teaching and Learning Model, integrity of refers to the harmony between the concept level, the competence level, and the thematic level of the model; whenever their integration fails, the quality of teaching degrades. The reasons for this degradation can be characterized, with the support of the Deep Structure of Teaching and Learning Model, as different types of so-called *didactic formalisms*. On the other hand, high levels of integrity refer to *didactic excellence in teaching*. In this way, the Deep Structure of Teaching and Learning Model is used for research on teaching quality and, in teacher education, underpins in-depth analytical reflection and evaluation of teaching and learning quality.

If the analysed teaching situations lack in quality then alterations can be suggested and justified that improve the quality of the situation and serve as an incentive for further discussion in professional community.

The Deep Structure of Teaching and Learning Model serves as such a guideline for the didactic analysis that ensures the existence of a shared language in a dialogue about teaching and learning. The didactic analysis focuses on educational content which enters teaching and learning "from outside": from the culture and its disciplines. Of course, disciplinary content cannot enter teaching and learning without having undergone didactic transformation that takes into consideration students' individual abilities and needs. That is why integrity of teaching and learning must be ensured, i.e., the cultural content must be transformed in order for teaching and learning to fulfil set educational aims.

Because the analyses realized within M3A are value-laden, the key characteristic of the approach is that it can generate judgements about the

degree of quality of authentic teaching and learning situations. As such it can pinpoint those instances of teaching and learning that represent examples of poor practice as well as examples of good practice, which makes it not only a valuable research tool but also an effective instrument for teacher education setting.

The findings that the M3A generates through the analysis of a teaching and learning situation are presented in the format of *didactic case study*. If the quality is identified as high, the didactic case study serves as a precedent of good practice; if it is deemed low, alterations are suggested and discussed that aim to increase the didactic quality of the situation. In any case, didactic case studies provide a tool to generate profound understanding of how specific context can be mediated to students and how students' learning of a specific content can be facilitated in the classroom.

The ability to formulate a judgement about the quality of observed teaching and learning opens the door for the comparing of different subjective experiences acquired by teachers and students and for profound understanding of meanings and qualities of teaching and learning. In order to do *that* it is necessary to take authentic instances of teaching and learning and abstract from them general categories and criteria that provide frameworks for the comparison of individual cases.[8] Shulman (1996, p. 474) explains this abstraction as the movement from direct personal *first order experience* to "recollected, re-told, re-experienced and re-flected" *second order experience*.

Shulman (1996) explains that such transformation of experience is accompanied by the question "What is this a case of?" The question stems from the fact that an individual case can only be presented with reference to other cases and therefore with more general (theoretical) categories that embed the case into a framework of reference (a theory). The study of individual cases (i.e., case study research) is a key methodological approach for the analysis of teaching and learning when we are interested in the quality of content transformations and the issue of *logical-psychological distinction*.

M3A generates findings in the form of didactic case studies that draw on content provided by various disciplines, yet that are structurally identical. The necessary methodological rigour then makes it possible for a multi-case study to analyse teaching and learning systematically and become a valuable tool by which transdisciplinary didactic knowledge is created that can be valuable to teachers in practice. It is because case studies can serve as incentives for teachers to implement alterations in their lessons and thus understand and improve their teaching (see Shulman, 1996, pp. 478–481).

1.6 Revealing didactic formalisms and didactic quality – The findings of a multiple-case study (Chapter 7)

The benefit of M3A as a research tool is twofold. On the one hand, it serves as a procedure to generate individual case studies that analyse authentic classroom situations and help theorize about their hypothetical improvements

(alterations) and thus contribute to the development of discipline-contexed theory of teaching and learning (disciplinary didactics). In the Czech context, it has been used by a growing community of researchers since 2011; case studies generated by M3A have been published as parts of research articles, qualification theses and teaching methodology papers by teacher educators, researchers and teachers alike (see Chapter 7). Case studies are presented and discussed in disciplinary didactics courses in teacher education programmes showing that the benefit of this methodology lies in the emphasis on understanding the context and on thinking deeply about teaching. The Deep Structure of Teaching and Learning Model guides prospective teachers to uncover the causes of reduced teaching quality, and the demands for critical assessment of proposed alternations develop professional communication and professional thinking.

On the other hand, M3A provides a wider methodological framework for the accumulation and abstraction of knowledge from these individual case studies by means of multiple-case studies. Thus, the findings formulated in the individual the case studies are fully exploited to generate transdisciplinary understanding of teaching and learning. The primary effect of the multi-case study design is that it generates knowledge that goes above the individual cases, across various contexts and beyond the limitations of questionable generalization. The presented multi-case studies do exactly that: their findings build on the specific knowledge cultivated by individual disciplinary didactics (mathematics, chemistry, history) yet allow for abstraction onto the transdisciplinary (transdidactic) level. In this way, different phenomena can be studied that manifest themselves in the teaching and learning of various school subjects but are of general didactic nature.

In Chapter 7, two such multiple-case studies are presented. We are interested in those phenomena that have to do with the integrity of teaching and learning, i.e., the harmony between the aims, content and students' activities as represented by the concept, competence and thematic levels of the Deep Structure of Teaching and Learning Model. Those phenomena that pose a threat to the integrity of teaching and learning are referred to as *didactic formalisms*; those phenomena that support and strengthen the integrity of teaching and learning are referred to as instances of *didactic excellence*.

Multiple-case study 1 builds on the review of 44 individual case studies to illustrate two types of didactic formalisms, i.e., known chronic flaws in the integrity of teaching and learning situations. In general, the term *formalism* refers to when the *form* (how content is shaped or treated) dissociates from – or drives attention from – the sense or meaning of the content (in education: what is to be learnt or understood). Didactic formalisms can be defined as flaws in the structure of links between the main determinants of the deep structure of teaching and learning (aims, content and learning environment), which corrupt the quality of instruction. Two types of didactic formalisms were identified: *stolen cognition* and *concealed cognition*. *Stolen cognition* refers

to instances when the teacher over-reduces the space allowed for the students' cognitive work with the content, preventing cognitive activation of students. Due to the disintegration of students' activity, learning aims and the content, students become passive in relation to the content because it is too remote from their cognitive and motivational states. *Concealed cognition* on the other hand refers to instances when cognitive activation of students is purposeless because of their disconnection from the content. It is not typically indicated by students' passivity and lack of interest. In fact, quite the contrary is true; students show keen interest in tackling their tasks which however fail to provide opportunities for the students to develop a deeper understanding of the subject taught. Put simply, students are keen on "playing" with the content, but they fail to understand it.

Multiple-case study 2 builds on the findings of 61 individual case studies and it is aimed to construct and illustrate in detail *constructive cognition* as a type of didactic excellence. Constructive cognition refers to classroom situations in which there is evidence that modern/constructivist didactic techniques (peer learning, self-assessment, formative feedback) functionally support teaching and learning in the classroom and *constructive work with error* describes such instances where students' errors prove as solid foundations for restructuring and improving students' knowledge and understanding. Five subcategories of quality which characterize constructive cognition were identified through a meta-analysis of the case studies. These are *closeness of representation*, *interconnection of empirical and instrumental experience*, *productive work with error*, *instrumental aptness*, and *instrumental clarity*. These subcategories are presented in detail and illustrated with transcriptions of authentic teaching and learning situations. We argue that in each subcategory there is a continuum between didactic formalism and didactic excellence and that each didactic formalism can be corrected by a series of improving changes leading to didactic excellence.

Chapter 7 is concluded with a set of recommendations that are concerned with how the findings generated by the two transdisciplinary multiple-case studies can be used in the very practical situation of planning a lesson. It is our goal to emphasize through these recommendations the practical side of the transdisciplinary approach to didactics in that it provides a shared perspective on teaching and learning and a professional language accessible to researchers, teacher, teacher educators, and other actors interested in analysing the quality of teaching and learning.

The approach discussed in this book draws inspirations from a variety of theoretical sources and presents a number of concepts related to content transformation. To provide the reader with a guide along the main line of presentation we summarize the core theoretical concepts in a brief overview (Table 1.1). We draw on our previous work (Janík et al., 2019a, 2019b, 2020; Slavík et al., 2016) where the theory of content transformation and related methodology has been presented and elaborated.

Table 1.1 An overview of the theoretical concepts presented in the book

Part I		Part II	Part III		
Chapter 1	Chapter 2	Chapters 3–5	Chapter 6	Chapter 7	Chapter 8
Introduction	Didactics	Theory of Content Transformation	3A Methodology	Formalisms/Excellences	Conclusions
	Pedagogy Didactics General didactics Disciplinary didactics Pedagogical content knowledge Aims-Contents-Forms-Methods-Media • Bildung-centred didactics • Didactics based on behavioural conceptions of learning and curriculum theories • Didactics based on theory of teaching and learning • Communicative Didactics • Constructivist Didactics Transdisciplinary didactics • Content-focused • Bildung-centred • Research-based • Case-based • Sematic for the teaching profession	Content Cultural mediation Content transformation Isomorphism Content and creativity Content and structure, circumstances Context and co-text Intentionality Instrumentation of experience Active content Content units Cognitive content transformation Cognitive change Personal epistemology Cultural epistemology • reformulation • objectification • re-presentation • idealization Cultural field Student- and discipline-oriented approach	Research-based teacher education and professional development Communities of practice, professional communities Analysis of learning environment Teaching and learning situations M3A (The 3A Methodology) • annotating • analysing • altering) Conceptual structure diagram • thematic level • concept level • competence level Quality of teaching and learning situations • elaborating situation • encouraging situation • undeveloped situation • failing situation Urgency of alteration Didactic case study Multiple-case study Generalizing findings from case studies	Operationalization • dimensions • subdimensions • characteristics • indicators Didactic formalisms Stolen cognition Concealed cognition Didactic excellences Constructive cognition Lesson planning Lesson reflecting	Professional language Knowledge base for teaching

Notes

1 Some authors (Duit, Kansanen, Gudmundsdottir) use the German word *Didaktik* in their English texts to emphasize the reference to the German tradition of thought.
2 *Didactic* (adj.) refers to teaching practices that are too traditional, practice-oriented, even formalist, dogmatic.
3 Kansanen uses the English term *subject matter didactics* as an equivalent of the German "Fachdidaktik". In contrast, we use the term *disciplinary didactics* to highlight the fact that it is various disciplines that provide the "ground" on which didactics operate.
4 When referring to cognitive transformation, the term *cognition* is understood very broadly in a pragmatic sense as the enrichment of experience through previously unknown content, acquired via learning of any type. For example, in the context of learning music or sports, cognitive transformation is determined by specific motoric or perceptual performance that is essential in acquiring knowledge in the particular domain.
5 We use the term *cognitive changes* as an umbrella term for more subtle terms (epistemic changes, conceptual changes, etc.).
6 The instrumentalization of perception in this sense depends on imagination in conjunction with social learning, at three basic levels: (1) content representation – imagining and enacting the same content and goal as someone else has done before (*imagining-for-learning*), (2) action planning or innovation – imagining variable possibilities for future action, (3) understanding the actions of other beings – imagining how I would make decisions "in another man's shoes" and estimating the future course of their actions (Currie & Ravenscroft, 2011, pp. 8–10).
7 Kvasz (2020, pp. 16–17) further characterizes idealization through its two subfacets: *compositional synthesis*, *deductive synthesis*. Compositional synthesis occurs when theorems enable systems of interacting parts to be described and interpreted; deductive synthesis is the ability to arrange facts into deductive relations of mutual entailment.
8 Anybody can form an impression about the quality of a teaching and learning situation and arrive at an intuitive assessment. That is, however, by no means enough to formulate an argued evaluative judgement.

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