On the Theory of Content Transformation in Education

The 3A Methodology for Analysing and Improving Teaching and Learning

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Chapter 3

Towards the Theory of Content Transformation

3   Towards the Theory of Content Transformation

Students always learn *something*, and teachers always teach *something*. This basic proposition postulates that teaching as well as learning are processes that have certain *content*. In other words, without content, there is no education (Janík et al., 2020, pp. 1–2). The general ability to learn content is a prerequisite for knowing the world, acting in it and surviving. Hence, it is important for teachers to understand the content of education in its broader cultural context (Englund, 1997). From such context, the educational content is elevated and processed into a form that meets general educational aims. Only then does it offer students the best possible learning opportunities. Therefore, the teacher should view content in a way that allows its "movement" or *transformations* between the world, human culture and the student's mind (Komorek & Kattmann, 2008).

Content transformation is a theoretical construct that allows for the analysis and explanation of the interaction of teaching and learning and for the evaluation of their quality. In European didactic tradition, the term *content transformation* (and its equivalents) means educational processes related to the content mediation between the culture and student's experience (see Section 2.4). Generally, the attention lies on transformation in the direction from culture and its disciplines to students (Bernstein, 1971; Bruner, 1966; Chevallard, 1985; Deng, 2021; Duit et al., 2012; Gericke et al., 2018; Schwab, 1973). Our approach (as noted in Section 1.2) includes the opposite direction as well: from the students to the culture. In this extension, content transformation becomes a link between the epistemic and the curricular approaches because on the one hand it refers to the processes of curriculum development and on the other hand characterizes the basic principle of human learning and cognition: to know and to manage "the same differently".[1]

Consciousness, knowledge, and the entire human culture depend on the ability to learn and share "the same differently", i.e., to maintain the interpretative identity of some specific content during changes in the way of its existence, characterization, or formulation (Janík et al., 2020). A written word, in this sense, is "the same" as a word in speech, a thought that was not uttered is "the same" as an uttered sentence, forged iron is "the same" as iron ore, 3^2 is "the same" as 3 times 3. We would not be able to agree on anything,

learn anything, or understand anything if we were not capable of grasping and explaining sameness through differentiating and at the same time capable to understand differences based on identity.

"The same differently" is a key principle of "two-way" content transformation. When speaking about "the same" content with respect to transformation, we understand the reference, although there are countless differences between transformed forms that could at any time be a pretext for their content differentiation. For example, we do not have to interpret the word "four" as "4", but as an example of a numeral or a four-letter word. In this sense, learning can be understood as a gradual improvement of the ability to master content transformations between the inner and outer environments, in relation to the desired aims/intentions (Janík et al., 2020, p. 2). We base our explanation on this general point of view, in connection to principles set out in Chapter 1.

3.1   Content and its cultural mediation

With the word *content*, we say that something exists in something or through something. The term content thus points to everything the meaning of which we consider specifiable without directly specifying it, e.g., content of experience, content of a term, content of an image, content knowledge. It also refers to completeness, e.g., by the content of experience, full experience is meant, not just its part.

Content is stored in the memory of mind and body of individuals (content is embodied) and remains in the shared cultural history of human society (content is embedded in culture). These two theses presume that content can be mediated through communication and social learning. Mediation of cultural content, as Vygotsky (1978) explained, is dual: it is performed by people, but it cannot be performed without instruments that every cultural novice must learn to use so that they can integrate into the culture, assert themselves and develop in it. Vygotsky's construct of dual mediation provides a "model of dynamic interplay between discourses and other artifacts, mental representations and patterns of neurological activity in the formation of human thought" (Daniels, 2015, p. 35). It follows from the dual understanding of mediation that content in culture exists in three key modalities, i.e., in three elementary ways:

- *intersubjective* – content shared by people and embedded in culture through external instruments – carriers of mediation;
- *subjective* – content embodied, kept in subjective memory, thinking and imaginations of an individual with the support of internalized instruments; and
- *objective* – content potentially accessible in phenomena, or in factual aspect of instruments, e.g., stone, engraving in stone, writing on a paper or on a computer monitor.

The three ways of content existence allow its mediation between people on the basis of a universal ontological and epistemological assumption of *reciprocity of perspectives* (Schütz, 1953, p. 7 et seq.).[2] Reciprocity of perspectives is based on two inter-related conditions:

- *Sharing of the world*. The basis here is objective – ontic: lived reality as one shared source of sensory and motoric experience arising from the concurrence of perception (*a priori* subjective) and action (potentially shared).
- *Sharing a partner perspective*.[3] The basis is intersubjective – anthropic: shared biopsychosocial basis of being and a shared culture constituted by a shared language.

All three ways of content existence are conditioned by the reciprocity of perspectives and are interdependent. Content knowledge therefore has *relational nature*: it is achievable only through mutual relations between the intersubjective, subjective, and objective content existence. This follows from the dual nature of mediation: content is mentally grasped and mediated between people through instruments, and these are the bolt of all ways of its existence.

The interdependence of the three ways of content existence is shown through a diagram (see Figure 3.1):

C1 – objective (what is perceptible),
C2 – intersubjective (what is expressible and communicable through instruments), and
C3 – subjective (what is conceivable and imaginable).[4]

It can be read from the figure that C1, C2, and C3 are physically situated in different ways, but equally ideologically interpreted: it is "the same" content (e.g., light coming from the Sun, the word "light" in a particular language, consciousness or perception of light by a subject). For this type of equivalence,
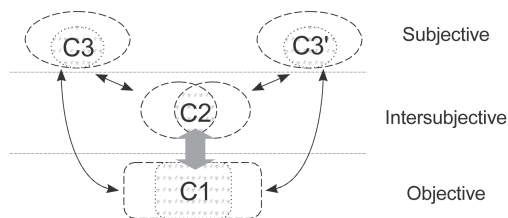

Figure 3.1 Three ways of content existence – key modalities of content

Note. Dotted area – determinable content; dashed line – permissible limits of interpretive variability while maintaining the identity of the content.

Source. Adapted from Slavík, J., & Janík, T. (2012). Kvalita výuky: obsahově zaměřený přístup ke studiu procesů vyučování a učení [Teaching quality: A content-based approach to the study of teaching and learning processes]. *Pedagogika*, *62*(3), 274. Reprinted with permission.

we use Hofstadter's term *isomorphism* (Hofstadter, 1979, pp. 9, 49). The term *isomorphism* is used to refer to the equivalence between different forms of the same content. Isomorphism is a necessary condition for the acquisition or intersubjective sharing of content during its transformation (Janík et al., 2020, p. 3). Isomorphism between causal structures of actions with objects and structures of thinking is a key epistemic condition for sharing content through its external representations (Piaget, 1970; Stoltz, 2018).

3.2   Isomorphism and content transformation

The term isomorphism can be used to explain that content passes between C1, C2, and C3 without losing its identity. For example, equation $1 + 3 = 4$ (C2) is in this sense isomorphic with the physical operation of grouping one and three abacus balls (C1) and with the mental operation of the same calculation (C3). We call it *operational isomorphism*. On this basis, another isomorphism situated in the line C2–C3 is applied: $1 + 3 = 2 * 2$, $2 * 2 = 2^2$, $2^2 = 3 + 1$, etc. We call it *instrumental isomorphism*.

3.2.1   *Operational isomorphism*

Operational isomorphism is the equivalence between the subjective, intersubjective, and objective existence of the same content. Without it, it is not possible to explain why operations with factual instruments at the intersubjective level have consequences for changing the content of subjective experience.

Operational isomorphism depends on the acquisition of common (intersubjectively shared) concepts and rules. When a student draws the upper side of a cylinder as an oval, they rely on the rules of linear perspective. When they speak, they rely on the rules of the respective language. When they make calculations, they follow the rules of mathematics, etc. Rules are a condition for understanding as well as for recognizing and correcting mistakes.

3.2.2   *Instrumental isomorphism*

Where the equivalence between different alternatives of the objective existence of the same content is found, there is an instrumental isomorphism. It depends on the operational isomorphism, because it follows from the relationship of intersubjective consensus and subjective judgement to commonly perceived external phenomena. Without reference to instrumental isomorphism, it is not possible to explain why "the same" can be expressed or interpreted "differently".

Instrumental isomorphism has two levels. First, the equivalence between the physical existence of an object and its symbolic representation: the interpretation of "the same differently". For example, the word "horse", "cheval", "kůň" is (in a given cultural context) isomorphic to this animal and the same is true for a depiction of a horse. This is the basis for the equivalence between

various alternatives of symbolic representation of the same content: the expression and interpretation of "the same differently". For example, a word expressed and interpreted by its synonyms or a word expressed and interpreted by an image.

Therefore, *two-level correspondence* applies to both types of isomorphism (Hofstadter, 1979, p. 49). The two-level correspondence elucidates the relationship between the deductive, analytical facet of reasoning and its inductive aspect, grounded in observation and synthetic judgements (de Jong, 2010). The first level (related to induction) encompasses the correspondence between phenomena and the meanings interpreted from them. The second level (associated with deduction) establishes connections between true statements and theorems within the relevant context. Their functional integration ensures the semantic and logical coherence of linguistic representations, herein referred to as the semantic-logical structure (S-L structure). Semantic-logical structure carries information about real or fictional existence (the answer to the question "what is it?") and about its context (the answer to the question "what does it belong to?"). It is therefore a necessary basis for any cognition or learning. It can be recognized in any description or explanation; it is possible to evaluate its aptness and completeness or errors in it, etc.

An example of two-level correspondence inspired by Frege is given by Hofstadter (1979, pp. 58, 457): counting drops flowing down a window when it rains. At the level of semantic correspondence in the interpretive context of mathematics, the equivalence of a *drop* is *one* applies. The logical correspondence for the mathematical context must also apply: the operation of addition. However, it is cancelled when two flowing drops merge into one. This is a challenge to rethink the context framework for content operations – instead of counting drops to count the volume of water in them. Note the fundamental change in the instruments and the knowledge involved: a pipette and a measuring cup have been added to a pencil and paper, together with physical knowledge and skills to use them.

The above characteristics and examples show that the identity of a particular content follows from the recognition of isomorphism between all modes of its existence according to the principle of "the same differently". It follows from two-level correspondence that the identity of a given content is never absolute, even though it is rooted in specific phenomena. It is only relative, because it always depends on the conceptual framework of interpretation and the interpretive circumstances that decide on the choice of what is important in the given situation – what is its content – and what must be neglected.[5]

The relative equivalence between the different ways of existence of identical content when working with it is called *content transformation* (cf. Hofstadter, 1979, pp. 9, 49). Content transformation according to the principle of "the same differently" is a general epistemological condition of its cultural mediation and is therefore a general condition of teaching and social learning.

3.3   Content as a potential for the interpretation and a consequence of creativity

The identity of particular content during its transformations is proved by the interpretation of phenomena or objects. Therefore, we characterize content as a potential for interpretation. The interpretation of content is always associated with its transformation: it is the deliberate assignment of objects in order to express and intersubjectively mediate the isomorphism of their content. The appropriateness or correctness of the interpretation depends on the circumstances and is based on the justification and success of follow-up activities with regard to the objectives.

3.3.1   *Content as a potential for interpretation*

The relation between the object and the content that is interpreted can most easily be formally written by the elementary sentence A is B, or $A = B$ ($2 = 1 + 1$, $2 = //$, $2 = 10$). It is clear from the notation that the content identity results from the mutual relation of phenomena/instruments A and B. Note that the relation in the interpretation must have two-way validity (it is symmetric). Without it, it would not be possible to reach an intersubjective agreement on the identity of the content. Only in this way can content be expressed in a manner that allows it to be shared by people when communicating and collaborating.

The equal sign points to the interpretive potential of mutual relation: by it we show the content unity ("the same") referring at the same time to the epistemic differences ("differently") that give the relation a good sense. For example, the statement "Venus is Venus" or "water is water" has no informative value compared to the statement "Venus is the morning star" or "water is H_2O". This is the principle of "the same differently" (A is B), characteristic of content transformations as well as of any cognition. In the background of the principle of "the same differently" is the anchoring of content in expressions and sentences of language or other symbolic conceptual systems maintained by social convention and cultural tradition.

If we want to emphasize that interpretation is not about equality, which applies rigidly and unambiguously regardless of the interpretive circumstances, we are talking about equivalence. Suppose that putting your index finger close to your closed mouth, the expression "shh" and the utterances "be quiet", "belt up", "shut up" are interpretatively interchangeable in a certain situation, in other situations, it may not be so. However, we are aware of the possibility of their interchangeability and in the given situation we can use this when choosing the best alternative.

The interpretation of content can be of various complexities, from the elementary levels to the most complex ones. For example, the number 2 in the decimal system can be interpreted as the notation $1 + 1$ in the same number system, or the notation $//$ ($=$ two lines), or a grouping of two branches, or 10 in a binary number system. These are examples of elementary interpretation in the context of mathematics. In learning, however, even seemingly elementary

interpretation can be challenging or unachievable for a cultural novice if they are not equipped with the adequate content knowledge.

The principle of semantic-logical assignment applies equally to both trivial and very complex interpretations. For example, human experience of moving in the countryside is interpreted by a geographical map or GPS, and conversely, the possibilities of relocation in the countryside can be interpreted from a map or GPS. Another interpretation of motion is Newton's laws, and yet another interpretation of motion is a car or a gymnastic exercise. With these examples, we deliberately emphasize the broad scope of interpretation far beyond just verbal interpretation.

3.3.2   *Content as a consequence of creativity*

The concept of content as a potential for interpretation leads to a creative conception of its transformations because it points out that content is hidden in phenomena and must be actively recognized and discovered in order to be expressed and shared. In education, this creative approach to content is important because it is opposed by a passive reproductive approach leading to a misunderstanding of the depth and dynamics of educational content.

The exploratory nature of interpretation follows from the need to reveal a previously unrecognized connection between phenomena on the basis of the principle of "the same differently". At the highest levels of the so-called H-creativity (historical or high creativity; Boden, 2004, pp. 2–4), there is the exploratory authorial work: formulation and instrumentation of yet unknown content, which fundamentally changes historical cultural development, for example, Einstein's theory of relativity in Physics or Picasso's cubist completion of the transformation of the classical way of depiction in fine art.

The consequences of authorial exploratory work are intersubjective: they lead to changes in the experience of many people and the whole culture. However, every creative and exploratory act must have its origin in the subject: in the particular empirical author in the current historical situation "here and now", which in its entirety has never occurred before and can never be repeated. Therefore, in the theory of creation, in parallel with the concept of *H-creativity*, the term *P-creativity* is used – personal creativity (Boden, 2004). P-creativity must be owned by any producer of content representation, from a genius to a child in the very beginnings of cultural development. Even seemingly only reproductive operations have creative aspects. At a minimum necessary level, e.g., a baby is creative in its initial reproductive attempts to use language, because it must be able to innovatively integrate the linguistic stimuli of its social environment into the current communication situation.

This connection between P-creativity and H-creativity provides an opportunity to understand every interpretive situation as a creative challenge for discovering the unknown; despite the fact that in everyday educational practice, reproduction and routine during the interpretation of content sometimes prevail over innovation.

3.4   Content, its structure, context, and co-text

It follows from the elementary sentence *A is B* that in order to recognize and assess the content identity, the units of content (A and B), must be distinguishable, e.g., concept, or meaning. A content unit is a whole that can be divided into parts. Under specific circumstances or from a certain point of view, a content unit may be considered a whole composed of parts or conversely a part of a whole. For example, a written sentence is a part of a novel, but as such it is composed of words and words are wholes that can be decomposed into consonants and vowels.

If content is to be comprehensible, the parts and wholes must be interrelated so that it is possible to recognize and determine some regularities of their relationship. Such a relational arrangement is termed a structure.

3.4.1   Structure

Structure is the way in which a whole is composed out of its parts (Peregrin, 1997, p. 113). Structure follows from regularity; it is recognizable only from repeated observations – structure is an abstraction. If it can be seen in specific phenomena and it is possible to show its arrangement and elements, it is understood as its representation: construction, composition, etc. For example, an octagon geometric shape has its own unique structure that can be constructed in various specific alternatives with a ruler and a pair of compasses; a musical composition has a structure arranged through composing, which can be recorded by notation and the structure of the composition can be repeatedly represented through performing it.

Content is a whole and its interpretive potential is determined by the structure of content units. For example, the content of a sentence is a whole specifically determined by the structure of meanings of its words. The content of a representation is a whole that is clarified by the interpretation of its meaning components. The content of individual experience is a whole that can be interpreted from the structure of activities of the individual in various situations.

Content units acquire value only as parts of a structure, i.e., in mutual relations forming wholes composed of parts. The framework from which the rules for the arrangement of structures are interpreted is referred to as the *context*. Content cannot be derived in any other way than from the relevant framework – from context, but context without content could not exist. For example, the content of an uttered sentence cannot be interpreted outside the context of language, but language could not exist without the content of its utterances. Content and context are two sides of the same coin (Bohm, 2006).

The term context refers to the framework of content interpretation, but in itself, during the analysis of particular situations, it does not allow for a more consistent distinction between intersubjectively shared knowledge of the interpretation framework (knowledge of mathematics, knowledge of a certain language) and immediate subjective experience with the object of interpretation

(immediate experience with counting, speaking). In order to overcome this difficulty, Eco (1990, p. 215) proposed distinguishing three main terms that represent interpretive aspects for the interpretation of present situations: *context*, *co-text*, *circumstances*.

3.4.2   *Circumstances, co-text, context*

In Eco's approach (1990, p. 215), *circumstances* is a superordinate concept which includes context and co-text. Circumstances are thus a sum of ideal and factual determinants, which together condition the interpretation at a given moment.

According to Eco (1990), *co-text* is the actual setting of the interpreted expression (phenomenon) during interpretation. The co-text of a written word is a sentence or a paragraph in which it is contained; the co-text of a sung note are other notes of the same melody; the co-text of a certain action is the state of the situation in which the action is currently taking place, etc. It follows from this that the co-text can be directly observed in the situation of interpretation with the possibility to influence the co-text by some real intervention. This is very important in any creative activity and of course in solving tasks where it is often necessary to fix something in an attempt to improve it. The correction intervenes in a certain place in the co-text, which always (together with the context) co-decides what is to be changed and how.

Context was characterized above as the basic interpretive framework from which regularities of the structure of content units are derived. Thus, the knowledge of co-text would be of no value for interpretation without the knowledge of context. For example, an observer who sees all the characters of a sentence written in Japanese perceives the visual aspect of their co-text and could copy them. However, this is undoubtedly not enough to interpret or possibly correct a word in the co-text of this sentence without the knowledge of the relevant context – the Japanese language.

3.5   From the content of actions to the content of experience and back: The intentional state

If potential content in the world is to be recognized, interpreted and managed, transformations must take place between the content of action and the content of experience. This means that the current state of experience must be connected to the action (perceptual, conative, linguistic) through operational isomorphism. The current state of experience, characterized by a certain content and isomorphic to the respective action, is called *intentional state* (Jacob, 2019; Searle, 2004, pp. 117–122).

The philosophical construct of the *intentional state* is fundamentally beneficial for the theory of content transformation in education. Supported by the term "content", it allows the formulation and investigation of the problems

of Dewey's *logical-psychological distinction* because it explains the operational isomorphism between the subject's experience or action and semantic-logical structures that are intersubjectively shared in culture.

The intentional state must be "about something" (*aboutness*), which means that it is (relatively) distinguishable ($A \neq B$) from everything else, interchangeable ($A = B$, $A \approx B$) with everything identical and comparable with everything similar according to a certain classification rule (A and B are colours). For example, "I see the red ball, not the orange one". is clearly in intentional state, the content of experience proves to be something definite ("a unit" of content) that the subject thinks of, imagines and can talk about or that the subject can otherwise express and communicate about with other people.

An intentional state is characterized by a dual epistemic nature: the distinction between the content of experience and the way it is grasped or managed – a *psychic modality* (Brentano, 1874/1973, pp. 88–89; Husserl, 2013, pp. 89–105; Searle, 2004, pp. 117, 120). In education, an example of the duality of an intentional state is famous Bloom's taxonomy of educational goals, divided into two dimensions: the *knowledge dimension* and the *cognitive process dimension* (Anderson & Krathwohl, 2001).[6]

The difference between content and psychic modality can be captured by description. For example, grasping or handling the same content of "rain – it is raining" can have countless different descriptions: I know it's raining; I imagine it's raining; I'm learning about rain; I love rain; I protect myself from the rain; I'm talking about rain, etc. The universality of the applicability of language means that description can express both what has been described above as content and what is a way of grasping it or coping with it referred to as psychic modality – psychic modality can also become a (meta-cognitive) content of thinking or conceptualized action (cf. Chrz et al., 2015, p. 29).

It is clear from the descriptions that content becomes the subject of psychic and factual operations through their psychic modality: it is updated by the subject through action. Action can be described in speech by active verbs, commonly used in didactics and among teachers.

3.6   Intentionality: Content in relation to the goal of action

It follows from the dual nature of an intentional state and from the universality of its descriptions that content is incorporated into the experience of subjects during their acting as a potential for their future actions. In this form, it can be considered the dispositional goal of learning. The relationship of content to the goal of action and learning is explained by the construct of *intentionality*.

Intentionality is a universal prerequisite for all goal-oriented operations.[7] It is the basic philosophical explanation for the fact that we attribute content to human consciousness, thought or behaviour (Searle, 2004, p. 117). The notion of *content* presupposes an isomorphism between a certain moment of the external environment, internal intentional state and targeted action.

This can be illustrated schematically with the support of Bloomfield's modified (1955, p. 233) paraphrasing of Watson's classical behavioural formula *stimulus (S) – reaction (R)*. The character C in the diagram means content, square brackets symbolize the internal dispositional environment (personal experience):

$$S/C \rightarrow [C] \rightarrow R/C...GOAL$$

Searle (2004, p. 132) offers a fitting illustration of the above scheme on the example of the intentional state of thirst: "What makes my desire a desire to drink water is that it will be satisfied if and only if I drink water". The quoted sentence is formulated carefully in the way the pronoun "it" refers to the stimulus (water), to the targeted reaction of drinking (of water) and to the internal need (of water). The agreement in the reference to the stimulus, the targeted reaction and the need can therefore be understood as an isomorphism: the same content.

The concretization of intentional behaviour for a certain content and goal is given by the *conditions of satisfaction* (Searle, 2004, pp. 119, 132–134). The conditions of satisfaction determine what the behaviour concerns and what it is aimed at, i.e., its content in relation to the goal: satisfying thirst has different conditions of satisfaction than, for example, determining the pH of water.

At the basal level of instincts, as with the aforementioned satisfying of thirst, the conditions of satisfaction do not depend on socio-cultural learning. Therefore, genetic equipment is sufficient to manage appropriate patterns of behaviour. However, human culture, through the dual mediation of content, significantly expands and enriches the range of possible needs and conditions of satisfaction.

The dual mediation of content depends on the fact that content in experience can be made external and intersubjectively shared by interiorizing linguistic or other symbolic expressions of content. According to Bloomfield (1955, p. 233), "language bridges the gap between the individual nervous systems" because expressions mediate content and can cause an equivalent response as the stimulus they symbolize. Bloomfield's modified scheme has the following form (E here represents the expression of a certain content that can be interpreted from the expression):

$$S/C \rightarrow [C] \rightarrow R/C...GOAL$$
$$\downarrow$$
$$E/C$$

In human culture, content mediation is far from being limited to language tools. Therefore, in accordance with Vygotsky's construct of dual mediation, the notion of E/C is understood more broadly: as a culturally conditioned operational synthesis of the expression of experience with the

perceived phenomenon. During this synthesis, a phenomenon is comprehensively grasped through operations that are intellectual as well as sensory and physical.

3.7   Instrumentation of experience in culture and its disciplines

In this sense, E/C is a sensory graspable "something" that can be interpreted and conceptualized as a certain content – information conditioning decision-making and intentional action aimed at a certain goal, i.e., at meeting certain conditions of satisfaction.

For example, a spoon is information that intersubjectively mediates people's historical experiences of scooping food represented by the linguistic term "spoon" (Vygotsky, 1981, 1994).[8] Using a spoon and a great number of other cultural artefacts during social interactions generates and develops human psychic processes and functions and plays a decisive role in shaping a person's mind and personality.

The philosophical or theoretical basis for such a broad generalization of experience manifestations is provided by *instrumentalist approaches* that posit that the interactive relationship between people and the world, as well as human cooperation and its conceptualization, depend on instruments (cf. Jacob, 2019). E/C can thus be generally termed an *instrument*.

Instruments are cultural means developed on the basis of intentionality, which accumulate and fix the content of experience and ensure the fulfilment of the conditions of satisfaction. Kvasz (2015) considers *protein instruments* to be the primary type of instruments – human body organs, perceptual and executive. Based on cooperation between people, they produce all other instruments connected with the linguistic conceptualization of their content as a condition of socio-cultural learning and a condition of the historical development of instruments.

All instruments used by people have both a physical and an ideological aspect.[9] It is usually useful to distinguish material instruments (the axe, the motor), used for physical operations, from symbolic ones (words, mathematical characters, musical notations), used for communication. However, no human instrument is just a thing without a conceptualization context, and for most instruments, their use directly depends on symbolic conceptualization – otherwise, they are not functional (thermometer, clock, computer, GPS).[10]

The instrument makes a certain content of experience external and enables its sharing by being tied to conceptualization. Thanks to this, instruments objectify, fix, intersubjectively transmit, and maintain the content of experience because they allow its conscious presentation, clear expression, repeated return, and enrichment through intersubjective communication and cooperation.

An illustrative example of an instrument is a thermometer (as noted by Vygotsky, 1999, p. 164). The data obtained by a thermometer are the result of a long cultural process of creating this physical instrument. At its beginning, there is the immediate experience of distinguishing alternative properties: a heated room provides a different experience than freezing wind. This experience is specified and can be shared in language communication through a range of references: cold, warmer, the warmest. The discovery and creation of the thermometer as a cultural instrument then follows from the gradual emergence of a *discipline* – a cultural framework for systematic observation, interpretation, and exploration of physical phenomena.

3.7.1   *Instrumentation of experience*

The mentioned example is an illustration of the fact that instruments connected to conceptualization are an expression of the content of a special cultural experience called by Kvasz (2015, 2022) *instrumental experience*. The universal basis of instrumental experience is human language as the starting point of all conceptualization. Through the relationship of language to intentional action and cooperation between people, a spectrum of other instruments is gradually developing, along with their conceptual context. For example, a pair of compasses and a drawing of a circle are instruments that represent and shape a geometric experience, a mechanical abacus or calculator are instruments of arithmetic experience, and a map or GPS are instruments of geographical experience.

Instrumental experience is developed through instruments, but they themselves shape and deepen it in the relevant context. The instrumental nature of experience is a necessary condition for the systematic acquisition and development of cognition on the basis of shared intentional action (practical and linguistic) in the instrumental practice of specialized cultural disciplines. Thanks to the instrumental practice of disciplines, people are able to significantly exceed the limits of their natural experience and get to know the world in depth (Kvasz, 2015, p. 43; 2022).

The process by which the content of instrumental experience shared in cultural disciplines is integrated into the subjective experience of individual people is *the instrumentation of experience*. Instrumentation of experience is the transformation and enrichment of experience with new content through social learning in instrumental practice.

A specialized manifestation of socially conditioned instrumentation is *teaching and learning* of the relevant cultural discipline or cultural field in science, technology, or art. An indication of this educational specialization is the preparation and implementation of special situations focused on the instrumentation of experience: learning tasks. In solving them, students' experience transforms through active content of culture (Fisherman, 2012), as we elaborate further in the following chapter.

Notes

1 The principle of "the same differently" – the key principle of content transformation – follows from the relations of objects to their features and becomes evident through the fact that different content representations may mean the same object but may differ in the way they characterize it. This is connected to the difference in the pieces of knowledge they mediate. For example, the object of Venus may be represented by terms "evening star" or "morning star" which reflect different experience with the object. This topic, tackled as early as in the antiquity, was stressed by G. Frege (1892) through differentiating meaning (*Bedeutung*) from sense (*Sinn*). It is reflected in differentiating extensions from intensions and is still addressed by many authors from different points of view (cf. Tichý, 1988; Peregrin, 2007). We consider it one of the fundamental topics for teaching and learning theories.

2 "Reciprocity of perspectives" is a term proposed by A. Schütz in the text *Common-Sense and Scientific Interpretation of Human Action* for expressing the fact that key prerequisite for the existence of a shared world is the possibility of mutual intersubjective sharing of subjective experiences from life in the world (1953, p. 7): "this world is not my private world, but an intersubjective world and therefore my knowledge of it is not my private matter but it is intersubjective from the beginning".

3 To place oneself in the position of somebody else so that I can reproduce their actions by my own actions, follow them or meaningfully define my own alternative position against them. In psychology, it is referred to as *mentalization*.

4 Two-way grey arrow conceptually connects the physical existence of an object (C1) with its symbolic representation by uttering, writing or displaying (C2). Intersubjective content sharing (C2) is represented by the intersection of the classification classes representing the subjective aspect (C3). It corresponds to the classical definition of the content of a term based on its scope. Subjective aspects may differ from each other in their details, but if the chances of understanding are to be maintained, they must have a common intersection.

5 As Goodman states (1988, p. 14) in relation to this: "Our capacity for overlooking is virtually unlimited, and what we do take in usually consists of significant fragments and clues that need massive supplementation".

6 It can be deduced from the difference in the descriptions of content and psychic modality that what we call content is a relatively constant "timeless" invariant moment included in the ongoing "timed" process of its treatment, which can only be artificially divided into a sequence of intentional states like a film into individual frames. The same content can be managed better or worse in the respective psychic modality, i.e., it is possible to learn how to handle the content as best as possible (factually, in experience, in communication).

7 Philosophy or theory of intentionality has its origin in the scholastic (Thomas Aquinas) conception of mental grasp of an object: the intentional state includes a certain content-object in various ways, e.g., something is confirmed or denied in judgement, something is remembered in memory, someone is loved in love, etc. In modern philosophy, the construct of intentionality was revived in the 1970s by F. Brentano and produces a number of fruitful questions. These include, for example, questions about the representation of content in relation to the target orientation towards the object: Do "link to content" and "focus on object" express two different ideas? Or are they two different ways of expressing the same idea? (Jacob, 2019).

8 We understand the expression interactively as the unification of the perceived phenomenon with the manifestation of experience in it. Expressions fulfil their informational role only in connections to mutual reference, i.e., in the relevant context.

Content thus becomes consciously available in phenomena that give it an *aspectual shape,* which is visual, auditory, haptic, gustatory, etc. (cf. Searle, 2004, p. 172; Slavík et al., 2013, p. 135). The aspectual shape is a marked shape if it meets the conditions for distinguishability, interchangeability and comparability with regard to a certain functionality. In the marked shape, the observer in a certain context reveals the content identity of the observed phenomenon (what it is) or its practical function (what can be done with it) and can subject it to subsequent verification by interpretation, action or experience.

9 Instruments are formed and used on an imaginary seam between *causal physical relationships* and s*emantic-logical mental operations*, through which cooperation and communication between people is organized. For example, a column of mercury in a thermometer represents causal physical relationships through its movement but acquires cultural significance only when it is interpreted semantically and when in thinking and communication it is logically connected with people's relevant knowledge of temperature and experiencing the changes between comfort zone and extreme states (cf. Štech, 2013, pp. 42–43).

10 Instruments that serve to indicate the states of reality (clock, thermometer, litmus paper, spectrometer, GPS) and the use of which depends on symbolic conceptualization, are included under the term *conceptual reporters* (Kolman, 2011, p. 431). A conceptual reporter is a tool embedded in the space of inferences, which with its indication states supports giving and requesting reasons. For example, two people may differ in whether they feel warm or cold in a particular room, but at the same time, they may confront this difference with the state of a thermometer – a generally accepted regular temperature indicator. In the concurrence of these two aspects, there is the opportunity to substantiate one's beliefs and to communicate differences in understanding or attitudes toward a particular content.

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