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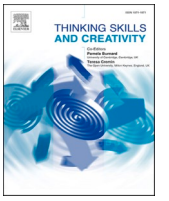

Mapping teachers' personal epistemologies – Phenomenographical approach

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ABSTRACT

Although a considerable amount of research proved a causal relation between teachers' conceptions of knowledge and the quality of their educational practice, personal epistemology still remains an under-investigated area in teacher professional development, both at the pre-service and in-service stage of career. The article presents the phenomenographic approach to investigating teachers' epistemological beliefs. Phenomenography offers unique tools to grasp the subjective dimension of human experience, especially valuable in trying to understand how teachers perceive and conceptualize their epistemological experiences grounded in everyday educational practice. The aim of the study was to reconstruct teachers' conceptions of mind and knowing. The following research questions were formulated: How do in-service teachers understand their own mind and knowledge? What conceptions of mind do they use to explain their process of acquiring new knowledge? How are these conceptions of mind, knowledge and knowing interrelated? Several conceptions of mind were elicited and described following the rules of phenomenographic analysis. In conclusions, the consequences of neglecting personal epistemology in teachers' education and professional development were discussed, furthermore methodological implications for future research were outlined.

1. Introduction

Human beliefs concerning the definition of knowledge, what it is and how it works in the mind of man, influence our behavior and choices in many everyday situations connected with learning, making decisions or resolving moral dilemmas. However, in the work of a teacher, this area of beliefs plays a special role – depending on how a teacher understands knowledge and cognition, their actions will be closer to the philosophy of indisputable, objective, reliable and factual knowledge transfer, or they will rather assume the form of seeking and constructing meanings in co-operation with students, a clash of arguments and views, negotiating common ways of understanding the world in which knowledge is perceived as subjective, non-obvious, and susceptible to change. The epistemology which a teacher uses in their work not only shapes their daily didactic choices, it will also be mastered and accepted by their students. Hence, the key in educational research is not the question about the epistemology with which future teachers begin pedagogical studies, but rather how pedagogical studies can help them to realize their beliefs in this respect. The purpose of the paper is an attempt to find the answer to this question. The theoretical parts of the text present various ways of defining personal epistemology and explaine the beliefs approach to the concept. The empirical parts contain the results of the phenomenographic research on how teachers understand the mind and cognition. The final sections of the article present the conclusions of the research and practical implications which allow perceiving personal epistemology as an important, though hardly measurable, area of learning outcomes in pedagogical studies.

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2. Personal epistemology - the nature and structure of the concept

Kitchener (after: Briell, Elen, Verschaffen, & Clarebout, 2011: 7) defines epistemology as "a theory of knowledge, reflecting its epistemological origins in the Greek words "episteme" (knowledge) and "logos" (theory)". Therefore, personal epistemology should be seen as an individual theory of knowledge, a set of a layperson's beliefs concerning knowledge/ knowing, often activated more or less consciously during the learning process. Regrettably, although the construct of personal epistemology has been the research area of psychology and pedagogy since 1970s, it is still perceived as an umbrella term - broad and complex, multidimensional but with blurred borders, often employed by researchers to tackle essentially different phenomena.

The main controversies arise over the very essence of the issue, i.e. the answer to the question what form and internal structure personal epistemology takes - is it a coherent and ordered system of beliefs activated in a problem situation, or maybe the processes of reasoning / reflection and their underlying grounds, assumptions / pre-conceptions, or even more primitive, not fully realized forms of understanding? Is it knowledge organized and ordered like a theory, or does it rather take a form similar to common knowledge, naive, unstable, often contradictory, susceptible to changes under the influence of current experiences (lay theories)? Is personal epistemology relatively stable, trait-like or is it somehow situated in educational, domain-specific, contexts? To what extent is personal epistemology meta-cognitive, do all or only some of its dimensions function at the meta level- which ones, when, in what situation? The lack of agreement among the researchers concerning the nature and structure of personal epistemology entails not only differences in the used research methodology, but also a kind of terminological chaos. As indicated by Briell et al. (2011): 8-11), their meta-analysis of 617 publications allowed them to distinguish over 39 different terms used to describe human beliefs regarding knowledge, including, inter alia, epistemic assumptions (King & Kitchener, 2004), epistemic cognition (King & Kitchener, 2002), epistemological meta-knowing/(Kuhn, 2000), epistemological beliefs (Schommer-Aikins, 2002), epistemic metacognition (Hofer, 2004), epistemic thinking (Barzilai & Zohar, 2014; Kuhn & Weinstock, 2002), epistemic climate (Feucht, 2010), epistemic resources (Elby & Hammer, 2010) etc. Each of these constructs assumes a multidimensional, complex nature of human epistemological beliefs, but at the same time, their authors, by operationalizing the concepts they propose, describe the structure of this area of beliefs in different ways and highlight other important elements. As summarized by Hofer and Pintrich "There are discrepancies in naming the construct as well as in defining it, to the extent that it is sometimes unclear whether the researchers are discussing the same intellectual territory" (1997: 111).

The attempts to organize this chaos have led to the identification of three research currents / methodological paradigms which define the essence and scope of the concept in a different way: a/ the developmental paradigm b/ the beliefs approach and c/ the resources approach. All of them are extensively described in literature (see: Kuhn, 2000; King & Kitchener, 2004; Baxter Magolda, 2002; Hofer & Bendixen, 2012; Urman & Roth, 2010; Kuhn & Weinstock, 2002 for an overview). In this article only the beliefs approach will be explained more thoroughly providing a background for the presented research.

3. Personal epistemology as a set of beliefs

Contrary to the developmental approach, researchers associated with this trend argue that in the case of such a delicate and difficult to measure area of beliefs one cannot speak of internal consistency. Although Perry was the precursor to this paradigm, Schommer's research from 1990 is considered groundbreaking. She described personal epistemology as a system of beliefs which are explicitly multidimensional and function more or less independently of one another. Schommer hypothesized that the system included beliefs about: "(a) stability of knowledge, ranging from tentative to unchanging; (b) structure of knowledge, ranging from isolated pieces to integrated concepts; (c) sources of knowledge, ranging from those handed down by authority to gleaned from observation and reason; (d) speed of knowledge acquisition, ranging from quick all-or-none learning to gradual learning; (e) control of knowledge acquisition, ranging from that fixed at birth to life-long improvement" (Schommer-Aikins, 2002: 104-105). The very definition of epistemological beliefs is not established in literature and remains controversial among researchers who interpret them in different ways (see: Hofer & Pintrich, 1997). Beliefs are often conceived as a form of personal, naive and emotionally charged knowledge, grounded in everyday experience, reflecting assumptions, expectations, values and attitudes which may affect epistemological reasoning in a particular context. In other words, beliefs overlap with knowledge, in the sense that they are possessed by an individual while being affectively charged, not always conscious or consistent (or even not available for verbalizing), having a limited access to logic, and resistant to change (Barzilai & Zohar, 2014). Research results prove that epistemological beliefs may have both, direct and indirect effects on learning, the choice of strategies, the monitoring abilities, the achieved results, etc. "By indirect effect it is meant that epistemological beliefs mediate learning. For example, a strong belief in isolated knowledge could set the standard for what it means to learn, in this case, learning would mean being able to recall a list of facts. This standard in turn leads the learner to select memorizing as a sole study strategy. This single, limited study strategy would result in an impoverished mental representation of the content. Ultimately this leads to inert knowledge" (Schommer-Aikins, 2002: 106). A direct effect means that beliefs about knowledge may serve as a filter in interpreting a particular piece of knowledge (e.g. as definite or questionable, sensitive to different interpretations). Although there is no clear description of developmental stages, studies usually posit that beliefs tend to change from naive, limited, simplistic, and thus less adaptive understanding of nature of knowledge, to more flexible, sophisticated and differentiated forms. However, as Schommer-Aikins explains (2002), beliefs constituting different elements of the system/ distinct dimensions of personal epistemology, may or may not develop in synchrony.

4. Epistemological beliefs development - in search of explanation

The problem of beliefs development still awaits a justified explanation. Recently several attempts have been made to create a unified model of personal epistemology which would integrate the most important factors discovered by previous research. In this approach personal epistemology can be perceived as "an identifiable set of beliefs about knowledge and knowing, organized as theories, progressing in reasonably predictable directions, activated in context, and operating both cognitively and meta-cognitively" (Hofer & Bendixen, 2012: 231). The need for such a model was driven mainly by the attempts to explain the mechanism underlying the developmental changes in personal epistemology of an individual as opposed to the description of stages / levels of development. The core question here is not "What is developing?", but rather "Why?" – "What drives changes in epistemological development of a person?"

One of such integrative approaches, worth mentioning here as particularly important for teachers' professional development, was offered by Bendixen and Rule (2004). Grounded in Piagetian notion of equilibrium in cognitive development, this model proposes that mechanism of change in personal epistemology consists of three interrelated components: (a) epistemic doubt (defined as weighing evidence and discerning the truthfulness of some beliefs), (b) epistemic volition (motivation to take responsibility for one's own development), and (c) resolution strategy (reflecting on beliefs, analyzing beliefs implications, discussions with others, making informed choices etc.) (Bendixen & Rule, 2004: 71-72). The model defines personal epistemology as a system of beliefs comprised of four underlying dimensions as described by Hofer (2004): certainty of knowledge, simplicity of knowledge, justification for knowing, and a source of knowledge. These four dimensions are assumed to evolve in a linear, stage-like and hierarchical planes at the same time - the authors explain the mechanism of change using the metaphor of rosebush growth (Bendixen & Rule, 2004: 73). Each of the branches of a rosebush develops in its rate, not necessarily at the same time, but following the general path of development. As much as pruning is essential for long-term growth and shape of a rosebush, regression and recursive thinking are necessary elements in long-term epistemological development. Two crucial conditions for epistemological change have been indicated in this model: dissonance and personal relevance, both affectively charged, driven by several emotional factors, like: emotional involvement, motivation and interest in the topic, self-efficacy related to epistemological change, resistance to external constraints, etc. In other words, the process of changes is emotionally "hot", although these affective influences are not clear, and might facilitate or constrain development. On the other hand, the model integrates the social environment as an important factor in epistemological development - not only in terms of social interactions necessary to reflect on one's epistemic doubts, discuss argumentations, or make informed choices, but also in terms of "reciprocal causation", created by the feedback loop. As the authors stated: "it is not only an individual's personal epistemology that influences his or her environment but also the personal epistemologies of the others with whom this individual comes into contact. Therefore, if an external factor causes the personal epistemologies of some individuals to rise, this will improve the environment of the others and make their personal epistemologies rise as well" (Bendixen & Rule, 2004: 76). The presented model touches the problem often observed in teachers' professional life - the line of personal epistemology development may sometimes have a progressive or regressive nature, both being natural, immanent parts of the process of growing into the teacher's profession.

5. The study

5.1. Design and methodology

The study presented here was designed as a research project summarizing the post-diploma degree for in-service teachers at Maria Curie-Sklodowska University in Lublin. 40 teachers took part in the study, all of them were fully qualified, holding an MA degree in pedagogy (with different minors, such as: general pedagogy, special education, social work, cultural management, early childhood education and care). Among them 23 participants were completing a postgraduate degree in Montessori education, and another 27 chose a course in ECEC. The aim was to reconstruct the concepts of mind and knowledge rooted in the teachers' everyday educational experience. The following research questions were formulated: How do in-service teachers understand their own mind and knowledge? What conception of mind and knowledge do they use to explain their own process of learning? To what extent are they aware of their own commonsense presumptions?

5.2. Collecting data

The phenomenographic interview was used as a main method to collect and analyze empirical data. The teachers were asked to draw their mind and explain how it works. A metaphor of a machine was offered as an inspiration for projective drawing. The following instructions were provided to evoke the epistemological reflection in participants: "Close your eyes and imagine that your mind is like an unusual machine. How does it work when you are learning something? What is going on inside? Try to draw this mind-machine, the machine which works as your mind. Explain how it looks. What elements does it consist of? What does it do when you are learning something new?" After drawing the mind the students were asked to complete the following sentences: (a) My mind is like a machine which (please describe how it is built and how it works); (b) When my mind is learning something new (What does it do? How does it work? What is going on inside?), (c) When I deal with a very difficult problem my mind (What does it do? How does it work? What is going on inside it?)

Metaphor appears in pedagogical research as a tool for revealing and describing hidden dimensions of human knowledge - the not fully realized beliefs, expectations, and mental schemes. From a linguistic point of view, metaphor is a juxtaposition of two seemingly

distant concepts - an object and a carrier. This combination results in a kind of interaction (overlapping) of semantic fields of both concepts, leading to a completely new meaning, irreducible to the original meanings of both components or to their sum. It is this shifting of meanings that makes metaphor astonishing, surprising and demanding explanation, "sometimes giving the impression of a syntactically correct structure, but anomalous or even semantically incorrect" (Nęcka, 1998, p. 95). This is also the source of the influence of metaphors on our imagination and their major role as a means of artistic expression. However, as psychologists indicate, metaphor cannot be reduced solely to the sphere of linguistic phenomena. It is an important cognitive tool - a specific way of coding information about the world or a characteristic type of representation of reality. From the point of view of cognitive psychology, a metaphorical statement can have a dual function (Nęcka, 1998: 85-86):

- First, it makes it easier to understand difficult, complex content by simplifying it, while underlining and highlighting some important, though hidden and non-obvious aspects;
- Secondly, it stimulates the creative process, providing unusual associations, expanding the scope of analyzed and processed content.

The former function seems to be particularly important for the research presented here. Thanks to metaphors, it is possible to talk about complex and difficult phenomena using simpler terms and categories belonging to another field which is closer to us or better known from everyday experience. It can be said that metaphor is a specifically human tool for partial understanding or even "taming" of what cannot be understood and explained completely, including abstract phenomena, emotional or aesthetic sensations, moral dilemmas, etc. In this sense, representatives of cognitive linguistics prove that metaphors are deeply rooted in our experience "through organizing and reflecting the way in which we understand the entire classes of phenomena, which is systematically and coherently reflected in language" (Lakoff & Johnson, 1988: 8). A language form here is more or less motivated by our sensual experience, becoming its result and generalization. However, it is never a direct reflection of sensory experiences, it rather results from their development and interpretation. Constructing metaphors is, therefore, a symbolization process which requires a particular mental effort from an individual. At the same time, however, such concentration on the search for unusual but apt associations weakens the logical control of a statement and makes an individual stop restraining their "political correctness", and reveal the elements of their beliefs which otherwise would never be expressed directly. Thus understood metaphorical approach in research is therefore based on the assumption that "the selection of specific words or expressions is not accidental and represents something more than just the surface of phenomena and concepts." (…) It represents "deep structures of a language", thus serving as a kind of link between various levels of human knowledge: the explicit, consciously declared, and the hidden, inaccessible on demand and difficult to verbalize (Inbar, 1996: 78). The consequence of this research perspective is the recognition that metaphors not only reflect the reality experienced by an individual, but also participate in its construction - on the one hand, the images offered by metaphors give a mirror reflection of human beliefs about what the world is (and what it is like), on the other hand, they affect an individual's behavior towards this world, shaping them in accordance with the adopted vision.

5.3. Analysing data

Phenomenography is an empirical study which aims to investigate the qualitatively different ways in which people understand, experience and conceptualize a particular phenomenon or an aspect of the world around them (Marton, 1981). These "different ways of understanding" or conceptions are the basic units of description in phenomenographic research. As Marton explains "a conception can be characterized as composed of both a referential aspect - i.e. a particular meaning of an individual object (anything delimited and perceived as significant by the subjects) - and a structural aspect - i.e. the combination of features discerned and focused upon the subject. These two aspects, though different, are intertwined in nature" (Marton & Pong, 2005: 366). Following Marton's instructions, a two-stage analysis, based on inductive approach, was applied to empirical data (Marton & Pong, 2005: 337): (a) the first stage was focused on identifying and describing teachers' conceptions of mind and knowledge in terms of their overall meaning. This was done by identifying and marking themes in transcripts of the interviews (searching for "what" was expressed); and (b) the second stage focused on identifying the structural aspects of each conception expressed by the subjects (searching for "how" it was expressed). The analysis was guided by a holistic approach - both, the verbal explanations (interviews) and graphic expression (drawings) were considered as an integral whole - the drawing co-creates and complements verbal expression, constituting its important part. This kind of approach was possible due to the fact that "phenomenographs do not demarcate the line between pre-reflective cognition and conceptual thinking (…) The structure and meaning of an experienced phenomenon can be found by the researcher both in the former and the latter element. What matters is not what the world is like, but what kind of world appears to us in direct experience" (Jurgiel, 2009: 99). The drawing was therefore intended to provide substitute, inter-semiotic tools to describe the parts of the experiences which have a pre-conceptual form, for which the respondents have not yet found sufficiently precise words. The graphic symbols and the accompanying verbal explanations were therefore recognized as complementary to each other.

One of the key requirements, and also the most difficult ones to meet, for the correctness of the phenomenographic approach is the postulate of the methodological reduction - "epoche", understood as the need to suspend the researcher's beliefs arising from knowledge of theory and literature, and which may have an overt or covert impact on the results of the conducted analyses (Męczkowska, 2003). Therefore, the study reconstructing different ways of experiencing the world must be subjected to a relatively rigorous procedure, ensuring an appropriate level of its accuracy and credibility. The credibility of findings was assured by a peer-debriefing process (Denzin & Lincoln, 2000). Another researcher was involved in the cross-checking process of 20% of 40 interviews to establish inter-rater reliability. His responsibility was to search for categories of description and quotes exemplifying each category. Then the

categories elicited by the two researchers were compared and discussed to reach common understanding. As a result, a map of different conceptions of mind/ knowledge was created with special attention to the variation in the ways teachers experience and apprehend their own minds. While searching for differentiation in teachers' conceptions several important features were elicited, such as presented in Table 1. Finally, the distinguished concepts of mind have been organized, beginning from the simplest, least advanced in development, and ending with more complex, sublime, advanced from a developmental point of view.

6. Findings

Mind as a mystery. Mind experienced as a secret was considered the least developmentally advanced - which should be described as "no conception". Here are examples of such statements:

"06" *"My mind is like a machine that looks like a spinning top. When it comes up with a new idea or comes across a problem to solve, it begins to spin and spin so quickly that all the patterns begin to merge into one. After solving the problem, it stops, rests and waits for the next stimulus to re-activate it"* (Fig. 1).

"06" *"My mind looks like a blue cube with a built-in memory of unexplored capacity and structure. The device is also equipped with a number of analyzers that transmit the collected information to memory, then to a printer that prints the necessary information from the database".*

The most important characteristics of "mind as a mystery" model are:

(a) A strong feeling of internal energy often expressed in terms of movement or by analogy with fire ("the mind works faster and faster"; "it emits a lot of energy until it boils, sparks and smokes"; "it gains more and more speed until it starts to rotate from information overload"; "it is spinning, purring, turning"; "my mind is burning, buzzing, exploding"; "it spins, whizzes, screams, sometimes pounds, but wants to solve the problem at all costs";

(b) The lack of control over one's own thinking, described by the respondents as "overheating" or "exploding" of the mind, which results in a feeling of extreme fatigue, exhaustion of the body, as well as awareness of the inefficiency of their own efforts (the mind starts to struggle; gets „stuck", „jammed", "suspended"). As a result, the respondents are not only unable to name any mental process, they also seem to have no conception of knowledge, no ability to undertake any conscious effort to make their own learning successful.

Mind as a storage for information/ data. The second conception can be conventionally called "mind as a data and information store". Its main distinguishing feature here is limiting the function of the mind to the processes of remembering information and then retrieving it from memory when needed. It is the mind that segregates, organizes and locates information in memory structures, simultaneously trying to maintain proper order - information cannot be entangled, it should be divided into fragments and coded, or put in the right place (drawer, compartment) so that it should be found quickly and effectively, e.g:

"07" *"My mind looks like a colorful chessboard. It consists of colorful drawers. Each of them stores organized information. The colors of the drawers symbolize a collection of information and messages. When I learn something new, my mind filters messages and puts them into appropriate drawers. When I solve a particularly difficult problem, my mind tries to connect the encountered difficulty with the knowledge stored in my memory"* (Fig. 2*);*

"07" *"When I learn something new, my mind puts bits of new information on empty shelves, they rest there and wait until they are called. Everything is described in detail, each piece of information is in an appropriate column".*

In this vision knowledge has an external, fragmentary and non-coherent character, consequently acquiring, understanding and remembering information are perceived as a compulsion - an external stimulus is needed to put the whole process in motion. The subject does not perceive himself/ herself as an author of their own knowledge or learning.

The analysis of teachers' statements allowed to distinguish two fundamentally different variations of the concept of memory storage. The first one is a purely cognitive depository, used for storing objective information (facts, dates, events). Such understanding is associated with an extremely strong feeling of knowledge fragmentation, a lack of its internal consistency. The most important aspect

Table 1
Mapping teachers' conceptions of mind - categories of description.

Structural aspects of conceptions	Features elicited - variations
Mental operations activated by mind in the process of learning (functions of mind)	Domains: cognitive/ emotional/ sensorial/ moral etc. Mental operations named by participants, e.g. memorizing, recalling, understanding, analyzing, drawing conclusions, etc
2. Internal relations between mental processes (the dynamic of cognition)	a/ Lack of internal relations; b/ linear connections, c/ non-linear, multidimensional relations static versus dynamic mind
3. The results of cognition - the conception of knowledge underlying the perception of mind	Knowledge as a set of single, isolated data versus integrated, internally coherent system objective/ subjective source

Fig. 1. Mind as a mistery - example 1 (source: authors' research).

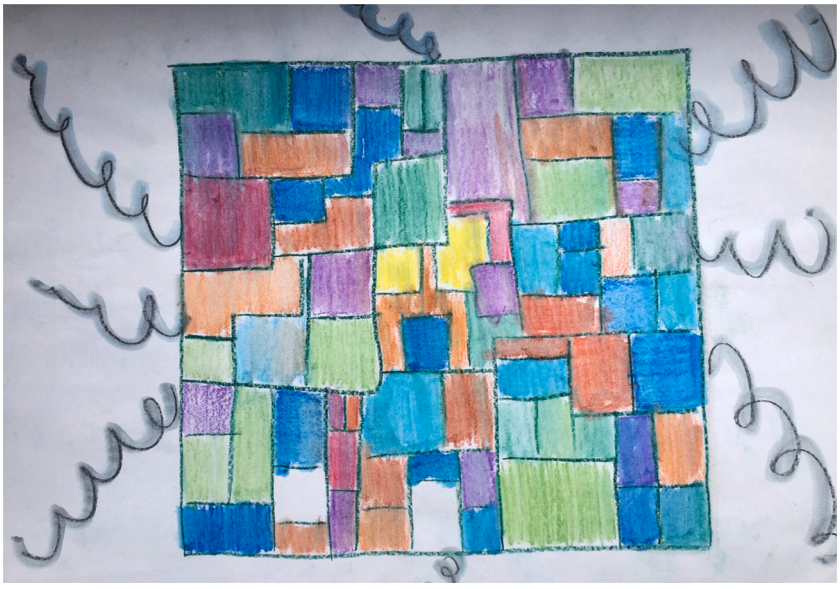

Fig. 2. Mind as a storage for data - Type A „Cognitive storage" (source: authors' research).

in learning/ solving problems is not to mix the data – the "input paths" are carefully closed. Therefore, the acquired knowledge is cut into pieces, with no possibility to form an integrated, holistic mental structure. Mind represented as a "file cabinet" or "file binder" has restricted possibilities.

The other subtype is the mind which stores not only information but also emotions, impressions, dreams and intuitions. Here the mind can both organize, remember data and associate them with one another, it can see simple connections and dependencies, e.g. :

"07" *"My mind is like a machine that contains many centers for storing new messages, skills, feelings, aesthetic impressions, as well as centers for difficult situations and activation. The main part is a separator which segregates valuable messages and junk. All these parts are closely connected. When I learn something new, my mind recognizes and seeks valuable messages placing them in the right center, and the trash is thrown into the bin"* (Fig. 3).

"07" *"When I learn something new, my mind segregates words into a large wardrobe with drawers. They are interconnected with threads - these are dependencies and relationships. Then I have to look into the chosen drawers and pull out one word, and the next, and the next, etc."*

"07" *"When I learn something new, new information is put on an assembly line. The machine moves. It stops at the "memorizing" station, then at the "understanding" station. Finally, the information reaches the center of the mind, where it is already remembered and understood and it is only to become familiar with the other previously acquired bits of information"*.

Therefore, the „mind as a storage" not only has limited possibilities of action, but it is also a conception of a static, passive mind, unable to construct knowledge, control and assess its quality and legitimacy - the mind is perceived here as an organ absorbing the incoming data.

Mind processing data. An important distinguishing feature of this conception is not only the fact that the respondents were able to list and/or describe many more mental operations here, but also the fact that these operations were clearly ordered in a logical sequence modeled on the stages of problem solving, e.g.:

"07" *"When I learn something new, my mind begins to figure out, domesticate new things in small portions, then I begin to segregate them into larger sections, clusters to better understand and remember new messages and skills. When I solve a particularly difficult problem, my mind first thinks for a long time, wonders what to do about it, isolates sub-problems, divides it into small tasks to perform (…). It begins to search for all possible messages, connections between various fields of knowledge, associations in memory, to finally "burst" with the solution";*

"07" *"My mind tries to use all its possibilities, absorb as much information as possible from various fields. It constantly longs for new knowledge, likes to analyze the encountered problems, phenomena, behaviors (…) When I learn something new, my mind tries to associate new and already known objects, phenomena, people. It is unwilling to learn the rules by heart, it constantly tries to transform them into simple hints from the surrounding world (…). When I solve an especially difficult problem, my mind analyzes a lot, looks for different ways, gathers the information it needs, and then chooses the path it considers to be the best way out. Then it collects additional information to have a full picture of the solution to the problem, and finally implements it, carefully controlling whether it is effective*" (Fig. 4).

As one can see, the operation of the processing mind is much richer, but clearly focused on the cognitive aspects of thinking (the mind: *receives, collects information from the world, transmits and processes information, analyzes, arranges, organizes and puts it in order, associates it with previously known things, rejects unnecessary pieces, synthesizes it and makes generalizations, looks for new solutions and selects the most valuable ones*). The processing mind is absorbent, but emotionally cool. Emotions, provided they appear in the respondents' statements, are perceived as an obstacle to learning rather than a stimulus or facilitator. Although an external stimulus is the trigger which sets the entire system in motion, descriptions of learning are accompanied by a much greater sense of control over how processes occur in the mind, e.g.

"07" *"When I learn something new, my mind sometimes rasps, gets jammed, but relentlessly looks for solutions to problems, tries to organize new messages and put them into the already functioning system"*;

"07" *"When I learn something new, my mind analyzes everything once again, rejects the unnecessary information, selects the new information most helpful in remembering, associates it with something that has already been learned, transforms, records associations"*.

This concept is clearly rooted in the understanding of knowledge as an internally coherent system in which new information is not only associated with the already possessed, but also sometimes changes the structure of knowledge, arranging it in a different order, noticing new relationships and dependencies, transforming the internal organization of data - here knowledge is structured and restructured as needed.

Mind as a command center. The last of the distinguished conceptions is the decisive mind. It has four main distinctive characteristics:

"09" First of all, a much more complex, multidimensional structure, particularly clear in the picture, and expressed in spoken statements as the presence of "different centers", e.g. *"My mind is like a machine that doesn't resemble real machines. It is made up of many areas in which experiences and knowledge responsible for our senses, feelings, emotions, functioning of organs, etc. are stored. Each area has its own energy outlet, and they all are interrelated due to the information they send to each other. One area can affect another. It is a very dynamic system, in constant motion and continuous operation";*

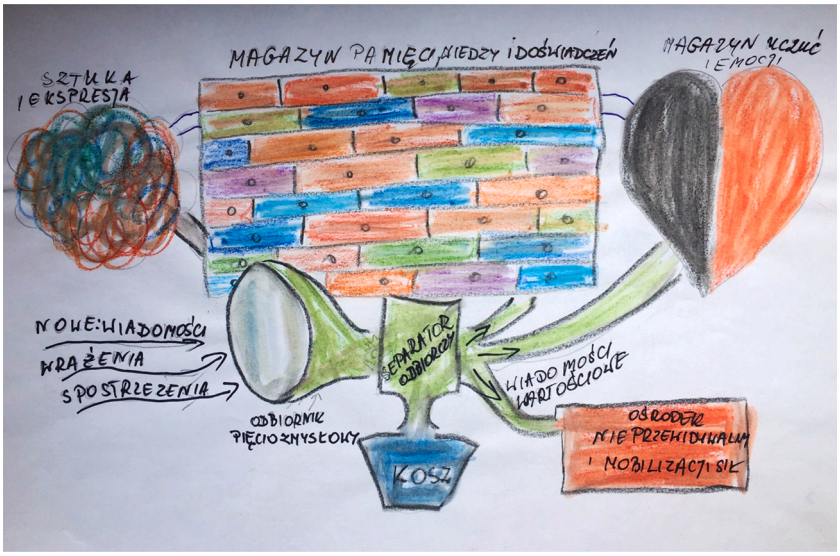

Fig. 3. Mind as a storage - Type B. „Multidimensional storage" (source: authors' research).

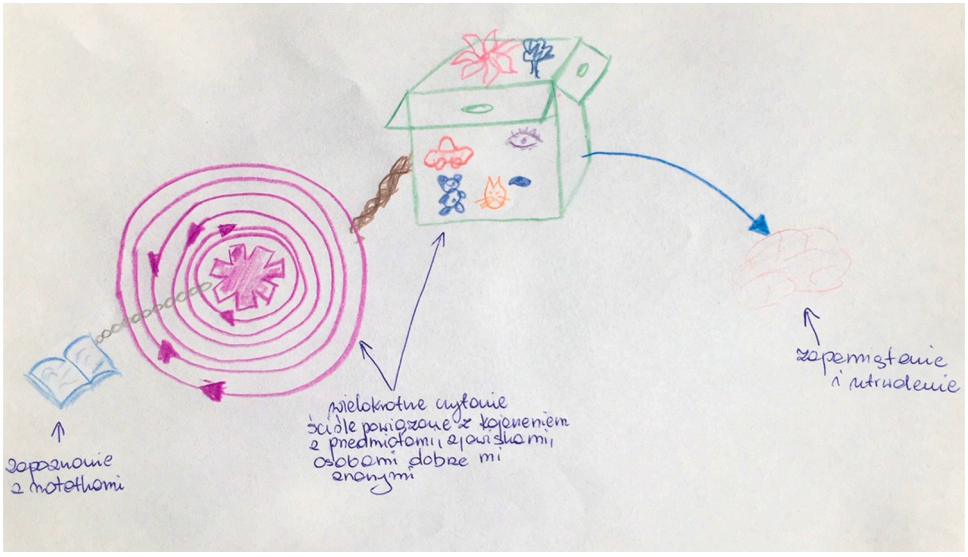

Fig. 4. Processing mind - source: author's research.

"09" An important place in this structure belongs to the non-cognitive dimensions of the human psyche, such as: emotions, intuitions, imagination, expression, and sometimes even the area of the subconscious - hidden memories, repressed into oblivion, too difficult to associate with them on a daily basis (clearly marked on the drawings in the form of graphic symbols, strong colors, and often additionally described in the picture);

"09" A clearly marked "decision-making center" which task is to control and manage the learning process, prevent errors, inaccuracies, overcome barriers in taming knowledge - the mind in this concept commands the process of constructing knowledge, giving it the right structure and useful form. Here is an example of such a statement: *"My mind is like a machine that is used to process and use information. It has its own command center, in which there are drawers–they contain the collected information taken for granted, which is used when needed. It has several "funnel-like inlets" - these are sources of information (sight, hearing, touch, i.e. direct cognition, also reading, experimenting, listening to lectures, surfing the internet, experiencing). The information obtained in this way goes to the command center through pipes, where it is verified after encountering other sources, processed, modified and "digested", adapted for filing. Information is also processed by modes - mental operations such as inference, generalization, prediction, etc. (…) When knowledge is systematized, it gets into a drawer (…). When analyzing a difficult problem, it happens that some information cannot squeeze through very*

narrow channels. Then they return, the command center issues an instruction to "reprocess the material", other sources of knowledge also analyze and "split" the problem into small pieces. Such fragmented information, passing through various thinking modes, takes the right shape, is carried to the command center, and the final decision on how to solve the problem is sent from there" (Fig. 5).

D. The creative character of the mind defined by the interviewed teachers as the ability to develop - is a mind which "grows and develops", changes and transforms under the influence of new experiences. Graphically, it is often expressed in the symbolic form of a plant or a flower, e.g.:

"010"
"My mind consists of three parts. Each part deals with solving different problems (…). Part 1 deals with solving "creative", cognitive and developmental problems. It is like a plant that grows, develops, becomes more beautiful and blooms after every problem is solved. The second part is a maze - a series of winding, intricate roads, of which only one leads to the destination. This part deals with solving the most difficult human problems. The third part is related to everyday, common life. It develops slowly but is the most harmonious part of the mind " (Fig. 6);

"010"
"My mind is like a self-weaving spider's web - since birth it has been establishing new connections between neurons - it constantly develops and enriches its knowledge and abilities".

7. Summary

Before coming to the conclusions it is important to underline a few observations considering the consequences of using metaphorical images as analytic and descriptive tools in the research:

"012"
The signs of great intellectual effort were observed during the research. In many cases the creative process was quite long - some teachers took even 40-45 minutes to prepare their drawings, many of them felt the task was difficult and needed a deep reflection (they made clear comments on that during an interview). In several cases the first drawing was abandoned because the participants in the course of creating a metaphorical image came up with a different, more meaningful/ precise object referent.

"014"
Even though the instruction suggested the „mind-machine" metaphor, many participants created their own analogies (mind as a spider web, a volcano, a plant, or some kind of a living creature etc.)[1] which might be seen as a value of such a methodology: the metaphor appeared to be not only inspiring, but also broad and flexible enough to be filled with personal meanings.

8. Conclusions

The research presented in the article, due to its phenomenographical nature, does not provide grounds to formulate generalizations, however it provides extremely valuable tools for insight into the subjective dimension of the educational reality in which the interviewed teachers function. This makes it possible to formulate a number of methodological and practical conclusions.

Using a metaphorical image as a form of inspiration for an epistemological reflection proved to be an interesting and effective way to expose the underlying assumptions and premises in the teachers' thinking. First of all, it weakened the logical control over the answers, allowing greater freedom of expression. The teachers were not afraid to make a mistake, neither they felt tested for their professional knowledge - the process of creating and explaining the metaphors did not allow to search for the „right" or „politically correct" answer. Instead, the teachers felt free to express their true beliefs – the metaphors revealed therefore the deep, hidden dimension of their knowing described by Polanyi as „tacit" or „personal" (1966; 2005). The English word „tacit" derives from the Latin adjective „tacite" which can be translated as silent, unspoken, latent (Zmyślony, 2012: 67). The main feature of tacit knowledge is therefore its non-discursive nature - it is the knowledge expressed or communicated without words, unavailable for a language, a kind of implicit reasoning – a natural, instinctive, mainly unconscious mental process by which human mind is abstracting certain features from the reality, perceives the logical relations between them, and discovers patterns. This type of knowledge might be described in literature under different names: it is „procedural" knowledge in cognitive psychology (Stemplewska-Żakowicz, 1996), folk knowledge

[1] The example of research allowing participants to create their own mind metaphor was presented in another article by D. Zdybel (2009; 2010). Elementary teachers were asked to complete the sentence: My mind is like… In general, the results revealed many stereotypes in teachers' thinking - metaphors were based on popular analogies coded in language: mind as a wax which can be shaped by environment, mind as a blank piece of paper to be filled with experiences, mind as a plant which needs to be taken care of etc. Some of the participants spontaneously used „mind as a machine" metaphor which inspired the research presented here.

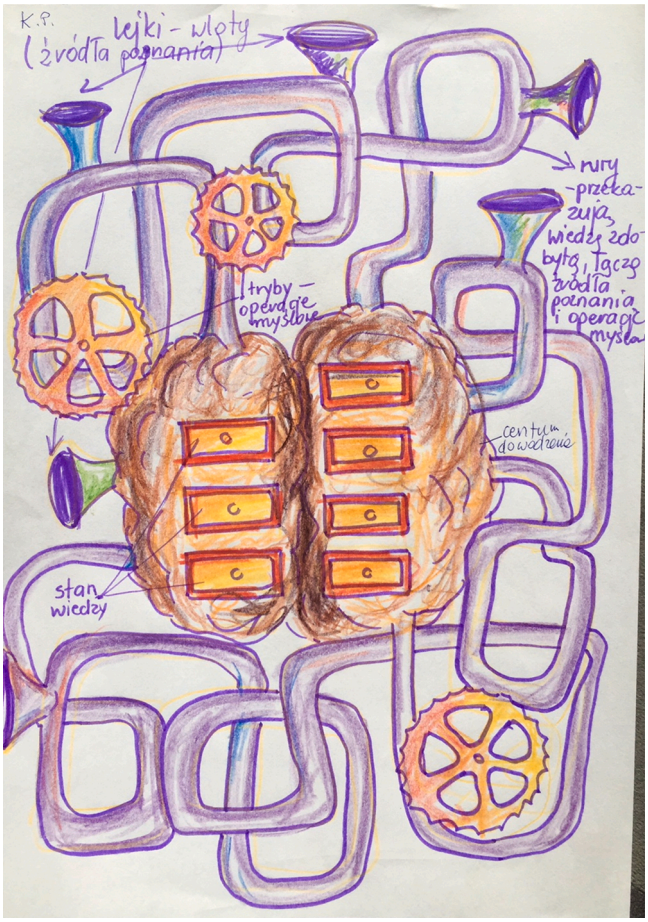

Fig. 5. *The mind as a command center* - constructing and verifying knowledge (source: author's research).

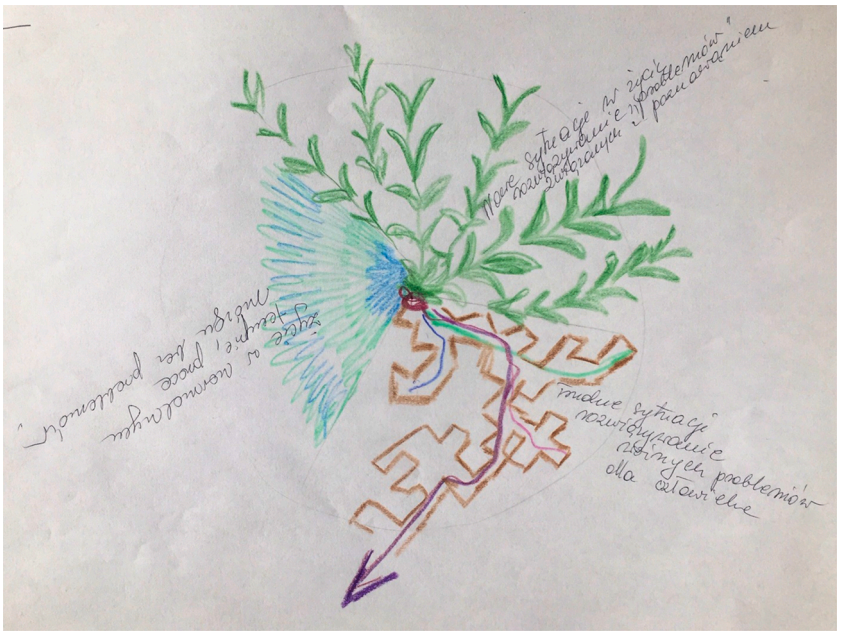

Fig. 6. Mind developing and growing like a plant (source: author's research).

or naive concepts in pedagogy (Bruner, 2006) or practical/ implicit knowledge in sociology (Fruehalf, Kohun, & Skovira, 2014; Klus-Stańska, 2010)[2] . Although these terms are not synonymous, the underlying idea is similar - in Polanyi's own words „we can know more than we can tell" (1966: 4). There is a part of human knowledge described as idiosyncratic and experiential, and as a consequence difficult to verbalize and explain to others. Contrary to a declarative knowledge which is available to the conscious insight, reflection and discussion, tacit knowledge is rooted in unconscious mind and intuitive processing (Zmyślony, 2012: 66). It is a form of practical knowledge, emotionally charged („hot"), built as a result of generalization of everyday educational experiences. It emerges from real life encounters, either as a form of naive concepts (folk knowledge) or as a form of „digested" knowledge, verified in everyday experience, embraced as one's own. The metaphorical image of mind-machine, along with intersemiotic means of expression, served as a link between this tacit knowledge, which is not readily accessible even for the owner, and the explicit knowledge acquired by teachers during their formal education. A figurative language (thinking in images) helped to grasp and communicate the missing piece in knowledge representation (Wiejak, 2003: 87).

Many researchers prove that tacit dimension constitutes an important coefficient of teachers' epistemological beliefs (Bruner, 2006; Olson & Bruner, 1996; Klus-Stańska, 2010) serving as a sort of a map (or GPS) which navigates everyday teachers' behaviours. The idea of a map seems to be particularly meaningful in explaining the role of tacit knowledge in human behaviour (Stemplewska-Żakowicz, 1996: 49-51). When we go to a new city, we use an official city map as a guide: it indicates the way from point A to point B, measures the distances, shows where museums, restaurants, hotels are and even provides a short description of important objects to see. However, if we have lived in the city for some time, we construct the personal map in our mind - it may not necessarily include the names of the streets or buildings, but it will include the details not available in the official guides such as: which coffee place offers the best espresso, where are the road constructions at the moment, which street has the most shaded sidewalks, where to buy groceries at a reasonable price etc. And these are the practical and emotional signposts which navigate our walks and dealings with the city.

In a similar way teachers epistemological beliefs, with their tacit dimension, serve as a practical map for everyday educational choices and decisions - although the map is mainly intuitive, it is automatically activated in a classroom in the forms of a language chosen to guide children's behaviour (Olson & Bruner, 1996: 18-20), in the ways of evaluating children's learning efforts and structuring educational environment (Kuhn & Dean, 2004), choosing methods and strategies (Ritchhart, 2015), even in perceiving the content of the curriculum. As a result, such everyday choices build a certain epistemological climate in the classroom (Feucht, 2010), sometimes described as a culture of thinking versus the culture of transmitting knowledge (Ritchhart, 2015). To what extend the teachers conceptions of their own mind influence the classroom epistemic culture? Neither the research presented here, nor the studies available in literature bring the clear answer to such a question (see: Bendixen, Feucht, 2010; Feucht, Browlee, & Schraw, 2017; Kuhn & Dean, 2004; Klus-Stańska, 2010; Feucht 2010 for extended review). The delicate, highly individualized matter of personal epistemological beliefs along with the method employed here do not allow to make easy generalizations - one has to be particularly cautious when interpreting the metaphorical images. As Inbar rightfully warns us: „metaphors can never convey the full content of their message, nor can they transmit only the content of their intended message. Metaphors rest on the mental process of selection and emphasis. They represent an emphasis of certain selected features of a whole phenomenon" (1996: 78-79). In the presented research this personal, intuitive selection of mind features and activities expressed in the form of a metaphor allowed an insight into the hidden dimension of teachers' epistemological beliefs. However, it would be highly interesting to compare these perceptions with: a/ the actual teachers' conduct in the classroom (classroom epistemic climate), and b/ other measures and indicators of epistemological beliefs. The research presented here is just a beginning of an inspiring field of investigation.

8.1. Methodological implications

In the perception of the respondents, the concepts of knowledge and learning seem to be internally related, remaining in a kind of dynamic interaction. Although these two areas of belief are sometimes separated at the level of theoretical constructs (Pintrich, 2002), making this distinction seems to be methodologically unjustified. The subjective interpretation of what knowledge is, how it is organized in the human mind and what the criteria of its legitimacy or reliability are, consequently entails the idea of how the acquisition process works/ should work. At the same time, it is difficult to state clearly which of these conceptions is genetically primary- understanding the essence and complexity of knowledge or rather understanding learning mechanisms. Both of these belief areas not only coexist in the minds of the subjects, but also interact with each other, remaining in a continuous interplay. Many researchers emphasize that epistemological development is not automatic and is liable to many socio-cultural conditions (Kuhn, 2000), consequently many adults stop at early multiplicistic stages of reasoning, never realizing the full potential of epistemological development. This, however, does not explain why some of the respondents, despite the long, often 5-10 years, of experience in the profession, (still or again?) use the conception of the storage mind perceiving knowledge as a set of accumulated facts. As suggested by Bendixen and Rule (2004) recursive development seems to be the key to understanding the simplistic character of some teacher's conceptions of mind. Everyday educational experiences can drive both progressive and regressive changes. What is more, the same critical event/ experience for a teacher can become a source of critical reflection and transformative changes in their attitudes towards students, while for another one it can be the beginning of doubt, strong anxiety and return to previous, conservative and safe views. Intensive research is needed to understand the role of affective factors in promoting the conceptual change in teachers' epistemological understanding, in addition tearing apart the potentially facilitative and constraining affective influences is particularly important for

[2] Due to the limted space it is not possible to explain the subtle differences between these terms here (see: Zmyślony, 2012; Fruehalf et al., 2014 for an extended review).

future research.

8.2. Instructional implications

A phenomenographic approach to mapping epistemological beliefs makes it possible not only to grasp the subjective, hidden dimension of teachers' ways of knowing, but also allows to appreciate how very subjective personal interpretation of the machinery of the mind formulated by individual participants differs from the official, scientific version of the issues raised. As Marton (1981) emphasizes, this type of diversity is admittedly a natural, inherent aspect of any educational process:

„In the classroom we can probably always find a variation in the way students understand the concepts and principles presented by the teacher or by the author of the textbook. As we argued earlier, at the time the class is moving to a new topic, the concept or principle is understood by some students in a way which is similar to the teacher's or the author's conception and by other students in other ways which differ from it (and from each other)" (1981: 184-185).

And it is not a problem as long as these personal conceptions remain in accordance with the standpoint of modern science. However, some of the teachers' conceptions identified in the research differ significantly from the achievements of modern psychology, and even utterly contradict the theories. In the case of the teachers, such a contradiction may pose a threat not only to the professional development process of the teachers themselves, but also to the quality of the activities which they undertake in the classroom. Many researchers emphasize that teachers' personal epistemology is, in a sense, a kind of "handy knowledge" (Stemplewska-Żakowicz, 1996) which is automatically and naturally, though not always consciously, activated during learning processes, "silently shaping the teachers' proceedings in the classroom" (Bruner, 2006: 77). However, its naive, commonsense dimension poses a serious danger - the fact that epistemological beliefs as prior knowledge possessed by a student/ teacher while beginning pedagogical studies become a type of interpretative filter for newly acquired scientific knowledge (Brownlee, Walker, Lennox, Exley, & Pearce, 2009). Personal, naturally acquired pedagogical knowledge:

"is an effective tool for evaluating newly acquired academic knowledge. The more personal knowledge deviates from scientific knowledge, the more academic knowledge is perceived as impractical, of little practical use. Leaving this fact to the natural course of life causes that in cognitive structures of a student two categories of knowledge are created, those are isolated from each other: academic knowledge- which must be mastered and demonstrated to students, the knowledge a teacher is supposed to have; and practical, personal knowledge - which will be useful in specific situations in the classroom" (Dudzikowa, 2015).

This duality hinders, or even prevents, the penetration of scientific thought into teaching practice, leading to shallow and intuitive educational activities, as well as theoretical helplessness, which Gołębniak calls "the inability to go beyond one's own definitions" (ref. in: Klus-Stańska, 2010: 72). And Klus-Stańska adds:

"The inertia of these definitions, their focus on parochial, everyday life, dependence on actual, specific conditions in which a teacher must function can lead to anti-developmental stabilization of the system not only of a teacher's knowledge, but also of the reality which he/she creates in the classroom by means of this knowledge. This type of stabilization indicates not so much traditionalism (though it may be a tendency towards it), but a creative failure when a teacher thrashes about between the vague need for change and the semantic closure of her/his own imagination" (2010: 72).

The questions arise: How to liberate the in-service teachers from this epistemological inertia? How to prevent simplifying or even reverting the teachers' epistemological beliefs to lay, commonsense versions? How to strengthen the relationship between school practice and the achievements of modern science - as long as these achievements remain solely the subject of academic debate, they have no chance to create the epistemic climate of the school so as to equip students and teachers with tools for navigation in the complex, changing world of modern knowledge. These are the crucial lines for future investigations.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

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