

UNCOVERING DIFFERENCES IN THE CONCEPTUAL VIEWS OF EXPERT AND NOVICE TEACHERS THROUGH CONCEPT MAPS PRODUCED BY SCONSATS INTERVIEWS

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Abstract. This study describes the use of concept mapping in regard to teachers' views on the meaning of knowledge, learning, and expertise of teachers, as produced by SConSAT (Standardized Concept Structuring Analysis Task) interviews with expert and novice teachers. The study is based on the assumption that concept maps are cognitive and meta-cognitive tools that make it possible to reveal covert and overt aspects of one's inner perceptions and to represent relationships between the concepts and the ideas associated with them in a flexible manner and in a variety of modes of representation (both verbal and graphic). The study suggests an informative and innovative analysis of concept maps and shows that concept maps can reveal differences in the conceptual views of novice and expert teachers, characterize them, and identify their connection to teachers' reflective thinking.

1 Introduction

Concept map is a tool that provides an external graphic representation of one's inner cognitive structure. It is the organized body of knowledge stored in one's long-term memory in the form of a semantic network of concepts, patterns, and systems of opinions, beliefs, and products (Ausubel, Novak & Hanesian, 1978). Many studies therefore, describe how concept maps are used to evaluate learners' knowledge structure, with a wide variety of goals and ways of constructing the map and interpreting its data (Cañas et al., 2003). Over the years concept maps have been used extensively both for purposes of teaching and knowledge structuring and as a tool for educational research (Hibberd, Jones & Morris, 2002). Moreover, some studies also describe the use of concept maps as a tool for revealing views, values, beliefs, or theories that constitute and reflect worldviews (Levine & Simon, 2009; Pomson & Hoz, 1998). Based on the research literature, which shows differences in the reasoning and functioning of expert and novice teachers (Berliner, 2004), the purpose of the current study is to examine how differences in the conceptual views of expert and novice teachers are manifested in conceptual mapping developed through SConSAT (Standardized Concept Structuring Analysis Task) interviews (Pomson & Hoz, 1998). The interviews and construction of the maps are further discussed in the methodology section.

The term "conceptual view" is defined as a personal mental structure that includes one's ideology, beliefs, perceptions, opinions, ideas, or theories, reflecting a significant integrated essence, a type of knowledge schema referring to a particular, spiritual, or actual entity (Levin & Simon, 2009; Pomson & Hoz, 1998). Conceptual views are therefore characterized by the following features: they are subjective and not always conscious; they could develop from theories, from practice, or from one's inner world and interactions with the world and society; they have a comprehensive, integrated, coherent and organized nature, and can be justified and defended by the person holding them; they are dynamic entities that can undergo changes based on practice and / or exposure to other sources of knowledge including other people. Since the study makes use of concept mapping to reveal the conceptual views of expert and novice teachers, we shall present in short major features of the thinking and reasoning of experts, and particularly of teaching experts.

2 Features of teacher expertise

Knowledge of expertise is based mainly on studies conducted in different disciplines where experts were asked to "think aloud" while performing problem solving tasks in their field (e.g. Berliner, 2004; Ericsson & Simon, 1998). The research literature shows that the exceptional performance of experts with domain-related knowledge has to do not only with their wider, richer, and more complex knowledge base, but also with its different organization compared to that of novices (e.g. Ericsson & Lehmann, 1996). Some claim that the multi-dimensional organization of experts' knowledge base reflects the quality and efficiency of their thinking, and that: 1. Knowledge representations of experts are constructed around domain-related key concepts and organized by abstract and inclusive laws and principles (Ericsson & Lehman, 1996). 2. Experts' knowledge schemes make it possible for them to reach deep analyses and complex conceptions of given situations, linking them with other similar situations (Popovic, 2003). 3. The high quality of the mental representations of experts' knowledge enables them to predict future situations based on a relatively small number of cues, and to adjust rapidly to changes in external circumstances (Ericsson & Lehman, 1996; Berliner, 2004).

Following the research on expertise in general, teacher expertise was studied as well (e.g., Berliner, 2004; Hogan, Rabinowitz & Craven, 2003), emphasizing mainly the behaviors of expert and novice teachers and the representations of reasoning and decision making processes they employ in the classroom. Based on an extensive research review, Hogan et al. (2003) describe clear differences between expert and novice teachers as related to decision making and problem solving in teaching. Expert teachers focus on the learning process and on students' ability to understand the concepts taught, address short and long-term teaching goals simultaneously; employ alternative teaching strategies corresponding to students' difficulties, easily identify problems that arise during the lesson, and spontaneously use multiple solution strategies. In contrast, novice teachers focus on their own abilities to implement the teaching process, focusing mainly on short-term and discrete teaching goals, use detailed plans for each part of the lesson and implement it strictly as planned, and do not always discern problems in lesson management in the classroom.

The research literature shows that experts' knowledge base is constructed through a lengthy training process focusing on one domain, and that this is the main reason for experts' distinct exceptional performance in that domain (Ericsson & Lehmann, 1996). It takes about four and a half years for successful teachers to learn how to teach well (Berliner, 2004), and teachers only reach maximal success in promoting student achievements after some seven years of teaching (Berliner, 2004). However, lengthy experience is not enough. One of the major conditions for the development of expertise is the existence of reflective and meta-cognitive processes, as part of the self-direction and supervision that accompanies the process of experiencing and learning. Since the literature shows that concept mapping relies on and activates reflective and meta-cognitive thinking, the main research question was: What are the similarities and differences in the conceptual views of expert and novice teachers concerning three major concepts: knowledge, learning, and expertise?

3 Methodology

3.1 Research type

The study is a mixed method study examining conceptual views of history high school teachers, both expert and novice, concerning ideas associated with the concepts of knowledge, learning, and expertise, using both qualitative and quantitative methods of analysis.

3.2 Participants

This study presents the concept maps of ten in-service high school history teachers, five women and five men, with 1 to 29 years of experience, from five different cities throughout the central region of Israel. It is part of a larger study exploring teachers' personal epistemology and self efficacy beliefs. The ten teachers were chosen by experience and gender from a convenience sample of 35 high school history teachers who gave their consent to be interviewed at the end of a questionnaire measuring teachers' personal epistemological beliefs. Based on Berliner's (2004) heuristic model of teacher development, novice teachers were defined in this study as teachers with 1-3 years of teaching experience, and expert teachers had 4 or more years of experience. Novice teachers had a B.A or B.Ed degree and expert teachers had an M.A. degree.

3.3 Research tools

3.3.1 Concept map produced by the SConSAT interview

The concept map produced by SConSAT (Standardized Concept Structuring Analysis Task) interview is web-type, not necessarily hierarchical, and describes the links between concepts by using whole sentences that explain in detail the essence of the link as perceived by the interviewee (Pomson & Hoz, 1998). Thus, on a sheet of paper the interviewee organizes a selected set of concepts chosen by the researcher, depending on how he or she perceives the relationship and the links between the concepts. The set of concepts selected by the researcher represents a relatively wide area and is regarded as suitable for examining participants' views of it. The SConSAT interview has several distinct stages (Pomson & Hoz, 1998). First, each concept in the set of concepts selected by the researcher is written on a separate card, and all the cards are spread in front of the interviewee on a table. Second, the interviewee is asked to : (1) Define or explain each concept verbally. The definitions are written by the interviewer. (2) Spatially arrange the concept cards on a large sheet of paper, such that this arrangement reflects perceived relations between the concepts. When the interviewee is satisfied with the arrangement, it is copied by the researcher onto the sheet of paper. If concepts are arranged in a group, they are circled by the researcher and marked with a Latin number. (3) Give each group a title, explaining the nature of

the group. (4) Verbally express meaningful relations among the concepts or groups of concepts. These linking sentences are recorded by the researcher on lines connecting the concepts. If more than two concepts are linked, the lines connect in a dot on the map. Each link is numbered. The interviewee is allowed to modify the map until he or she is satisfied. (5) Re-inspects the map and add new concepts that are missing from the selected set of concepts according to his or her conception. Appropriate links are added. (6) Provide a title for the whole map. Concepts that the interviewee chose not to include in the map (omitted concepts) are recorded and the interviewee is asked to explain their omission.

The set of concepts used in this study was related to the theory of personal epistemology, self efficacy, and expertise. Based on the literature we selected the following 17 concepts for the SConSAT interview: Knowledge, information, justification, inquiry, truth, evaluation, ambiguity, flexibility, decision making, reflection, learning, insight, thinking, efficacy, control, expertise, experience.

3.4 Research setting and procedure

The SConSAT interviews were conducted in the teacher's home or in a quiet room at the teacher's place of employment. Each interview and development of the concept maps took 45-50 minutes on average.

3.5 Concept map analysis

3.5.1 Map structure and content analysis of the conceptual views

A concept map describes three prominent visual elements reflecting components of one's conceptual view and their interrelations (Yukhnovetsky, 2000): 1. Placement of concepts in the map space; 2. Organization of concepts within each group; and, 3. Linking sentences among/between groups. Map analysis focused therefore on both the structure of the concept map and content analysis of verbal statements.

3.5.1.1 Analysis of concept map structure

Structure analysis of the concept maps was performed in this study through some modifications of the four dimensions of analysis suggested by Yukhnovetsky (2000): **A.** Spatial structure - Features of cognitive structure according to spatial organization of the constructed groups of concepts in the map. **B.** Consolidation - Degree of integration between components of the conceptual view as reflected by the nature of links in the map. **C.** Focus - Major issues in the conceptual view as expressed by concept organization and the prominence of specific concepts. **D.** Depth and wealth of ideas - Complexity and depth of views as reflected by the entanglement of concepts and links

3.5.1.2 Scoring scheme for each dimension of the concept map's structure

In order to analyze and compare the concept maps of different teachers, numerical values were assigned to the data for several characteristics within each of the above mentioned dimension. Scores (in ordinal scale) were determined by a scoring rubric. Using the scoring rubric, each of the dimensions was rated and a general score for the whole map was calculated as well. The scoring scheme is presented in Table 1:

A. Spatial structure	Score
Diffuse arrangement: Displays groups in the map without a clear direction or organization clearly showing how the various parts of the conceptual view fit together.	1
Divided / differentiated arrangement: Displays discrete components of the conceptual view arranged next to each other.	2
Symmetrical arrangement: Displays components of the conceptual view as either related to each other or at odds with each other.	3
Sequenced arrangement (linear or circular): Organization of the components indicating a direction of a process which reflects an idea.	3
System arrangement: Organization indicating a multi-dimensional and a contextual view	4
B. Consolidation	
Simple link Level 1 - Several independent links, each between a pair of concepts within a group. These multiple individual links indicate a non coherent view. Scoring of each link.	1
Simple link Level 2 – A link between a pair of concepts organized in two different groups and also a link between a single concept (outside any group) and an existing group. Scoring of each link.	2
Complex link Level 1 – Links among three or more concepts within a group. Multiplicity of complex relationships indicating an integrative or coherent view. Scoring of each link.	3

Complex link Level 2 – Links between three or more concepts / within or across groups. Scoring of each link.	4
C. Focus	
a. There are no key concepts: Score=0. b. There is a key concept with multiple links: Score=1 c. There is a centrally located key concept: Score=1. d. The location of the key concept and its content/idea/role-based centrality are compatible: Score=3	1-3
All concepts are organized in groups.	3
Concepts are left outside the defined groups or concepts are unlinked (indicating no inclusion within the mental structure or being emotionally loaded concepts).	1
Concepts added to the map (highlighting, expanding, or creating new meanings): For each concept added to the map.	1
All concepts are considered and included in the map (i.e. no concept is left out).	1
D. Depth and wealth of ideas	
1. Coherence of linguistic representations of ideas in the map title and the group titles: a. There is no coherence in content or language representation of the map title and the group titles: Score=0. b. There is a connection of content or linguistic representation, but the group titles in the map represent discrete components of the teacher's view: Score=1. c. Group titles represent connected components of the same context, whereas the map's title represents a different context: Score=2. d. All titles are related thematically and present a coherent view: Score=3.	1-3
2. Complexity of linking sentences,; a. The sentence explains the link's direction: Score=1. b. The sentence describes a process, an opinion, or a belief: Score=2. c. The sentence explains the nature of the process or presents causes and reasons for a certain opinion or belief: Score=3	1-3 for each sent.

Table 1: Scoring scheme for each dimension of the concept map's structure

3.5.2 Content analysis of verbal statements in the map: definitions of concepts and linking sentences

The SConSAT interview generates two types of verbal components: 1. Definitions given by each teacher for the 17 concepts chosen. 2. Linking sentences in the map. Content analysis of these verbal components was carried out in two stages. First, we analyzed the definitions given by all teachers using categories derived by themes emerging from the definitions (emic). Second, we used these categories to analyze the linking sentences connected to central consensual key concepts appearing in the maps of most teachers.

4 Results

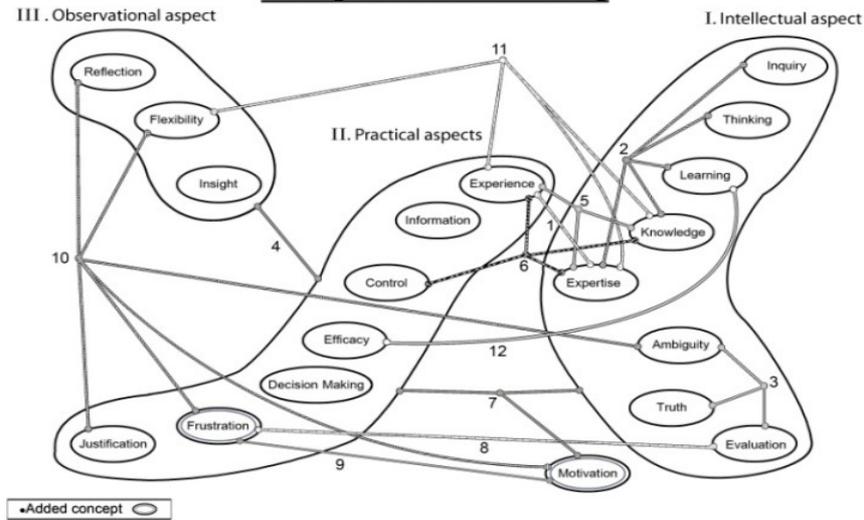
First, we present two selected maps generated by an expert and a novice teacher, using the SConSAT interview. The expert teacher's concept map represents the map with the highest general score and the novice's map depicts the one with the lowest score. Following these maps we present the results of the structure analysis of all participating history teachers' maps, according to the levels of their teaching expertise.

4.1 Concept map of Expert Teacher 1 (28 years of teaching)

Map Title: Through the Maze of Learning. **Group titles:** I. Intellectual aspect. II. Practical aspects. III. Observational aspect. **Key concepts:** Expertise, Knowledge. **Omitted concepts:** none. **Added Concepts:** Motivation, Frustration.

Linking sentences: 1. Expertise stems from experience and experience stems from expertise, one leads to the other. 2. The tendency to inquire or to explore is the foundation. It leads you to thinking, and thinking develops a desire to know and leads to learning. In the absence of exploration, learning becomes automatic and lacks depth. This process, of course, leads to knowledge. Putting all of these together, it leads to expertise. 3. Ambiguity is the opposite of the truth. In order to leave things ambiguous, sometimes the truth remains unspoken. These three concepts undermine the process of inquiry, exploration, and thinking, it sounds like indoctrination. You re-evaluate, you check yourself. 4. There is a continuum. Experience leads to ability, to better control, and to meaningful decision making. This is a clear way of thinking; in some way it is a formula. I can justify the whole process I went through. On the other hand, if I don't have reflection, flexibility, and

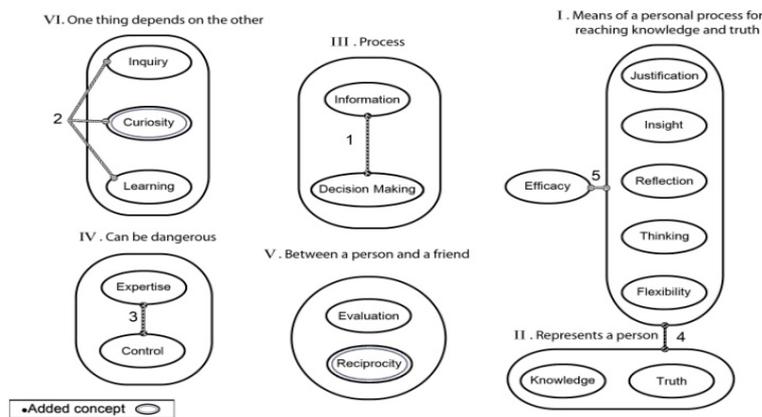
Through the maze of learning



insight, everything might be undermined. I need to know how to use them. I should have the ability to place myself on the outside, to reflect, to break the rigid formula. Such, that it would not seem that everything is clear to me and understood by me, a kind of doctrinaire ideology. It saves me. **5.** Knowledge leads to expertise and expertise is the basis of experience. **6.** When I accumulate more knowledge, I can control the situation better. When you're talking to some professionals, "selling ice to the Eskimos", your knowledge actually gives you a better sense of control and security. This way, you can convince people to learn something new even when they think they know everything there is to know in their field. **7.** Efficacy is a precondition of the ability to learn. **8.** If I begin a process of inquiry, I need motivation to start the process, something that urges me to take this direction. **9.** In all the steps we take there are delays and frustration. Things do not flow, we depend on others and it's not what we thought it would be. In a way, it causes frustration. **10.** If my motivation is strong enough I can overcome my frustration. **11.** Sometimes reflection leads to frustration. Then, if you are not flexible enough you try to justify the process you went through at all costs. The motivation to justify your moves is strong. If you are really frustrated, you prefer your conclusions to be vague (when you make a decision). **12.** When a person is not sure of his knowledge, his insecurity can lead him to doctrinarism, because his lack of knowledge keeps him in one place.

4.2 Concept map of Novice Teacher 4 (1 year of teaching)

Orit's Observation of the Concepts



Map Title: Orit's Observation of the Concepts. **Group titles:** I. Means of a personal process for reaching knowledge and truth. II. Represents a person. III. Process. IV. Can be dangerous. V. Between a person and a

friend. VI. One thing depends on the other. **Omitted concepts:** Ambiguity, Experience. **Added Concepts:** Reciprocity, Curiosity.

Linking sentences: 1. Information is the basis of decision making. 2. Curiosity and inquiry are essential for learning. 3. Expertise and control are problematic or dangerous because they can create vanity. 4. These are means to arrive at the truth and achieve knowledge. 5. Efficacy is the result of a process that uses and includes all the concepts.

4.3 Structure analysis of the maps

Structure analysis of the maps shows that there are distinct differences between teachers by level of expertise. The concept maps of teachers with over three years of teaching received higher scores (general scores range from 47 - 86 among experts, compared to 23 – 46 among novices) (see Table 2 and Figure 1). Namely, the maps of expert teachers are more coherent and focused than the maps of novice teachers and they show a greater depth and wealth of ideas.

Expertise	Spatial structure	Consolidation	Focus	Depth and wealth of ideas	Total Score
Expert 1	4	38	11	33	86
Expert 2	2	24	7	35	68
Expert 3	3	23	9	28	63
Expert 4	3	19	9	21	52
Expert 5	3	22	3	21	49
Expert 6	3	19	2	23	47
Range	2-4	19-38	2-11	21-35	47-86
Novice 1	2	15	7	22	46
Novice 2	2	19	4	21	46
Novice 3	3	14	6	9	32
Novice 4	A	11	3	8	23
Range	1-3	11-19	3-7	8-22	23-46

Table 2: Structure analysis scores by levels of expertise

It is important to note that Table 2 shows a greater distribution of scores in the expert group than in the novice group (39 points difference between the lowest and highest general scores, compared to 23 points difference, respectively). In addition, the results show that the general scores of two novice and two expert teachers fall in the same range (score range 40-49, see Figure 1), indicating that in some cases the coherence and depth of the conceptual views of expert teachers are similar to those of novices.

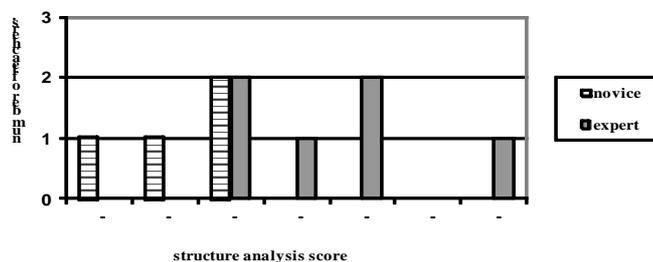


Figure 1: Distribution of structure analysis scores of novices and experts

5 Discussion

Structural analysis of the concept maps in this study demonstrates distinct differences between novice and expert history teachers in the graphic representation of their views concerning ideas associated with knowledge, learning, and expertise. Expert teachers portrayed a more consolidated arrangement of concepts and a higher

degree of integration within and between components of the conceptual map. This integration is manifested in: 1. A higher correspondence between the various headings on the map, indicating existing conceptual coherence of teacher views. 2. A greater number of links between concepts; and 3. A larger number of key concepts linked to other concepts. The complexity and depth of expert teachers' conceptual views are also manifested in the linking statements, which show a higher level of reasoning and explanation of their beliefs and ideas.

The findings of this study, which show complex structure and high connectivity expressed in the conceptual maps of expert teachers, are compatible with the findings of other studies exploring differences in the graphical representation of knowledge schema between experts and novices in other fields (e.g. product designers, Popovic, 2003). These studies indicate that the concept maps of experts display a complex structure and contain more links between key or prominent concepts. The findings of the present study also show congruence between the high level of conceptual complexity and the integrative nature of expert teachers' conceptions about knowledge, learning, and teaching, and the stated behavioral and instructional characteristics of expert teachers, as suggested in the literature (Berliner, 2004). The findings show that expert teachers' experiences during their years of teaching, leading to expansion of their knowledge (Hogan, et al., 2003), contribute to the coherence and depth of their conceptual views as revealed in the concept maps.

However, in line with claims by other researchers (e.g. Berliner, 2004), the high variance within the expert group found in this study suggests that teachers' years of experience by itself is not an indication of level of expertise. It is important to distinguish between 'experienced' teachers and 'expert' teachers. Namely, expert teachers are characterized not only by their large knowledge base of accumulated facts from similar processes that recur over time, but also by their ability to respond in an inventive and flexible way to unfamiliar challenges (Berliner, 2004).

The findings of this study also suggest a possible explanation for the differences between novice and expert's conceptual views, i.e. expert teachers' high level of reflective and meta-cognitive thinking. More specifically, the results concerning the dimension 'Depth and wealth of ideas' show that the concept maps of expert teachers reveal more representations of reflective thinking than those of novice teachers. Moreover, linking sentences in the maps of the expert teachers express the idea that experience strengthens teachers' expertise only if accompanied by reflective thinking, as one teacher wrote: "One nurtured the other, expertise feeds reflection and reflection nurtures, inspires and improves expertise". These results are compatible with research in the area of expertise regarding reflective thinking as one of the primary conditions for the development of expertise (Ericsson & Lehmann, 1996; Levin & Nevo, 1998; Tsui, 2009). In particular, Tsui (2009) claims that teacher expertise is developed by constant reflective processes that translate experiences and practical insights into principles of action, organize teachers' practical knowledge as a personal theory, and allow teachers to implement new theoretical knowledge in their teaching practices.

The results of this study, demonstrating more representations of reflective thinking among expert teachers compared with novices, validate and strengthen the usefulness of concept maps in revealing differences characterizing experts' and novices' conceptual views. This is because concept maps as a tool for exposing conceptual views actually activate reflective thinking and meta-cognition (Levin and Simon, 2009). More generally, the advantage of the SConSAT interview presented in this study as a tool for exposing conceptual views is that it is based on active and creative cognitive processes allowing teachers to express their views in a complex way that is both graphic and verbal. Specifically, the creation of the concept map takes place in defined stages and allows teachers to construct their view using various means of representation: words, graphics, and spatial placement. In contrast to other types of qualitative research tools such as interviews, where one's ideas are verbally communicated linearly one after the other, the concept map affords teachers the flexibility to expose the network of connections between ideas and concepts that constitute their conceptual structure by using multiple presentation modes, where each might reflect a different layer of one's involvement with a particular idea or belief. This flexible and open process reinforces the use of the concept map as a unique instrument for exposing latent components of one's conceptual understanding or beliefs, which are sometimes not even conscious and therefore hard to formulate clearly in words (Pajares, 1992) and do not always emerge in oral interviews.

An additional strength of the concept map as a research tool is that the researcher's impact on the process and its products is very limited compared to the use of other tools for exposing conceptions, such as questionnaires or semi-structured interviews, whose phrasing and even the order of questions can influence respondents' answers. In this context, it is important to note that although generating a concept map in a SConSAT interview relies on the initial set of concepts chosen by the researcher, the list is not absolute and teachers creating the map may add or subtract concepts in order to present the cognitive structure of their

conceptualization as they see fit. Adding new concepts to the map facilitates the reflective process by contributing to the exposure of latent or ambivalent aspects of the teacher's view, thus displaying the conceptualization and its changes with greater clarity. We could therefore say that the concept map is a unique tool that offers a real opportunity to manifest the conceptual ecology of the teacher and can reflect the variability of the teacher's network of cognitive products.

In conclusion, this study describes the unique use of concept maps produced in a SConSAT interview as an instrument for studying differences between expert and novice teachers' views. In contrast to the customary use of concept maps as a knowledge evaluation tool, we presented an approach to concept mapping which makes it possible to collect and analyze data in order to reveal teachers' conceptual views and monitor differences in both visual representation of the perceptions and their verbal-conceptual manifestations. However, due to the limited number of participants in this study we recommend further research to establish the use of concept maps as a valid and multi-representational tool for investigating conceptual views of teachers teaching different subjects at different levels of formal education.

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