

Using Unstructured Cognitive Maps to Analyse the Reflective Thinking of Teachers: Results of Qualitative Research

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Abstract

In recent years, discourse in education sciences has focussed on the study of the reflective thinking of teachers. Researchers, however, do not agree on how the reflective thinking of teachers can be measured. This qualitative study looks for an answer to the question whether a cognitive map is suitable for the discovery of teachers' reflections. The study analyses the reflections of a secondary school teacher of mathematics using an unstructured cognitive map. The sample was selected on the basis of availability. The analysis of the map was done deductively, in a concept-driven way, on the basis of the number of contacts (edges) and concepts, central, peripheral and isolated concepts and their degrees, and the levels of the map. The teacher involved was recorded commenting on the process of map-making, which was then transferred to writing. The text corpus was then analysed inductively, in a data-driven way. The results show that the teacher interpreted his own activity – which depends on pedagogical knowledge, beliefs and pedagogical situations – in a complex manner. The filter function of beliefs can be observed when the teacher's activities and thinking did not match because some internal and external factors. The data from the map contributed to analysis of reflections and the analysis of the map added new elements to existing techniques.

Key words: *beliefs, unstructured cognitive map, qualitative research, reflective thinking*

Introduction

In recent discourse in education sciences, reflection is often defined as a key competence for professional teaching activities (Leonhard & Rihm, 2011), an essential skill at every level and in every field of education (Perkowska-Klejman & Odrowaz-Coates, 2019). During the years of becoming a teacher, acquiring an approach that necessitates reflection during and after pedagogical activities (i.e. teaching) can be seen as a key competence for students who want to become teachers (Baumgartner & Welte, 2009). At forums focussing on teacher training and further training we often encounter questions about levels of professional performance, the content of competence-based teacher training, and the relationship between reflection, beliefs and activities. During professional activities, teachers are able to use different models of teaching and learning, which contribute to the development of students and also help the process of the lesson (Dragos & Mih, 2015).

Problem of Research

The study argues that it is important to explore and analyse reflective thinking in teacher training, further training, as well as in everyday pedagogical activities, because it can increase the efficiency and professionalisation of teaching and pedagogical work. The scope of activity changes as a function of in-service years and experience, revealing the cause-and-effect relationships which propel a teacher's activities in a complex environment. A teacher striving to improve his/her teaching activities continuously reflects on his/her work and in a suitable environment uses the possibilities of collegial reflection so his/her professional skills are systematised on the basis of his/her practical experience. Reflection requires the teacher to be explicit and consequently, leads to a growing awareness of unconscious, subjective theories (Sántha, 2018).

In terms of teacher development, it is important to think about how reflective thinking is present in the institution (school), and how it appears at the individual and institutional levels. Individually, details of activities are analysed and beliefs are explored using a special research methodology; institutionally, using collegial reflection and communication inside work communities can be ways for professional development. These methods can be analysed using several methodologies (see the theoretical background of this paper), but in this methodological arsenal, cognitive maps get little attention. In what follows the way unstructured cognitive maps can help to uncover reflective approaches is discussed.

Research Focus

The study presents the possibilities of uncovering reflective thinking and in a qualitative study focuses on the role of unstructured cognitive maps in the analysis of reflections. Its main aim is to find a possible method for analysing the data from the map. This is not without purpose; specialised literature lacks instances of the use of cognitive maps in the exploration of reflective thinking.

Uncovering reflective thinking

Researchers have failed to agree on how reflective competence can be most precisely grasped. Thus, quantitative, qualitative and mixed methodological processes are all used to explore reflective thinking.

The reflective competence of teachers can be studied using various methods with the aim of methodological triangulation (Wyss, 2013). This is exemplified in the study by Mirzai, Phang and Kashefi (2014), who analysed the reflective thinking of teachers with methodological triangulation, including questionnaires and semi-structured interviews. Dammerer and Schwab (2019) held evaluation conferences, including quantitative and qualitative elements, and structured interviews to analyse reflections of beginners and their mentors. Here, they used a short questionnaire on becoming a teacher, followed by group interviews. Dervent (2015) conducted a study on the effects of reflective thinking on the everyday teaching practice of PE teachers, where the different levels of reflections were mapped. In this qualitative study, methodological triangulation was ensured by the use of reflective diaries, interviews and video recordings of micro teaching.

Levin and Meyer-Siever (2018) go along with this when they emphasise that there are several methods for discovering and evaluating reflective competences, but all these need to be improved because they do not fully capture the hierarchical representation of reflective levels and thinking in main and subcategories. There is often criticism of the hierarchical structure of reflective levels and the methodology used to uncover reflections does not offer definitive explanations. It is agreed, however, that reflection can be learnt and practised (Etscheidt, Curran & Sawyer, 2012).

Levin and Meyer-Siever (2018) established a four-phase model to study reflective thinking. The model is named STORIES (Students Training of Reflection in Educational Settings) and it is done in the following phases. First, it is worth reviewing the theories and/or empirical materials that offer the best explanations related to the situation in the focus of reflection (1). This is followed by the percep-

tion of different perspectives (2), so it is worth highlighting how the participants felt about the situation. In the phase of developing alternatives and reflection (3), what alternative behaviours could occur on the basis of the previous analysis has to be considered, and what changes and supports in the system are necessary. First, reflection focuses on finding alternatives, then on the analysis of the given system (dormitory, school activity, lesson). Finally, at the level of individual professional development (4), the question what conclusions there are for professional development has to be answered, in order to find relevant strengths and weaknesses.

Extending single-case studies in order to analyse similar cases comparatively is known as multiple case study. Multiple case studies are seen as a research strategy that pays special attention to the complexity of the cases. While case studies focussing on one case are capable of uncovering deep layers in individual situations, they do not enable comparison from multiple perspectives because of their context-dependence; multiple case studies enable us to extend the meanings through multiple cases (Vassinen, 2012). Ostorga (2006) in his study concerning the development of reflective thinking, used the method of multiple case study, analysing the activities of four teacher trainees, putting beliefs during apprenticeships in the focus.

When exploring the reflective thinking of teachers, written data have a significant role, as reflective diaries, lesson commentaries, and portfolios require the integration and rearrangement of information, at the same time necessitating analytical thinking (Sántha, 2019; Tynjälä, 1998). It is worth noting that the methods of uncovering reflective thinking through text will not automatically lead to the improvement of reflective performance (Maclellan, 2008). Just as in the case of analytical thinking, portfolios represent the process of becoming a teacher, as well as beliefs concerning learning (Johnson, Mims-Cox & Doyle-Nichols, 2006). So with their help, the thinking behind the text corpus can be mapped. The electronic form of a portfolio is an e-portfolio, which can be seen as a collection of materials from an author in a given time period (e.g. trainees in teacher training). The content of an e-portfolio can range from links (event, blogs, training programmes) through multi-coded data (voice, text, picture, video) to references (letters of credence, qualifications) and can be used in many different areas of competence (Levin & Meyer-Siever, 2018).

Perkowska-Klejman and Odrowaz-Coates (2019) used an enhanced QRT questionnaire (Questionnaire to measure the Level of Reflective Thinking) developed earlier (Kember, Leung, Jones & Loke, 2002) thus making students' reflections measurable at the levels of acting, understanding, reflection, and critical reflection. When using questionnaires capable of studying reflective thinking, it is worth con-

sidering the insights described in the methodological paper of Duşa & Frunzaru (2011), which offer an alternative to the Likert scale in the form of a visual scale.

Other complex methods, ones that use pictorial, visual elements besides text have also appeared recently in the study of reflective thinking. Sántha (2017) studied the reflective thinking of teacher trainees by means of unstandardised network cards, the making of which was also accompanied by the commentary of the students, thus creating a complex unity of visual and textual data. In addition, the method of stimulated recall can be mentioned. This method facilitates the uncovering of reflective thinking (Levin & Meyer-Siever, 2018; Messmer, 2015). Video-based interaction also contributes to the professional development of teachers, as the observation and analysis of teaching activities by means of video recordings also helps self-reflection and contributes to the professionalisation of teaching activities (Budiastra, Erlina, & Wicaksono, 2019).

Methodology of Research

General Background of Research

The study can be classified as qualitative research, studying the reflective thinking of teachers with unstructured cognitive maps. Instead of a hypothesis, the study was constructed on a set of open questions and problems, and it looks for answers to the question if an unstructured cognitive map is an appropriate tool to explore reflective thinking.

Sample of Research

The study was conducted with a teacher who has been teaching mathematics for nine years in a secondary school. The size of the sample is justified by the fact that qualitative research places its focus on discovering context-dependent elements, and does not aim to be representative. In qualitative research there is no definitive, specific sample size, researchers define the sample size in different ways. The sample size can depend on research aims and questions, as well as data analysis (Morse, 2000; Malterud, Siersma & Guassora, 2016; Onwuegbuzie & Leech, 2007). The sample size used in the study is enough to present a possible way of analysing the data of a cognitive map, thus also illustrating the usefulness of cognitive maps in the process of uncovering reflective thinking.

The sample was selected on the basis of availability. This method is problematic as it means involving people who are easily available to the researcher. It is worth noting here that many teachers did not want to participate because the process

of creating a cognitive map was an unknown to them (they said they had mostly taken part in questionnaire-based interviews). During the preparation stage of the research, many teachers refused to participate. They justified their refusal by saying they had no time, there were difficulties with group cohesion in their class, but they also stressed that cognitive maps were unfamiliar to them.

Ethical parameters

In qualitative research the researcher spends a lot of time with the participants, asking for and giving trust, because this is the only way of uncovering internal, hidden motives. During the study, the formation of a good professional and collegial relationship that excludes any misinterpretation and misunderstanding was essential. Before the research, therefore, it was important to discuss research objectives, processes and methods. With a view to the specificities of the methodological culture used, the study was carried out voluntarily, with the consent of the teacher and the school management. Anonymity was also guaranteed. After the research, the teacher stressed that the time spent in the research was very useful and the experiences he gained would be used in his later work.

Instrument and Procedures

The aim of the cognitive map is to present structures and elements of them that can be described and explained verbally only with difficulty. The teacher made his unstructured cognitive map about 'classroom work'. This concept can be interpreted broadly enough to evoke thoughts freely with minimal control. The unstructured characteristic of the map means that apart from the concept 'classroom work', there was no other factor to limit the teacher in bringing up his ideas. Thus, he could gather everything he thought was important about the topic and then he made a drawing.

While creating the unstructured cognitive map the teacher was drawing, naming and explaining the concepts that he thought were important in terms of classroom work. These explanations were being recorded on a dictaphone, subsequently transcribed and processed using qualitative content analysis by the researcher.

On the map, the teacher represented all the elements in a hierarchical structure (e.g. super- and subordination, arrows, lines, underlining, frames) and he was free to use his own set of symbols. The teacher made the cognitive map in the school, in a quiet room specially designated for this activity. All disturbing factors were excluded during the process, the circumstances were suitable for careful work and the uncovering of the different aspects of reflective thinking. There was no time limit. The teacher drew and commented on the concepts on the map within 45 minutes.

Data Analysis

The aim when analysing the cognitive map was to define concept categories that enable the uncovering of the deep cognitive structures of the teacher and also to analyse reflective thinking. The analysis was done with a combination of concept-driven and data-driven methods (Kuckartz, 2019). Concept-driven analysis requires the presence of certain aspects, as these provide the framework for the analytical process. Although this is a qualitative study, the concept-driven processing of the cognitive map was done using mathematics and graph theory.

The analysis of the concept map was done in a deductive, concept-driven way, using the following aspects taken from research experience and specialised literature (Eden, 2003; Kane & Trochim, 2007):

- the number of connections (edges): connections (edges) are the contacts between the concepts.
- the number of concepts on the map.
- central and peripheral concepts in classroom work: central concepts are the ones highlighted (stressed, underlined, framed, etc.) by the teacher on the map and the ones explained in the commentary of the cognitive map. A peripheral concept is one that only has one contact with a central concept and is only marginally mentioned in the commentary.
- the degree of the concept means the number of any (guided, highlighted, etc.) contacts (edges) connecting to any of the concepts on the map. The degree of a concept shows what and in what context something comes up for the teacher when thinking about that particular concept.
- detailed and isolated concepts: a detailed concept means that the commentary shows which concept is linked to another one and why. Thus the connection between concepts can be explained. Isolated concepts cannot be reached on the map by using any other contact.
- number of levels and the number of concepts on one level: the concepts directly connected with the central concept constitute the first level. The second level is the level of concepts that are directly connected with first-level concepts. The definition of other levels is similar. In all cases, the central concept is the starting point, so it does not constitute any level (it can be regarded as the zero level).

With regard to the transcribed voice recordings, the analysis of the text corpus was done inductively in a data-driven way on the basis of categories. The data-driven approach can be used to uncover the meanings and deeper relations of text segments, and works without preconceptions or an external set of criteria. The reading of the text was followed by a step-by-step formulation of categories.

After reading the text twice, the categories established (planning, deviation from the plan, control-assessment, knowledge about the student, methodology, sources, education, disciplining, decision) did not need any change in terms of concept, only some changes in terminology, i.e. changing the name of one of the categories. The name “methodology” was felt to be justified here as this category can refer to different methods of teaching and work forms.

These categories are further discussed in the Discussion section.

Results of Research

On the basis of the concept-driven process, the teacher drew 11 concepts on the map, with one central concept, ‘teaching’, around which he organised his ideas (Figure 1). Peripheral and isolated concepts were not detected. The teacher assessed his activity in a complex manner. All the concepts on the map have their places in his activity and this was further evidenced in the commentary. The concept with the highest degree was ‘teaching’, which was interpreted as a central concept and was given a rating of 7. The number of concepts is quite similar to the number of contacts (edges), which suggests a simple system of relationships. There are nine contacts (edges), all of which are represented by a directional relationship (arrow).

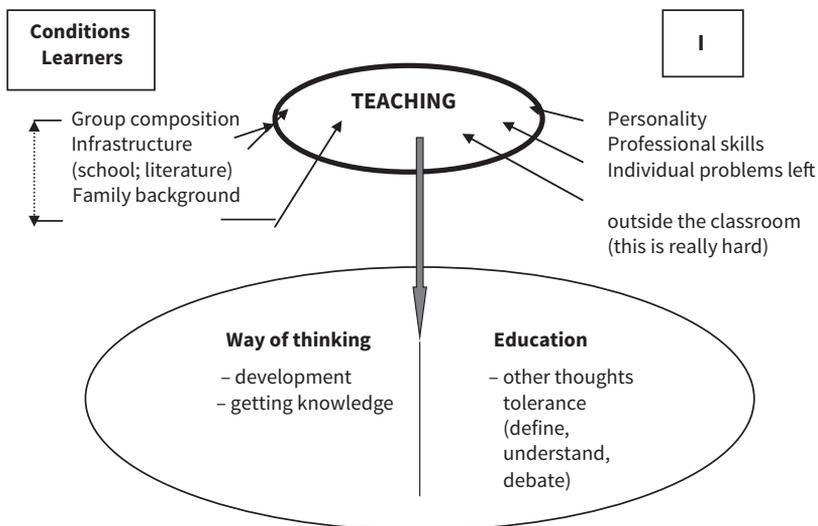


Figure 1. Unstructured cognitive map of classroom work

The levels show the systematic structure of reflective thinking. The number of first level concepts is significant, as these are closely related to the central concept and thus form the backbone of the cognitive map. The teacher worked with one level. He used eight detailed concepts on the first level (group composition, infrastructure, family background, personality, professional skills, individual problems left outside the classroom, way of thinking, education).

Looking at the layout of the map, it can be seen that it was made from top to bottom on an A4 sheet (the default is portrait orientation). The technique of drawing is variable, the teacher built the map starting from the central concept and moved in different directions. The central concept was the first to be drawn. This technique might be called radial build-up.

The data-driven process was based on the commentary on the map-making, where the categories used were planning, deviation from the plan, control-assessment, knowledge about the student, methodology, sources, education, disciplining, decision. In the following section, the analysis is done based on the categories listed.

Discussion

The results of the cognitive map showed the complexity of the teacher's thinking and the variety of his reflective approach. The content of the reflections and the conceptual system of the cognitive map were aligned, as the two main categories of classroom work, 'I' and 'Conditions, Learners' appeared in a complex way in the categories formulated from the text segments (planning, deviation from the plan, control-assessment, knowledge about the students, methodology, sources, education, disciplining, decision). The teacher reflected upon his/her activity using cause-and-effect relationships.

During planning, the lesson plan played a crucial role, while the other key issue was defining the goals. The goal was, according to the teacher, the development of the mathematical and problem solving skills of the students. He wanted to achieve this with a critical approach, giving help and by being very precise.

When there were deviations from the plan, the teacher managed his time very well, sometimes he spent a whole lesson analysing all the relevant details of a problem. When speaking about why there were deviations, the teacher named students and the difficulties they had doing some of the exercises.

Control and assessment were problematic according to the reflections. The teacher reflected on oral and written forms of testing and besides the general

parameters of assessment he also mentioned issues of objectivity and subjectivity. His assessment skills were mainly based on his experiences as a student, the knowledge gained during his pedagogical and psychological studies as a student, his personality and his experience. Yet on his cognitive map the teacher did not represent control and assessment.

Knowledge about the students was represented by the concept 'students', which was drawn as the third step out of the 12 needed to draw the map. As far as directions of reflection are concerned, the dominant direction is teacher – student, but the teacher also used less typical directions as well, as he analysed the relationship between the students and mathematics. The teacher made an effort to get to know his students and he interpreted the different student behaviours in different pedagogical situations, as well as the reasons for activity and passivity.

The teacher wanted to achieve variety in methodology that takes account of several factors. According to the direction of the reflections, the teacher had difficulty finding the best forms and methods of work, but in many cases he also reflected on students and the education system. In the case of forms of work, it was seen as a problem that, although he used individual work, the tasks set were not differentiated. He did not reflect on and he did not use pair work. In his reflections, he speaks about his awareness of the difficulties posed by frontal work, yet still he had to use it. Group work is not popular and is not used because of the necessary preparation and the modified teacher – student roles. The teacher reflected most on traditional methods, dominated by demonstration and explanation. In the case of interactive methods, debate was mentioned, but new generation methods were not mentioned at all. The teacher indicated the teacher's tasks in very general terms, shown on the map under 'professional skills'.

The teacher used sources different from the coursebook or the exercises. He saw the role of the coursebook as not too important. In the map he drew 'infrastructure' to include the importance of specialist literature. The notion is at the first level and it is first degree as it is connected to the central concept 'teaching.' However, it was drawn 8th out of the 12 steps in drawing the map, which might show that in his thinking, resources did not play an important role.

Education was seen as something important even outside the classroom, as besides specialised knowledge the students also need preparation for a balanced life, which was one of the goals. The teacher stressed tolerance, giving help, and mutual acceptance of each other. The concept of 'education' appeared in the first level of the cognitive map, according to which the point of teaching is tolerance towards differing ideas.

Although the teacher did not represent disciplining on the map, he reflected upon it. The techniques he used were knocking on the desk or asking the students to be quiet. Sometimes he had to use these as during his lessons students are allowed to discuss solutions and argue about the results. Thus, background noise was a natural part of his lessons.

It is hard to know much about the decision-making structures of the teacher on the basis of the available data. From the little reflection available, he preferred well-grounded and conflict-free decisions. On his cognitive map the teacher did not represent the concept of decision.

Conclusions

On the basis of the results it can be stated that unstructured cognitive maps help to uncover reflective approaches. The data in the map contributed to the analysis of reflections, so the study can be repeated on larger samples. Map analysis synthesised and complemented existing techniques.

Thanks to the methodological culture used, the mapping of the teacher's thinking could be undertaken with the exception of the categories decision and disciplining. The teacher held efficient lessons due to his teaching style and beliefs. His teaching activity served the development of independent, problem-centred thinking in his students. He listened to all the students' opinions amid greater than usual background noise and they analysed the problems together on the basis of the mistakes made.

On the basis of the results it can be stated that methodological triangulation has positive effects when studying reflective thinking, as a multi-faceted methodological approach can facilitate the uncovering of individual and context-dependent reflections. Similar studies could rely on both cognitive maps and stimulated recall. The concept map highlights the problem that the teacher cannot represent some situations, concepts, or events in a map-like manner. In this case, stimulated recall helps, where the teacher can speak about more abstract pedagogical situations. The key issue in using the two methods side by side is whether the concepts on the map and the words uttered during stimulated recall are reflected in the teacher's actions. In similar studies in the future, it is worth remembering that methodological triangulation can contribute to the convergence and complementarity of different methods, resulting in a deeper understanding of the topic and the reinforcement of the methodological foundations of the study.

This teacher's activity depends on his pedagogical knowledge, his beliefs and the pedagogical situation. He reacts on the basis of his beliefs and pedagogical knowledge and acts as a function of his routine and cognitive schemas. The filter function of beliefs can be observed when the teacher's activities and thinking did not match because of some external (time limit, school equipment, class composition) and internal factors (emotions, empathy, giving help, mutual acceptance of each other). The number and quality of beliefs influencing reflections and the schemas appearing in teaching activities gave us an opportunity to map the relationship of thinking and acting in different pedagogical situations.

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