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Teaching Competence for Organising Problem-Centred Teaching-Learning Process

Renata JONINA¹, David OGET² and Jacques AUDRAN³

¹University of Strasbourg, 67000 Strasbourg, France

²INSA Strasbourg, 67000 Strasbourg, France

³INSA Strasbourg, 67000 Strasbourg, France

Abstract

The problem-centred education (PCE) is a teaching-learning process which includes meta-subject tools as part of its content. The given tools, which find their origin in OTSM-TRIZ theories, allow to structure and reorganise information with the aim of identifying, analysing and solving problems in various domains. In the framework of the PCE students develop not only their subject-matter skills (e.g. language, maths, etc.) but also their problem solving competence or inventive thinking skills. While the research has shown that the PCE has had a positive impact on learners, the empirical experience of helping regular school teachers learn to organise problem centred teaching-learning process showed that while some teachers succeeded to introduce some changes, the majority of them failed to introduce any changes in their classrooms. The given situation has brought to the foreground the problem of teaching competence required from a teacher for organising problem-centred teaching-learning process. The given chapter will define the PCE highlighting the features which differ it from the existing problem-based and teaching for thinking approaches and will present the first results of the study into the teaching competence required for organising problem-centred teaching learning process.

Keywords

Problem-centred education, teaching competence, inventive thinking skills, problem solving competence, OTSM-TRIZ models, teaching for thinking approaches

I. Defining the Problem-Centred Education

a. Educational Context and the Problem-Centred Education

The need to develop students' higher-order thinking skills and problem solving competence in the framework of school education has already been highlighted since the middle of the 20th century. Nowadays, the given requirement has been shifted to the foreground of educational agenda due to the radical changes the world has been going through on its way from industrial society to information society (Lyotard, 1984; Paul & Foray, 2002), imposing on a person the demand to "*have a stock of information-processing skills, including literacy, numeracy and problem solving, and "generic" skills, such as interpersonal communication, self-management, and the ability to learn [...]*" (OECD, 2013a, p. 46). At the same time, the recent international research results highlight that neither modern students reach successful results in terms of literacies and problem solving abilities for successful functioning in knowledge society (OECD, 2013b, 2014), nor teachers seem to have relevant teaching competence for organising the teaching-learning process that would meet the needs of the modern school (Izglītības Attīstības Centrs, 2008; Leat, 1999; OECD, 2005; Sawyer, 2006; Sternberg & Martin, 1988).

In the educational literature the approaches and programmes which target the development of higher-order thinking skills and problem solving competence are referred to as *approaches for teaching higher-order thinking* (Zohar, 1999, 2004, 2008; Zohar & Schwartz, 2005), *approaches for teaching thinking skills* (Adey, 1999; Adey & Shayer, 1993, 1994; Avargil,

Herscovitz, & Dori, 2012; Johnson & Siegel, 2010; McGregor, 2007; McGuiness, 1999; Moseley, Elliott, Gregson, & Higgins, 2005), *inquiry-based instruction* (Baumfield, 2006; Baumfield, Butterworth, & Edwards, Gail, 2005; Dostál, 2015; Lehrer, Schauble, & Lucas, 2008; Windschitl, 2003), *problem-based educational approaches* (Barrows, 1996; Barrows & Tamblyn, 1980; Матюшкин, 1972; Махмутов, 1977; Мельникова, 2002), *cognitive-activation instruction* (Echazarra, Salinas, Mendez, Denis, & Rech, 2016, p. 35), *teaching for understanding* (Fennema & Romberg, 1999; Perkins, 1993, 1998; Perkins & Blythe, 1994; Wiskey, 1997) and the like. I apply the umbrella term ‘teaching for thinking approaches’ to refer to this family of approaches, programmes and methodologies. Having different theoretical backgrounds and being different in their specific focus, all teaching for thinking approaches rely on the constructive or socio-constructive theory of learning making students active participants of the teaching-learning process and involving them in constructing their understanding rather than practicing rote memorisation and recall of information. In addition, all of them promote relevant thinking dispositions (e.g., being persistent, thinking flexibly, adopting a questioning attitude), encourage the language of thinking (such as summarise, estimate, conclude, imply) which allow associating thinking words with their relevant cognitive processes, develop meta-cognition, and teach transferring of knowledge, skills, dispositions and strategies to students’ everyday lives (Burke & Williams, 2008). Moreover, all these approaches target to develop students’ conceptual understanding of phenomena under study in the framework of the subject-matter teaching (be it science, math, languages or any other school subject). Hence, they blend subject-matter content instruction with explicit instruction about thinking skills and processes and are often called *infusion approaches* (McGuiness, 1999; Moseley et al., 2005).

Despite a lot of positive features which characterise teaching for thinking approaches, none of them relies on any problem solving theory that would serve as the basis for developing students’ problem solving competence (Sokol, 2007; Sokol, Lasevich, Jonina, & Dobrovol'ska-Stoian, 2013; Sokol, Oget, Sonntag, & Khomenko, 2008, p. 34). The Problem-Centred Education, on the other hand, relies on the General Theory of Powerful Thinking

(OTSM) and the Theory of Inventive Problem Solving (TRIZ)* (Altshuller, 1984, 1986, Хоменко, 1993, 2008; Хоменко & Аштиани, 2007) and offers to integrate into the teaching-learning process domain independent tools (which in educational context I refer to as meta-subject tools) for managing information in the process of problem solving. The given domain independent tools uncover the cognitive process which leads to solving a problem as it is viewed in OTSM-TRIZ.

So, on the one hand, the Problem-Centred Education can be considered to be a part of the teaching for thinking family since it shares its core features: the view on socio-constructive nature of learning, the content of education as a blend of subject-matter content and explicit thinking instruction, development of meta-cognition and promotion of relevant thinking dispositions. On the other hand, relying on the OTSM-TRIZ problem solving theories, the Problem-Centred Education adds a new content into the teaching-learning process, namely, OTSM-TRIZ models and technologies, thus targeting the development of additional cognitive skills and dispositions, which in the framework of the Problem-Centred Education are referred to as **inventive thinking skills and dispositions** or **problem solving competence** (Sokol, 2007; Sokol, Lasevich, Jonina, et al., 2013). Therefore it would be legitimate to say that teaching competence for organising problem-centred teaching-learning process can also be referred to as teaching competence for organising teaching learning process aimed at the development of students' inventive thinking skills and dispositions in the framework of the subject-matter instruction (see Fig. 1).

Problem solving competence or inventive thinking skills: *“an ability and disposition to solve linguistic, sociolinguistic, pragmatic and other kinds of problems when no typical solution is available”* (Sokol, 2007, p. 56) and avoiding a large number of trials and errors (Sokol, 2007, p. 46).

* From Russian *Общая теория сильного мышления (ОТСМ), Теория решения изобретательских задач (ТРИЗ)*.

Figure 1 The Main Content Components of the Problem-Centred Education: General View

b. TRIZ-Based Educational Movements and the Problem-Centred Education

The Problem-Centred Education is an umbrella term and is also referred to as OTSM-TRIZ pedagogy (Терехова & Нестеренко, 2012). It includes complexes of pedagogical technologies based on the system of OTSM-TRIZ models and technologies which I refer to as domain-independent tools or meta-subject tools. Currently, it includes three developed pedagogical technologies: technologies for developing imagination, thinking and speech of pre-school children (Сидорчук, 1998), technologies of problem-centred education (Нестеренко, 2006a) and technologies of the thinking approach to language teaching and learning (Sokol, 2007).

The Problem-Centred Education should be distinguished from other so called TRIZ-based educational movements[†]. Even though, all of them set the priority of developing creative personality able to define and solve problems in different domains, and apply classical TRIZ, TRTL[‡] and RTB[§] instruments as its theoretical basis, the content they offer to teach is different. If the classical TRIZ pedagogy keeps the classical TRIZ content as much as possible, then the Problem-Centred Education is using the improved instruments of classical TRIZ and new OTSM instruments for working with inter-disciplinary problems (Тепехова & Нестеренко, 2012, p. 40). Moreover, in the framework of the Problem-Based Education, the instruments are integrated in the subject-matter content. For instance, the Thinking Approach to language teaching and learning (Sokol, 2007) offers technologies for developing inventive thinking skills while learning English as a foreign language.

Another aspect which is important to highlight is the instruction or the organisation of the teaching-learning process as such which stands behind the content. Any content can be presented to students in a form of a lecture or a scattered set of tasks and lack to involve students in meaningful learning activity, which would not eventually bring to the effective development of their problem solving competence. The Problem-Centred Education relies on a socio-constructive view on learning (Vygotsky, 1978; Леонтьев, Запорожец, Гальперин, & Эльконин, 2005) and is based on the idea of a non-linear nature of learning and thus non-linear organisation of teaching-learning process. This has certain implications on how the process of content acquisition is organised and may differ the Problem-Centred Education from other TRIZ-based educational movements.

Even though the line between the TRIZ-based educational movements may seem blurred, the difference becomes much more apparent once the

[†] For the comprehensive review of TRIZ-based educational movements refer to (Тепехова & Нестеренко, 2012)

[‡] TRTL, from Russian «Теория развития творческой личности», Theory of the development of creative personality.

[§] RTB, from Russian «Развитие творческого воображения», Development of creative imagination.

observation of the real teaching-learning process where students are involved in learning activities that lead to the development of their inventive thinking skills is held on a long-term basis.

c. Aims, Definition, Content and Instruction of the Problem-Centred Education

Aims and Definition

The development of the Problem-Centred education has been driven by the contradictions between a constantly increasing content of education which appears as a result of a general trend of ever-increasing volume of information and speed at which it becomes outdated, of the reduced amount of time available for the acquisition of this content and of vagueness or even absence of information that students will need in future. Hence, the driving problem of education was formulated as follows: „teachers must prepare students to the life that teachers know nothing about” (Мурашковска & Хоменко, 2003, p. 32). The offered conceptual solution has been to move away from structuring educational content by division of content into subjects (see Fig. 2) to organizing it through the study of a problem (Мурашковска, 2004, p. 5) (see Fig. 3).

Figure 2 Model of the structure of education content guided by division of content into subjects (Мурашковска, 2004, p. 2).

In other words, a problem should become a cornerstone, a pivotal component for organization of educational content, the central value in the system (Sokol, 2007; Нестеренко, 2006a, 2006b, 2007) and the domain independent models for defining, analysing and solving problems should become its new structural content component (Нестеренко, 2006a).

Figure 3 Model of the structure of education content guided by the study of a problem (Мурашкова, 2004, p. 8).

The aim of the Problem-Centred Education is then formulated as *“the development of a world view centred on a problem”* (Sokol, 2007, p. 43) and **the Problem-Centred Education is defined as** *„a teaching-learning process which includes meta-subject tools as part of its content; the given meta-subject tools allow to structure and reorganise information with the aim of identifying, analysing and solving problems in various domains”* (Нестеренко, 2006a, pp. 3, 13)

The Problem-Centred Education has been explicitly aiming at helping learners develop skills which are necessary for coping with so called non-typical (creative) problems in various domains avoiding a large number of trials and errors (Sokol, 2007; Sokol et al., 2008, p. 34), where a non-typical problem has been conceptualised as *„the one for which no solution exists or is not known to the problem-solver”* (Sokol et al., 2008, p. 34). The cognitive skills and dispositions which are targeted to be developed in the

Problem-centred education: *“a teaching-learning process which includes meta-subject tools as part of its content; the given meta-subject tools allow to structure and reorganise information with the aim of identifying, analysing and solving problems in various domains”* (Нестеренко, 2006, pp. 3, 13)

framework of the Problem-Centred teaching-learning process are referred to as inventive thinking skills (see Fig. 4).

Content

The content of the Problem-Centred Education contains three main structural components: subject-matter or subject-specific information and thinking strategies which form the building blocks of problem situations and OTSM-TRIZ models and technologies referred to as domain-independent tools used to work with the subject-specific information transforming problem situations into solutions (see Fig. 5).

Figure 4 Structure of inventive thinking (Sokol, 2007, p. 46)

The subject-matter content gets a new format. If subject-matter content is considered to have three structural components – (1) facts which describe objects and processes, (2) strategies which describe transformation of objects and processes, i.e. operations or algorithms of transformations, and

(3) dispositions, which include beliefs, values, and attitudes – then in the framework of the PCE, students are working with the models of objects and processes and with the models of transformation and strategies.

A model is viewed as *“a system represented in mind or in a material world, which being a representation or a reproduction of an object of the study is able to substitute that object in such a way that the study of that representation/reproduction allows us to discover new information about the object itself”* (Штофф В.А., 1966, с 19 in Нестеренко, 2006а, p. 35). In other words, models are a schematic, rough representation of reality. They *“constitute a bridge between the observational and theoretical levels; and are concerned with simplification, reduction, concretization, experimentation, action, extension, globalization, theory formation and explanation”* (Apostel, 1961, p. 3 in Chorley & Haggett, 2014, p. 24).

For example, instead of teaching students specific facts, such as specific historical events, they are offered a general model of a historical event which is described through a specific set of interconnected parameters. The next step is to build a model of any event which will further serve as a model for describing specific events, be it historical, economic, cultural or the like. The same holds true about procedures or methods for action. Instead of teaching students how to identify causes of a specific historical event, they can be build a more general model of how to identify causes of any fact and this model will serve as a basis for various specific procedures (Нестеренко, 2006а).

Building theoretical models allow efficient organisation and transformation of information in the process of problem solving. The developed models further serve as a basis for newly acquired information and as a result work on diminishing the amount of separate content components which traditionally have to be acquired in the subject-matter teaching-learning process. The focus of work shifts from finding a solution to building a strategy for developing solutions when dealing with a given type of tasks. However, as a result, students are not so much supposed to acquire a pool of separate models as to learn HOW to build new models when they face a problem. In order to ensure the effective organisation of the above defined teaching-learning process students should be provided with meta-subject tools that would allow them to build specific models for specific learning contexts.

The meta-subject tools used in the framework of the Problem-Centered Education are the improved instruments of classical TRIZ and new OTSM instruments for working with inter-disciplinary problems. These include the ENV model and the Advanced ENV model (or the Multi-screen model), and a set of ARIZ models. Working with these meta-tools should lead to the development of inventive thinking skills presented in Fig. 4**.

Figure 5 The Main Content Components of the Problem-Centred Education: Specific View

Instruction

The PCE relies on findings from several psychological theories when it comes to building the teaching-learning process, the main ones being the socio-cultural theory of learning (Vygotsky, 1978) and activity theory (Гальперин, 2011; Леонтьев et al., 2005) including theory of developmental education (Давыдов, 1996). Moreover, it takes into account information processing perspective on human cognition or schema theory (R. C. Anderson, 1978, 1984) and various implications of cognitive approaches to learning (Adey, Hewitt, Hewitt, & Landau, 2004; L. W. Anderson, 2004;

** The detailed list of inventive thinking skills defined under each group presented in Fig.4 can be found in (Appendix 1.1 Sokol, 2007)

Bloom, 1984; Emery & Wilks, 1998; Ferretti, MacArthur, & Okolo, 2001; Steve Higgins et al., 2004; Steven Higgins & Baumfield, 1998; Koufetta-Menicou & Scaife, 2000; Krathwohl, 2002; Li, 2011; Naisbett, 1997; Topping & Trickey, 2007; Zohar & Schwartz, 2005), as well as implications of problem education (Кудрявцев, 1991; Лернер, 1982; Матюшкин, 1972; Махмутов, 1977; Мельникова, 2002).

The main implications of these theories for the Problem-Centred Education are manifested in (1) the instructional sequence, (2) method of teaching and (3) dialogic approach in teacher-student interaction.

Within the problem-centred teaching-learning process the instruction is organized through the three steps represented in the Thinking Task Framework (Sokol, 2011; Sokol, Lasevich, & Jonina, 2013) (see Fig. 6).

Figure 6 The Thinking Task Framework (Sokol, 2011; Sokol, Lasevich, & Jonina, 2013)

In step one step, which is suggesting to ‘increase room for thinking’, students are given a problem task which causes a problem situation (Матюшкин, 1972; Махмутов, 1975; Мельникова, 2002) or a cognitive conflict (Adey, 1999; Adey & Shayer, 1994) in student’s minds. The second step invites a teacher to ‘build the stairs with learners’, which can be in-

terpreted as helping students build models with the help of meta-tools. This step involves applying psychological mechanisms of learning and managing the learning activity of students instead of merely letting them look for the solution following a trial and error method. In the psychological literature the given process is referred to as scaffolding (Vygotsky, 1978). It includes developing a system of sub-tasks which would keep challenging students cognitively and would involve students in learning activity leading to building a model or a strategy. This step also includes pursuing students' reasoning. The last step is reflection when students are asked to reflect on the process (procedural steps that helped to build the models), on the meta-tools which helped to build the model and on the model itself, its quality, application scope and limitations. In this step, as well as throughout the process, students are also involved in reflecting on thinking strategies that were used in the process.

Speaking about the method of teaching, it is worth making a distinction between the method of teaching and tools of teaching or resources of teaching (Лернер, 1982). The teaching-learning process is the unity of the activity of a teacher and the activity of a learner. Tools or resources that a teacher can use in this process can be represented in different forms: graphical or pictorial (*images, graphs, videos, etc.*), in a form of tangible objects (*microscope, book, experimental material, etc.*) and in a verbal form (*story, lecture, explanation, etc.*). And a method of teaching is a way of organising learners' activity with the tools or resources, i.e. method of organisation of learners' cognitive activity. Any tool or resource can be used for the purposes of different methods. For instance, a simple picture can be presented to learners and accompanied by teacher's narration. In this teaching-learning situation, learners' cognitive activity will be limited to perception and awareness of new information. If learners are invited to answer questions about the picture they've just heard of, then their cognitive activity is involved in reproduction of knowledge and possibly methods. And only when students are given a picture and a task connected to its analysis, their cognitive activity raises to problem solving (Лернер, 1982). The main method of teaching in the Problem-Centred Education is the research method (or the method of inquiry).

The dialogic approach in teaching-student interaction means that a teacher should have competence in organizing a qualitative dialogue with students while pursuing students' reasoning in the teaching-learning process.

The organization of the above defined problem-centred teaching-learning process requires specific competences from the teacher. The empirical experience^{††} showed the lack of understanding of which exactly competences are required from a teacher for organizing the problem-centred teaching-learning process and why some teachers are more successful in this endeavor while others fail to change their usual teaching habits.

II. The Study of Teaching Competence for Problem-Centred Education

a. Teacher Competence and Teaching Competence

After analysing different approaches to defining teacher competences in Europe, the Thematic Working Group 'Teacher Professional Development' (The European Commission, 2011, 2013) concluded that approaches vary a lot and range from general guidelines (for instance in France, Hungary or Luxembourg) to detailed lists of specific competences (for instance, in Estonia, the Netherlands, the UK). Despite the differences, the international review of both policy documents and research studies done by the Thematic Working Group (The European Commission, 2013, pp. 45–46) allowed to identify key aspects of teacher competences that are commonly mentioned in the majority of studies. These are regrouped in three areas or structural components: knowledge and understanding, skills, and dispositions (which include beliefs, attitudes, values and commitment).

^{††} Among other projects and professional development events there were two international projects supported by the Nordic Council of Ministers in the framework of the Nordplus Horizontal programme which led to this conclusion:

- 2010-2012 Bringing Creativity and Thinking Skills in Educational Process;
- 2012-2014 STEP to Thinking – Summer Schools for Teachers Professional Development.

As stated by Caena (Caena, 2011; The European Commission, 2013) teacher competences imply a wider, systemic view of teacher professionalism, and considers the multi-faceted roles of the teacher on multiple levels – the individual, the school, the local community, professional networks. Whereas teaching competences are focused on the role of the teacher in action in the classroom, directly linked with the 'craft' of teaching - with professional knowledge and skills mobilised for action. It can thus be defined as “[...] *complex combinations of knowledge, skills, understanding, values and attitudes, leading to effective action in situation. Since teaching is much more than a task, and involves values or assumptions concerning education, learning and society [...]*” (The European Commission, 2013, p. 8).

We can, thus, assume then that in order to solve the problem of the lack of understanding of knowledge, skills and dispositions mobilized for action in a problem-centred classroom, a teacher in action has to be studied, and a wider understanding of his underlying knowledge and dispositions has to be sought for. The author has initiated the research which aims at studying teachers' experience of working with the problem-centred education with the aim of identifying criteria and indicators of teaching competence required for organising the problem-centred teaching-learning process. The study described further on is a part of this larger research and is focused on studying instructional patterns of a teacher in action who is organising the problem-centred teaching-learning process.

b. The Study of a Teacher in Action Organising the Problem-Centred Teaching-Learning Process

Study problem and aim

The specific problem the study addressed was to reveal whether there is any core difference in classroom instruction between teachers who are experts in organising the problem-centred teaching-learning process and those who are non-experts.

The aim of the study was thus to identify instructional patterns of expert teachers who build their classroom instruction following the three steps of the Thinking Task Framework (see Fig. 6) and to compare them to those of non-expert teachers. In addition to identifying instructional patterns the study focused on comparing the quality of teacher-student interaction of expert and non-expert teachers.

The given chapter presents the results of the study on one expert teacher (referred further as T2-nk) and focuses only on identification of her instructional patterns.

Research base

The expert teacher whose lessons were analyzed was a Russian as a mother tongue teacher, the head of the Russian language department in the secondary school in Latvia (Daugavpils). The teacher was named as an expert since she had more than 3 years of experience of working with the problem-centred education. In addition, she had more than 10 years of experience of working with the Developmental Education (Давыдов, 1996) and in 1997 she received the title of the best teacher of Russian as a mother tongue.

Data collection method

The permission was obtained from T2-nk to observe and film her lessons during which she was purposefully working through the three steps of the Thinking Task Framework organising the problem-centred teaching-learning process. During one month, from September 2013 to October 2013, the researcher was attending and filming her lessons, occasionally recording the teacher's comments on her own lessons. As a result 16 lessons (40 minutes each) were filmed with forms eight (two groups) and nine (two groups).

Data selection logic

Two consecutive lessons of T2-nk were selected for the purpose of the study analysis since the teacher introduced a new grammar topic. Non-structured interviews of the teacher on her own lesson were recorded. The next four consecutive lessons were selected since these were held with the same group of students and teacher continued working with the same grammar topic. Non-structured interview of the teacher on her pre-last lesson was recorded. As a result, 6 lessons were selected for the analysis.

Data analysis method

In order to identify instructional patterns, the study adapted the analytic approach to modelling the teaching process developed by Teacher Model Group at the University of California at Berkeley, Graduate School of Education (Schoenfeld, 1998a, 1998b, 2000, 2011). The Teacher Model Group developed the model of classroom teaching (teacher-in-action). The core components of the model are based on the assumption that the teacher “has” knowledge, goals and beliefs, makes decisions and takes actions. The model of the teacher, thus, contains representations of knowledge, goals and beliefs attributed to the teacher, and the decision-making mechanism that suggests what actions the teacher is likely to take (Schoenfeld, 2000, p. 249). The model has a descriptive nature and can be used to characterize, in extremely fine-grained detail, what happens in a given teaching session and used for making predictions about teacher’s classroom instruction in various circumstances.

Procedure of the study

The study followed the following procedure:

1. The researcher transcribed all the six lessons of T2-nk;
2. The first two consecutive lessons were then analysed together since they constituted one unit. The same was further done for two other lessons and then, two remaining lessons.

3. The first lesson was divided into 6 episodes and the second lesson into 8 episodes (large action sequences) each containing brief summary of the content of that episode.
4. Each episode (large action sequence) was then parsed into smaller action sequences going down to the level of 'simple talk' (see Fig. 7 for an example of a parsed lesson). Each action sequence was characterized by triggering and terminating event, as well as beliefs, goals, and knowledge attributed to the teacher.

Figure 7 Extract of one example of a parsed lesson

5. The discussion on the parsing was held with the peer following the principles of competitive argumentation. (VanLehn, Brown, & Greeno, 1984). The general idea of competitive argumentation is that *"it's the investigator's responsibility to consider all possible explanations of the situation being examined, and then look at the pro- and con- evidence for each. If every explanation but one is discredited, and that one is credible, then it's the best explanation"* (from the personal email correspondence with Alan Schoenfeld, January 01, 2014). The first parsing was then refined through multiple iterations.
6. After the lesson was parsed, the researcher proceeded to identifying the action sequences where the teacher organised learners'

work with the system of tasks (a problem task and sub-tasks) following the instruction defined by the Thinking Task Framework. The guiding question was to identify whether there is a specific pattern (routine) how the teacher worked through these tasks.

Results and discussion

Doing the same analysis for all the six lessons allowed me to identify a certain pattern in how T2-nk works through the system of problem tasks following the Thinking Task Framework (see Fig. 8). I refer to this pattern as a loop instruction.

As can be seen from Figure 8, the teacher starts with offering students the main problem task, which involves students in the first learning activity in the form of an individual work, pair work or group work. As a result of this activity, students produce their first result, which is then discussed in a plenary session during the teacher-student interaction^{**}. The result of this interaction is involvement of students into the second learning activity during which they work on improving their first result taking into account the conclusions of the plenary session. This is specifically during the second learning activity that the real learning is taking place since students apply new understandings gained during the stage of the social construction of the meaning to the problem task. Students never start doing any other task before they work on the improvement of their first result. The given loop instruction can be repeated several times in the framework of doing one task.

I would assume that organising the instruction in the format of the loop allows planning enough time and steps for learners to build a model or a strategy. Moreover, this is specifically during the first teacher-students' interaction that students have to be offered or reminded of the meta-

^{**} The quality of this interaction is highly important and as stated in the section on 'study problem and aim' it was also assessed following certain defined criteria. The results of this quality assessment are not reported in this article.

subject tools which have to help them build their model or strategy. I can tentatively assume then that the competence of organizing the instruction in a form of a loop seems to be essential if one wants to work with the problem-centred education.

Figure 8 An expert teacher's (T2-nk) instructional pattern for working through a system of problem tasks following the Thinking Task Framework in the framework of the problem-centred teaching-learning process

The meticulous analysis of the expert teacher in action has to be repeated for other expert teachers as well before any conclusion on a common pattern can be made or any specific conclusions drawn. In addition, this pattern has to be compared to non-expert teachers' instruction in order to reveal the main difference between the two and identify those essential components of classroom instruction which make expert teachers succeed in organizing the problem-centred teaching-learning process and which are missing in the instruction of non-expert teachers.

Conclusions

The given chapter presented a brief overview of the essence of the problem-centred education and the respective teaching-learning process.

This provided the implications on the general competences (i.e. knowledge and understanding, skills and dispositions) a teacher needs in order to be able to organize the defined process. These competences include both those which are specific for the problem-centred education (PCE) and those which are shared with other teaching for thinking approaches and make part of the competences required for organizing effective teaching-learning process as such.

Among others, these essential competences include the following:

1. Aims and objectives of the Problem-Centred Education
 - Dispositions:
 - belief in the need to develop students' worldview centred on a problem;
 - belief in the constructive nature of learning.
2. Content of the Problem-Centred Education
 - Knowledge and understanding:
 - knowledge and understanding of the subject matter being taught;
 - knowledge and understanding of mental modeling and strategy development;
 - knowledge and understanding of the meta-subject OTSM-TRIZ tools;
 - knowledge and understanding of inventive thinking skills and their connection to the meta-subject OTSM-TRIZ tools;
 - knowledge and understanding of thinking strategies and higher-order thinking skills
 - Skills
 - Skills to select the relevant subject-matter content, single out features common for specific types of tasks within that content, and transform this content into a system of problem tasks (a problem task and sub-tasks)

that would create and maintain cognitive conflict in students' minds and that requires developing a model or a strategy. The task should have the potential of applying the meta-subject tools for developing the model, strategy.

3. Instruction of the Problem-Centred Education

- Skills
 - ability to organize the instruction following the three steps of the Thinking Task Framework: create cognitive conflict or a problem situation in student's mind, involve students in learning activity for building the solution and reflect on the process and result.
 - ability to use the method of inquiry for organising students' learning activity;
 - ability to hold qualitative teacher-student interaction;

The weaknesses of the given general list are twofold: firstly, the list is not complete and secondly, it is too general.

In order to address the given weakness, the author initiated the research that should result in measurable criteria and indicators of the problem-centred teaching competence. The first study presented in the given chapter focused on classroom instruction and allowed to identify a specific loop instruction which seems to be one of the characteristics of teachers who are experts in the problem-centred education. Further study is required in order to confirm the given hypothesis and to extend the understanding of teaching competence required for organizing the problem-centred teaching-learning process.

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