IMPROVING TEACHER CANDIDATES' PROBLEM -SOLVING SKILL

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Efficient problem-solving skill is one of the fundamental competencies that teachers need to possess. Teaching is a practical activity. Nevertheless, pre-service teacher education mainly aims at developing knowledge rather than improving candidates' functional and flexible skills that are essential for everyday practice. This theoretical framework aims to give a theoretical approach for improving candidates' problem-solving skill based on the result of pedagogy, psychology and management science. This framework relates to the nature of problem-solving process, the main features of teachers' problem and decision-making process and the possibilities for improving problem-solving skill during pre-service teacher training.

Keywords: Teachers' competency; Improving problem-solving skill; Pre-service training.

1. General introduction

Teachers' tasks are getting more and more complex because of the technically, economically, socially, and politically changing world. Teachers have to face with increasing challenges (new ways of technology, motivation, team work, differentiation, classroom management, assessment connection with parents). Nearly every class has students facing integration problems, students who are under-motivated, aggressive or have other behavioural problem, students who have learning problems. Most teachers agree on the areas that need greatest development are preparing for students with special needs, handling behavioural problems and discipline (OECD 2009: 62). Gender role stereotypes also influence teacher-student classroom interactions (on school subject; student ability, achievement, behaving, motivation) and can cause further problems in teaching-learning process (AAUW 1998, Scantlebury 2006). Another fact that can affect the features of teachers' problem is the high number of female teachers compared to male teachers in education. In 2008 nearly 70 % of teachers were female in TALIS countries (OECD 2009: 16-17). A Hungarian research (Mrázik 2009) showed that female teachers find the main pedagogical activities more difficult comprised to their male colleges. Behind many situations causing problems for teachers can be one or more reasons mentioned above.

The whole teaching-learning process (from planning to evaluation) is textured by making decision and solving problems. Therefore, developing future teachers' problem-solving skill should be one of the main aims of pre-service (initial) teacher training.

Our current on-going research (at Eszterházy Károly College, Hungary) deals with the following topics:

How can initial teacher training/ preservice teacher training help teacher candidates to prepare for pedagogical challenges?

How can it develop candidates' pedagogical problem-solving skill?

What are the features of pedagogical problems?

How do teachers identify, interpret, analyse, reflect on a problem and find a solution for a situation?

What are the features of teacher's decisions?

What kind of tools can help future teachers making long-term decisions?

What are the differences between beginner and exported teachers in solving pedagogical (classroom) problems?

This theoretical framework (based on former results in pedagogy, psychology and management science) may concern:

1. the general nature of problem-solving process,

2. the main features of teachers' problem-solving and decision-making process,
3. models and tools as a possible way to improve teacher candidates' problem-solving skill.

2. Teachers' problem-solving process

2.1 Meaning of the word "problem"

First of all, it needs to be explained what is the meaning of the word: problem. There are many approaches and definitions of it. A short draft of the main changes of its meaning begins with behaviourists. Skinner said a problem exists when a person cannot give a successful response for a stimulus (Skinner 1973). According to the gestalt psychologist a problem is "when a living creature has a goal but does not know how this goal is to be reached." (Dunker 1945: 1). Cognitive approaches found that a problem exists when there is a "barrier" between a given situation and the desired one (see Johnson 1972, Jackson 1983, Dörner 1976, Kahney 1986). "Whenever you have a goal which is blocked for any reason – lack of resources, lack of information, and so on – you have a problem." (Kahney 1993).

Many approaches differentiate between task and problem. Task is where the "barrier" is known or the solution of the situation can be reached with a known algorithm. (Kantowsky 1981). Important differences between task and problem (unfamiliar task) problem are the distance (gap) and interaction between task requirements and solver. Therefore a situation can be task or problem depending on the personal characteristic. "The same task may constitute a problem for one solver, but not for another (Funke and Frensch 1995)".

I use the following statement defining pedagogical problem and pedagogical task. A teacher faces a pedagogical problem when the task is unfamiliar and one cannot find a way for the solution related to teaching-learning process. When a teacher has some difficulties relating to teaching-learning process but the solution process is known and done by routine I call it task.

2.2 The problem-solving process

Problem solving process in general is determined as a cognitive process directed at transforming a given situation into a goal situation when no obvious method of solution is available (Mayer and Wittrock 2006).

Psychologists and researchers examined the nature of problems from the beginning of the 20th century and the nature of problem-solving process especially from the 50's-60's. So there is a huge bibliography of researches on problem-solving process. To see the changes it is necessary to pick out some important steps of its history. Behaviourists saw problem-solving as a passive, reproductive process of stimulus and response (Thorndike 1911). Gestalt psychologists like Köhler, Wertheimer, Duncker exclaimed that problem-solving was a productive thinking process where the structural reorganization of the representation of the problem leads to a flash of insight. Cognitive scientists went further and started to examine the different component of the process between stimulus and response (perception, different type of thinking, decision-making etc.). Allen Newell and Herbert Simon (1972) had a new theory focused on problem space. They found that problem solving is to search in a problem space that has more components such as current state, the goal state and the set of operators for transforming the given state into the goal state. Cognitive scientists also found that real-life problem-solving situation is a complex process. The researches on Complex Problem Solving have a North American and a European route. In North America, researches initiated by the work of Herbert Simon, mentioned above, focused on problem solving by different knowledge and field (mechanical, political, managerial aspect). While in Europe Donald Broadbent and Dietrich Dörner had the main influence of the development of problem-solving researches by examining the nature and different aspects of the process. (Funke and Frensch 1995). They gave a definition for complex problem-

solving: “Complex problem solving occurs to overcome barriers between a given state and a desired goal state by means of behavioural and/or cognitive, multi-step activities. The given state, goal state, and barriers between given state and goal state are complex, change dynamically during problem solving, and are not transparent. The exact properties of the given state, goal state, and barriers are unknown to solvers at the outset. Complex problem solving implies the efficient interaction between a solver and the situational requirements of the task, and involves a solver’s cognitive, emotional, personal, and social abilities and knowledge.” (Funke 1995). Complex problem solving situation has the features of intransparency, politely, complexity of situation, connectivity of variables, dynamic development, time-delayed effect (Funke 1991).

2.3 The features of teachers’ pedagogical problems of teaching-learning process:

Following Funke’s definition (Funke 1991) mentioned above, teachers’ pedagogical problems – that are not simple tasks - are complex problem-solving situations. So pedagogical problem situations are complex because they:

- have a lack of clarity of the situation (intransparency);
- have multiple goals (politely);
- have a large number of elements relevant to the solution process (complexity of situation);
- are highly interconnected with other situations (connectivity of variables);
- are dynamically changing over time (dynamic development);
- do not always have immediate consequences (time-delayed effect).

3. Teachers’ decision-making process

3.1 Characteristics of problem solving process

Following Bloom (Bloom 1956) taxonomy Heppner and Krauskopft (1987) mention cognitive, affective and behavioural characteristic of real-life problem-solving. Funke in his definition of complex problem-solving mentions cognitive, emotional, personal, and social abilities and knowledge of the solver (Funke 2002). To sum up, the problem solving process has three main features that depend on personal skill and knowledge:

- cognitive characteristic such as mental skills such as perception and representation of the problem, attributing (reasoning), critical thinking, creative thinking, planning, making judgment and decision, reflecting;
- affective characteristic such as emotions, motivations, attitudes, and feelings;
- behavioural characteristic or social component: physical skills that can help acting after decision-making.

3.2 Decision making and teaching-learning process

As we have demonstrated above, decision-making is a cognitive characteristic of problem-solving process. While the behaviourist aspect studied how teachers behave in certain situations (during classroom process), the cognitive point of view went further. Researchers started to study: whether there is any conscious or unconscious decision behind their behaviour. Whether there is any reason, purpose behind their decision. What kind of reasons, aims can be behind teachers’ decisions.

Teaching is a planning-acting-evaluating process. It was Shavelson who argued that decision-making plays a central role in teaching-learning process because “any teaching act is the result of decisions, whether conscious or unconscious” (Shavelson 1973: 144). From the 70’s there has been more research aimed at teachers’ thinking processes focused on teacher decision-making during interactive teaching (see Clark and Peterson 1986, Shavelson and Stern 1981).

According to the phases of the teaching process there are two main types of decision: short-term, immediate decisions during the interactive teaching and long-term, reflective decisions during the planning process (Sutcliffe and Whitfield 1979). However the two are linked and affect each other and often there is no strict border between them.

In a classroom situation teachers need to react to many situations. The reactions to these situations are mostly generated automatically without conscious decisions because of the quantity of impression made by children, subject etc. and the lack of time to plan and reflect on each decision.

Kansanen's starting point is that the personal belief system is thought to be behind the decisions (Kansanen 1995). He made a connection between the intuitive - rational personal belief system (Kindsvatter, Wilen, Isher 1992) and conscious - unconscious selection behind the decisions. Broadbent also emphasizes the distinction between cognitive problem-solving processes that operate under awareness versus outside of awareness (Broadbent 1977). Klein's research showed that in real-life problem we use the current goal and the current circumstances to draw from memory of those actions that have worked under similar circumstances in the past (Klein et al. 1993, Klein 1997). So it can be said that during interactive teaching teachers have mainly unconscious, intuitive, *short-term decision*-making process where routines, schema thinking and recipes play important role (see Brown and McIntyre 1993). That's why instead of any explanation teachers give a simple interpretation their immediate classroom decision: "that would be relevant to the content and the situation" (Kansanen 1995). The orientation of decisions can be different depending on the distance between the plan and the classroom reality (Morine-Dershimer 1978-79). In case of minor discrepancy between plan and reality the decisions are reality oriented. Wider discrepancy between the plan and the reality cause problem oriented decisions while large discrepancy can cause postponed decision making. The former situation I call simple task of teachers with routine based decision. The latter situations are problem situations where finding solution needs long-term decision-making process with analysing, reflecting and planning.

Long-term decisions are made usually during the planning and evaluating process, before and after interactive teaching. Strategy thinking plays main role in this process. The authors' hypothesis that using problem-solving and decision-making methods and models can help teachers for strategy thinking and finding efficient solution of their problem during planning process. Also the development of long-term decision-making skill can effect efficiently or short-term decision-making. In Figure 1. There is comparison between short-term and long-term decision-making process of teachers.

	Teachers' problem-solving and decision-making	
	During interactive teaching-learning process	During planning process
Dominant characteristic of problem-solving process	Behavioral, physical aspect	Cognitive aspect
Duration of decision-making process	Short-term decision-making process	Long-term decision-making process
Level of consciousness	Mainly unconscious decision (outside of awareness)	Conscious decision (with awareness)
Belief system	Intuitive base	Rational base
Type of the problem	Mainly familiar task	Mainly real problem (unfamiliar task)
Thinking type	Schema thinking by using recipes	Strategy thinking
Selection of decisions	Immediate, spontaneous selection made by routine	Planned selection
Features of thinking process	Mainly reproductive	Mainly productive
Level of handling problem	To handle symptom of the problem	To handle reason of the problem

Figure 1. Features of teachers' problem-solving and decision-making process

4. Teachers' competencies and problem solving skill

4.1 Problem-solving skill in teachers' competencies

Problem-solving skill is one of the essential competences of teaching-learning process. This competence either mentioned directly or referring to its component is involved in every descriptive document that work with teacher's main competencies.

For instance, the European Commission defined the key features of teacher expertise such as:

- reutilisation – i.e. the development of patterns of action and teaching repertoires;
- domain- and subject-specific expertise in recognising patterns (recurring situations) in the complexity of classroom life;
- sensitivity to social demands and dynamics in the classroom;
- understanding problems;
- flexibility and improvisation;
- critical examination of one's professional practice (in school and national contexts, as well as in professional dialogues) (European Commission 2011)

It is seemed that these features of expertise are strongly related to problem-solving skill.

In Hungary, a government edict of teachers' professional development contains problem-solving skill beside dozens of other teachers' competences (326/2013 Korm. Rend.).

4.2 The role of pre-service teacher training and teachers' problem-solving skills

It can be said that the program of pre-service teacher training is usually divided into general education, specialized knowledge (of chosen subject), professional knowledge (of the nature of education, teaching-learning process) and practice (of personal skill). (Lawrence 1977). However, pre-service training is often criticized as it does not give enough support for candidates to improve their professional abilities and skills (Allen 1989). Teacher education mainly aims at developing knowledge rather than improving candidates' functional and flexible skills that are essential for everyday practice (Kagan 1992). For instance in Hungary teacher education has been still rather theoretical. Consequently there is a big gap between theoretical preparation and everyday school situations (Falus 2006). The former provides theoretical and scientific knowledge of pedagogy and psychology while the latter requires practical skills and abilities. A recent survey showed that Hungarian teacher's candidates are not prepared for the real-life classroom problems (mentioned at the beginning of this paper) during the pre-service training in Hungary (Jancsák 2012).

Shulman divided teachers' knowledge to subject matter knowledge (concerning the field of the subject itself); content knowledge (concerning the teaching and learning process of the subject); pedagogical knowledge (concerning handling pedagogical situations such as classroom management, discipline, handle children's behaviour, decision making, problem solving) and curriculum knowledge (Shulman 1987). It can be seen that making decisions and solving pedagogical problems are not a subject specific knowledge so every candidate should possess it on a high level. The main question is that how (with what kind of methods?) and which part of the pre-service training pedagogical problem solving skill can be improved.

This question is not easy to answer because of the complexity of pedagogical problems. In spite of the common conditions every situation is different and depends on many factors. In general personal factor, situational determinants and system characteristics influence the problem-solving process (Funke 1991). Other division makes differences between internal factors (experiences, cognitive variables, non-cognitive variables) and external factors (problems structure, problem context, environmental factors) (Funke and Frensch 1995). Teachers' judgments and decisions can depend on their characteristics (beliefs, personality, conception of subject matter, conceptual complexity); their

cognitive process (information selection, inference of judgment, decision); their information about students (ability, behaviour, participation, parents of students); nature of the actual task (aim, activities, materials, groping); classroom and school environment etc. (Shavelson 1981).

5. Improving teacher candidates' problem-solving skills

5.1 Tools and models for successful problem-solving

Teachers' pedagogic problems are complex and not subject-specific phenomena. That means there are no two same situations because of the factorial differences that influence every situation. However, there are many books on methods for handling certain situations in classroom process. These recipes can be good suggestions, used mainly in short-term decisions. These can be used for task or to handle the symptom of the problem. However, handling the symptom in many cases is not enough and teachers need to go deeper through reasoning, analysing, planning, reflecting etc. These problems need long-term decisions. Numerous problem-solving models and decision-making tools are used widespread in manager science and in leader training. Our hypothesis is that teachers can use these tools efficiently during long-term decision-making process. These models can help to break down the features of the problem or the process of the solution-finding into different parts and levels. With these contributions, teacher candidates can build their own strategies to solve their problem. They can also help teachers to transfer their knowledge into everyday practice and make successful long-term decisions that can affect the short-term decisions too.

Below you can find a list of some models and tools that can be useful during long-term decisions, used in manager science. They are not domain-specific models so teachers can use for any kind of problems.

5.2 Models where the problem-solving process is divided into steps

Many approaches of problem-solving gave descriptions of the different stages of the process. The common stages are perception - solution finding - acting (saluting) – evaluating. The differences among the descriptions can be the number of the steps, the emphasis, the order and the techniques they used in each step. At the beginning the description emphasized the linearity of the process. Later dynamic and cycled features of the process were stressed. To mention some examples: Wallas (1926) set out four phases: preparation, incubation, illumination, verification that Osborn (1953) improved the model of Creative Problem Solving: preparation, analysis, ideation, incubation, synthesis, evaluation. From this model, based on Sidney Parnes' improvements, Isaksen and Trefflinger (1985) created a model of steps of objective finding, fact finding, problem finding, idea finding, solution finding, acceptance finding. Pólya's (1957) starting point was mathematical problems and created four steps: understanding the problem, devising plan, carrying out the plan, and looking back. Another popular cycle is called PDCA (plan-do-study-act) made by Edwards Deming (Deming 1986).

5.3 Tools for finding possible causes of a problem

Fishbone Diagram (or cause and effect diagram) was created by Kaoru Ishikawa in the 60's. It helps grouping causes into main categories like people, methods, process, materials, and environment.

5.4 Tools for generating solutions

SCAMPER model starting from the problem situation provides unusual cognitive operation (substitute, combine, adapt, magnify, put to other uses, eliminate, rearrange) for finding new solutions made by Alex F. Osborn and developed by Bob Eberle (1984).

5.5 Tools for consideration and decision-making

KJ model (Affinity Diagrams) made by Kawakita Jiro helps to analyse and categorize information or random ideas.
Decision tree can show the consequences of the decision by possible algorithms. One type of this tree is The Vroom-Yetton decision tree, which was originally described by Victor Vroom and Philip Yetton (1973).
Force Field Analysis originated form Kurt Lewin (1943) provide a frame for analysing the positive and the negative side of a possible change.

5.6 Methods where the process is divided by its characteristic

Six thinking hats invented by Edward de Bono (1985) based on parallel thinking. This method can help to divide the facts, the emotions, the discernment, optimistic side and the creative ideas of a problematic situation.

6. Conclusion, final suggestion

The lack of teachers' (especially beginning's) practical skills leads to misunderstanding, helplessness and bad decision-making in problematic classroom situation. Therefore, theoretical preparation of pre-service training should provide more practical approach that can help candidates to transform their theoretical knowledge into everyday practice. The training also should put more emphasis on improving candidates' problem-solving skills by analysing and understanding pedagogical situations. Results of gender pedagogy showed that teachers' attributions and decisions are influenced by gender stereotype (AAUW 1998, Scantlebury 2006). Gender studies in pre-service training can contribute to avoiding problems of the teaching-learning process based on gender stereotype by, for instance, widening cognitive perspectives, improving sensitivity especially towards students' need and interest (Allan 1993); separating fact form teachers' feeling, attitude and stereotypes in a classroom situation. One practical approach can be the using of problem-solving and decision-making models and tools. Creating successful long-term decisions by teachers during the planning process can positively affect short-term decisions, too.

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