THE TRANSVERSAL COMPETENCE FOR PROBLEM-SOLVING IN COGNITIVE LEARNING

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ABSTRACT

The opportunities education provides to develop the student's ability to use cognitive skills to understand and solve problems whose solution is not obvious and the student's willingness to engage in problem solving as a constructive and thinking citizen are essential for the realization of the approach from transversal competences to transversal personality. The study puts an emphasis on exploring the conditions for the development of transversal competence for solving educational-and-cognitive problems that is portable through different learning contents, different activities and ages. The highlights of pupils' cognitive development have been used as a basis for turning them into subjects of problem-based training aiming at the development of transversal competence to solve problems. The here developed task system for solving integrated problems in science education allows diagnosing the level of competence of cognitive-learning problem solving as transversal. Achieving this result in school education is directly linked to the teacher's competence to design a proactive educational environment i.e. to the requirements for the training of pedagogical specialists in existing conditions.

1. INTRODUCTION

The idea that the key competences formed in the course of school education are the foundation for cultivating any special competence for full personal and professional development serves as a basis for a continuous research on the level of knowledge and skills that students have acquired at the end of the compulsory stage of their education and on the to which extend this would allow them to realize and compete in the labor market. The evaluation of mathematical, reading and science literacy of the students through PISA criteria includes tasks related to solving problems that in particular measure the ability of students to use the knowledge acquired in school to cope with the challenges of real life. However, unlike the traditional evaluation of PISA, assessment of problem-solving skills focuses on the ability of students to think and manage the solving problem process by putting them in unfamiliar situations. This type of tasks were first included in the PISA 2003. test and were the first attempt at standardized assessment and definition of problem-solving skills and their role in future development of young people and their effective and active contribution and functioning in society.

It is believed that these skills are not formed in the training of just one subject and are not limited to a specific content area. They are interdisciplinary and are the product of the overall preparation of the students. The PISA 2003. concept for problem solving skills is further developed in 2012. when the assessment of this module became a computer-based test. The new format allows computer simulations of problem situations to be used, as well as a focus on the so-called interactive problems, the solving of which is the students main prerogative. This approach was also applied in the testing in 2015, which includes assessing student skills for cooperative problem solving. Thus, the study develops further to test the ability of young people to deal with various problems in significantly more complex situations requiring cooperation and mutual

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assistance (OECD, 2014; Petrova, 2016: 3-4).

Already in 2012, Bulgarian students are lagging significantly in terms of their ability to use cognitive skills to solve **real-life problems**. As it can be seen from Table 1, the 9th graders in Bulgaria are in the last place with respect to this indicator.

The data in this category are quite controversial, as in other countries, such as Denmark and Germany, the students have quite high scores in the general education categories (mathematics, reading comprehension and science) but still show significantly worse than expected problem-solving ability. Bulgarian 9th-grade students, however, have undoubtedly very little ability to use their knowledge to solve problems compared to students from other countries with similar knowledge in mathematics, reading, and science.

Table 1. Results in solving real-life problems PISA 2012

Problem-Solving		Problem-Solving	
Korea	13,98	Taipei (China)	-9,74
Japan	10,64	Belgium	-9,90
Serbia	10,62	Denmark	-11,43
USA	10,37	Cyprus	-11,73
Italy	9,92	Germany	-12,47
England	7,98	Malaysia	-13,88
China	7,69	Turkey	-14,04
Brazil	7,09	Estonia	-15,00
Australia	6,91	The Netherlands	-15,86
France	5,19	Hong Kong	-16,31
Singapore	1,55	Ireland	-18,45
Norway	1,08	Ireland	-19,50
Chile	0,96	Croatia	-22,38
The Czech Republic	0,85	Monte Negro	-24,46
Canada	-0,2	Uruguay	-26,84
Sweden	-0,92	Israel	-27,66
Portugal	-2,96	Slovenia	-33,57
Russia	-3,80	Hungary	-33,87
Slovakia	-4,77	UAE	-43,20
Austria	-4,88	Poland	-44,11
Columbia	-6,91	Shanghai (China)	-51,46
Average OECD	-7,00	**Bulgaria**	**-54,33**
Finland	-7,98		

[1] Negative values show that the students in the respective country are doing worse in solving real-life problems than students with similar results in maths, reading comprehension and science world-wide.

In one of the first surveys - the "PISA 2012" survey, Bulgaria occupies the penul-timate 43rd place, with the 9th graders reg-istering their lowest results in terms of problem-solving compared to their achievements in mathematics, reading com-prehension and natural sciences, which are also tested by PISA - 402 points vs. 500 points on average for the OECD countries. Bulgarian students have serious difficulties in researching and understanding problems, presenting and formulating, planning, im-plementing, controlling and rationalizing certain situations. This is why they fall below the first (33.3% of the students, with an av-erage of 8.2% for OECD countries) or are in the first level of results, with only 1.6% in the fifth and sixth levels where results can be considered excellent.

In the context of cooperative problem-solving to the PISA 2015 problems, only 2% of students show a high level of cooperation, successfully overcoming disagreements in the team and **taking effective action to solve the problems**; the average result of Bulgarian students in cooperative problem solving (444 points) is lower than the average for all participants (500 points).

The search for ways to increase the effectiveness of learning, the interest and motivation for learning is a major task of modern education and an important determinant of its quality. Problem-based learning is seen as one of the possibilities to achieve this increase.

The main characteristics of the problem-based education **were** defined by Leemkuil, H., T. de Jong, S. Ootes, 2000: 38 and are based on cognitive components described by Jonassen, D. H. and Tessmer, M. (1996): knowledge (information, concepts, rules and principles); structured knowledge (building information networks, semantic maps/conceptual networks and mental models); Skills for expanding knowledge (constructing/applying arguments, applying analogy and deduction); metacognitive skills (goal defining and goal setting, cognitive resource allocation, initial knowledge assessment, progress assessment/ error checking); motivation components/components of attitude (effort, persistence, conscious engagement); self-knowledge (clarification of what I know first, clarification about what sociocultural knowledge we have, awareness of our personal strategies and awareness of our cognitive prejudices or weaknesses) (Leemkuil, H., T. de Jong, S. Ootes, 2000: 38).

The development of modern education is directly related to the pursuit of different approaches enabling the development of the personality in multiple dimensions: social, psychological, emotional, intellectual, cognitive

and cultural. Organizing an educational environment that allows for such development and improvement of learning efficiency is a key priority of secondary school education. Problem-based learning is an excellent opportunity to achieve this as it can be realized both inside and outside the classroom, its possibilities with respect to the interactions of the performing subjects as well as their personal experience makes it a possible alternative to the traditional training and classroom and directs it into the field of constructivist interpretation of modern learning. Problem-based education is at the heart of developing cognitive autonomy of students and their creative abilities (Petrov and Tsankov, 2010: 212).

2. COMPETENCE-ORIENTED EDUCATION - NATURE OF THE RELATIONSHIP COMPETENCE (AS A PERSONAL QUALITY) AND COMPETENCIES (AS NORMATIVE REQUIREMENTS)[1]

The rapid development of modern economics and the scientific-and-technological progress along with the ongoing tendencies for working democracy and humanism in society require that the educational system should change and transform from a system of long-life knowledge to a system of mastering a long-life competence. This transformation may turn into a solution to the problems of improving the quality and efficiency of modern education wherein modern education is seen as a process oriented towards real life and practices and an important economic potential, a main factor of social and cultural integration in a global world. The necessity for a new quality of educational results is obvious and therefore requires the employment of the competence-based approach on all levels of education as it meets the necessity for **educational results** in the shape of competence as an *indicator of human capital*.

The competence-based orientation of contemporary education is a world-wide tendency. The competence approach is therefore part of the paradigm of educational theory. Unfortunately, it enters educational practice as a component of the normative and administrative tools of the State Educational Requirements rather than as the main priority in a well-planned educational reform. Thus, the modernization of education and the improvement of its quality are impossible to realize at the expected rate. One of the main reasons for this lag is the inadequacies in the application of the competence-based approach in education sciences and in educational theory and practice in both high-school and higher education. Hence, it is of vital importance to provide for adequate educational environment stimulating the employment of the competence-based approach not only in modern educational theory and practice but also in the educational activity of the teacher and the university professor. All this is in line with the idea of training the future pedagogical specialists with respect to the contemporary requirements regarding the essential competences of the modern students and the possibilities for their full formation and development in the system of the school education. The requirements for this training are also related to providing a variety of methods and tools that reveal new opportunities in the learning environment. They definitely allow the educational process to be supported and thus organized in a way that takes into account the individual needs of the learners and also enable them to build up competences, in particular the competence of problem-solving. so necessary in a knowledge-based economy. The implementation of this transformation requires a thorough readiness of the future pedagogical specialists for the implementation of problem-based learning, and their personal competence to solve problems in a pedagogical context needs to constantly be developed. This requires the design of the educational environment to be efficient, effective, yet attractive and technologically enriched, to take into account the needs of the participants in the educational process and to deliberately and systematically project a type of training that is based on the solving of integrated problems from the real pedagogical practice ensuring that the future professionals are building competence to solve problems in the didactic and methodical context.

A number of studies and analyses have put the focus on literacy and competence as key concepts in modern education (Tsankov and Genkova, 2009; Toshev, 2010; Tafrova-Grigorova, 2010). When applying the competence-based approach, the educational results and achievements in learning and learning activities are not so much related to acquiring knowledge, skills and personal development,

[1] The conceptual framework presented in the paragraph has previously been published in Tsankov, N. (2012). High school students as subjects in the process of formation and development of cognitive competencies. *Romanian Journal of School Psychology, 5(10),* (47-54).

as to mastering competences necessary for the personal development and the social practices of the modern individual. Therefore, the technocratic paradigm should be replaced by a more humanistic **individual-oriented and constructivist paradigm** of education, aiming at the formation of personal and socially important characteristics of the individual such as independence, self–control mechanisms, self-reflection, and responsibility. Arguably this process occurs against the background of the formation of all the other key competences.

The characterization of the competence-based approach requires an analysis of the *concept/event* pair 'competence - competency'. It is a textbook truth that concepts occur after the objects and phenomena they generalize, while the words that denote the concepts only signify them terminologically. The phenomenon of competence therefore has been in existence long before the term that refers to it came to be.

Before presenting the major properties of the concepts *competence* and *competency*, it is necessary to define the terms concept and event. All categories (constructs) characterized as a hypothetical entity in education sciences come under the umbrella of the cover term *concept*. These entities are products of reasoning and theoretical thought. They describe or explain other, more concrete and specific entities. A variety of categories can be included here, such as consciousness, reason, intellect, goal, knowledge, skill, **competence**, ability, motivation, will, mental process, etc. (Radev, 2005: 130). This gives grounds to define the concept *competence* as both an integral personality property and an element of the environment, i.e., as a succession of events in which the individual participates with his/her competencies.

Generally, an event is a phenomenon that has short duration; it occurs as an identifiable, observable change. Defining the essence of the representation of the cause-and-effect relations between the concepts *situation* and *event*, John Lyons contends that a situation can be both static and dynamic. A static situation (state) is homo-geneous, has duration, and undergoes no change during the period of its occurrence. The dynamic situation is characterized by change, different temporal contours, and sometimes by heterogeneity. According to the British linguist, two basic situation types are formed as regards the duration of the dynamic situation: process, occurring over a long interval and event, taking place momentarily (Lyons, 1977: 483).

M. Levunlieva discusses this phenomenon from a different perspective arguing that "ontologically *events* and *actions* are the points of interaction between the surrounding world and the individual experience. They represent the dynamics of the relation between objective and subjective reality, against the background of which personal experience becomes motivated and circum-scribed by the environment. *Processes* and *states*, on the other hand, represent the resultant state of affairs which occurs in the aftermath of an *action* or *event*" (Levunlieva, 2011: 204).

From a pragmatic point of view, all these discussions amount to the one and the same issue; the problem of being able to cause an event or perform an action in a manner that is suited to the situation and brings about necessary and expected results. Far in the past there were people of enlightened spirit mastering encyclopaedic knowledge of the universe. They were adept in a skill or some other activity-art, science, technology, etc. Now we speak about competence in a more narrow sense, in association with professional activities. Competence seems to exceed our notions of being informed, experienced, educated, proficient, etc. "Competence does not mean a universal education but authority and recognition of a skilful and knowing individual, an individual with high self-awareness of his/her own abilities and talents who uses them rationally for the benefit of the society and his/her own spiritual and material welfare" (Naydenova, 2004: 63). Competence is related not only to gaining knowledge and experience but also to developing certain types of skills in the individual, to the broadening of the boundaries of his/her knowledge and refining the spirit through education and self-education. The competence required today is manifested and developed through 'the combining of strong characteristics - innate and acquired, (…) and a strong know-how' (Delor, 1997).

Professional competence was an object of an extensive debate (in the 80's and the beginning of the 90`s) regarding both the structural and functional content of the concept in the context of the evaluation of the results of professional education and in the search of an adequate definition of the level of professionalism. After J. Raven's book "Competence in modern society" was published in 1984. the interest in the concept of competence quickly rose and a distinction had to be made between *competence* and *competency*. Various interpretations on the volume and content of both

terms appeared which made their differentiation and systematization difficult, especially after 1990. when a new evolution in the development of the two notions began.

The comparative semantic analysis shows a difference in meaning between the two notions. "Competency is realized through a certain action in a practical performance on the basis of an already acquired system of knowledge, skill, experience and prerogatives of an individual in a certain field, (…) while competence is a broader term; it is much richer in both potential and effective content. Competence is related to personal characteristics and shows completeness, a result of an action or an activity" (Naydenova, 2004: 65). It is related to the ability of the individual to function adequately (performance) in a professional field where he/she demonstrates behaviour that meets certain set requirements (Burke, 1989). Although this definition is to a certain extend limited, it allows the consideration of *competence as behaviour and the evaluation* of how, when and if the specialist applies his knowledge into an activity or context through certain skills and attitudes.

Competence suggests at least minimal experience in applying a particular *competency*. Therefore the notion of competency is seen as a result of education - readiness, adaptability, and goal achievement; competence is most commonly understood as an integral quality of the individual which manifests itself through the individual's abilities and readiness to act; it is based on knowledge and experience gained in the process of education and socialization and oriented towards an independent and successful performance in an activity (Selevko, 2004: 139-140). A more pragmatic point of view on competence considers it a personal characteristic (quality) of the individual (student) that helps him/her to fulfil/achieve what is important to him/her and society.

Thus, the competence of a student or an individual can be defined as "an integral individual characteristic manifested through the specifics of the ability of the individual to organize and use different types of knowledge and skills which allow him/her to find efficient solutions and have efficient behaviour in particular situations" (Radev, 2005: 162). This mostly didactic interpretation of competence can be further completed by adding psychological accents to its interpretation and seeing it as "a possibility in the form of a skill of the individual to function efficiently in his/her environment; a characteristic of an individual having a number of behavioural patterns that help him/her to act selectively and actively; to successfully affect his/her material and social environment and change it for the purpose of his/her own intentions and goals" (Desev, 1999: 260). The above-mentioned definition of competence as a psychological phenomenon shows that competence is related to all subsystems of the individual, to the individual's entire development and to the results of this development and self-development.

As it is evident the complex phenomenon and concept of competence (used as a collective noun in the singular) comprises all the components of an individual's system connected to its formation and development as result of communication and activities in different types of environment – family, school, social life, etc. Competence is manifested differently in different individuals as it is dependent on the individual talents, intellect, abilities, interests and motives; the environment also plays a leading role in the development of these factors and characteristics.

When studying the pair competence-competency as a pair of the concept-event type, competence should be considered a concept (a construct - Pl. Radev) i.e. a product of logical thinking, needed in the cases when a connection should be established between objects or events which cannot be observed or are difficultly measured. The event of 'competency' is a case, a phenomenon, a part of reality, a thing happening in a behaviour or an environment, a thing with a beginning and an end that can be defined within the terms of the variability (Radev, 2005: 129).

The analysis offered above leads to certain conclusions concerning the concepts *competence* and *competency* as elements of a conceptevent pair. *Competence* as a construct represents an **integral personality property** and a **system of competencies** structured in a concrete manner that **integrates knowledge and skills**, as well as attitudes of the individual towards oneself and others as well as towards educational and other activities and their results in the context of the development of transversal competencies, which offer an opportunity for the individual to **function adequately in terms of individual practice and performance**.

Importantly, the concept of competence is associated pre-eminently with "untapped potential abilities" leading to the carrying out of effective activities; they relate to the "emotional aspect of the actions of the individual" and "give meaning to those actions". The concept competency on the other hand is more

pragmatically oriented; this is what makes possible the practical implementation of one's competence. It can be described by being able to tell "**how** to relate knowledge and situations" rather than being able to tell **that** knowledge and situations are related. Etymologically, both terms evoke the original meaning of the root meaning "apt, adequate, able, meaningful". Thus, summarily, competency is a subjectively represented competence. Competence is therefore a predominantly subjective and personality-oriented characteristic of human activities, while competency is preeminently subjective and social.

The vital importance of the educational issues discussed so far, their conceptualization and methodological grounding set the trail for future research in the field of education sciences on several planes of social and economic life. In terms of social development the competence-based approach contributes to a successful search of opportunities to resolve the now existing controversy between objective social demands education faces and the ways it meets them. In terms of theory of education, it gives scientific grounds to the necessity to develop students' key competencies in a transversal manner. In terms of practice, it facilitates the improvement of school practices and orients them towards the formation and development of key competencies as personality properties.

All of this draws attention to the problem of the correct operation of each of the competences so that they can be formed and developed, as well as evaluated in a specific context. Competence is an integral feature of personal expression; in particular, the competence to solve learning problems is related to the search for ways to differentiate the system of competences (as a normative requirement of the training and its expected result) and meaningful, purposeful, and systematic cognitive activity in which the subject manifests the process and its outcome.

3. PROBLEM-SOLVING COMPETENCE IN COGNITIVE-LEARNING - CONTEXT OF UNDERSTANDING

In the course of social development, the understanding of the main components of PISA research has also been changing. The reading, mathematical and natural science literacy are now complemented by new areas of research introduced in 2012. and 2015. - **problem solving and cooperative problem solving**. This change is determined by the PISA understanding not only to assess students' knowledge in the field of science, but to also assess students' abilities to implement this knowledge and apply these abilities in life situations by solving problem-based cognitive learning tasks.

The problem solving module in PISA 2012. was focused on the cognitive skills of the individual student related to the recognition of the problem situation and its understanding; defining the specific problem; planning the process of finding solutions and choosing strategies; monitoring and assessing the result achieved, etc. In the definition of the new PISA 2015. module another element has been added and the emphasis has now been placed on cooperation among pupils in solving a particular problem (OECD, 2017, Petrova, 2018: 631).

The program aims at assessing knowledge and skills of a transversal and interdisciplinary nature, through setting tasks that: (1) resemble a real life context presented through a source of information, (2) ask several thematically related questions to one source of information: a text, graphics, chart, table, animation, simulation or a combination of them, (3) are gathered in clusters and the individual student does not have to solve all the tasks, but only some of them that are generated on a rotational basis by a computer; (4) are an individual combination for a particular student containing tasks in math, reading or the cooperative solving problem component. In this context, the term "literacy", as used by PISA, is related to students' skills to find, interpret, transform and present information; to solve problems in situations close to the real ones.
In the context of Ray, B. (1996) research on **transversal competencies**, their typology and attempts to operationalize them, Y. Merdjanova points the ability **to detect and formulate problems** in the cognitive competence group for information processing (Merdjanova, 2002: 101).

The competence to solve problems in PISA 2012 evaluation process is defined as "**... the student's ability to use cognitive skills to understand and solve problems whose solution is not obvious. It also includes the student's willingness to engage in problem-solving as a constructive and thinking citizen**", while in 2015 this definition is expanded with the cooperative problem-solving ability, namely: "... **the student's ability to participate effectively in activities to solve**

problems in cooperation with one or more partners, sharing knowledge, skills, understanding, and efforts to achieve a certain outcome" (Petrova, 2018: 633).

In general, **problem solving** is seen as a process that involves individual cognitive skills to solve individual issues. The first element - individual cognitive problem solving skills - involves understanding and presenting the content of the problem, implementing problem-solving strategies, controlling the process of achieving the goal. Individual problem solving skills are summarized as: (1) research and understanding; (2) presentation and formulation; (3) planning and implementation; (4) monitoring and reflection (Petrova, 2018: 634).

Problem solving is a specific process in which students follow a certain routine: *analysis of the situation* – assessing what is known and what is not; *problem formation (task); building a hypothesis*; proving of a hypothesis and explanation (conclusion). According to Y. Merdjanova, the essence of solving a problem is *to transform the problem into a situation* (i.e. to include it into a context) and *to transform the situation into a problem* (identifying the problem in the environment), in the context of multisensory training the following milestones of problem solving technology have been defined: *exploring the problem* (its nature, its identification and additional features and components), *analyzing the problem* (through experience, comparison, adaptation of the analogy), *visualization* (general and multi-sensory "direct and indirect" information gathering), solution choice (by comparison of alternatives, coordination, trial of decisions, final solution choice) (Merdjanova, 2005: 110-111).

This also defines the structural elements of competence to solve learning-and-cognitive problems, as learning and cognitive practices are a matter of priority being the core of competence integrated with the knowledge and attitude of the person towards the activity and its results.

4. CONDITIONS FOR DEVELOPING THE COMPETENCE OF SOLVING COGNITIVE PROBLEMS AS A TRANSVERSAL ONE

The context of understanding a particular competence as transversal one and the specific characteristics of the student's transversal competencies have been clarified in previous studies (Tsankov, 2017: 130-134), therefore only some specific conditions for the developing of problems as transversal ones in sync with the idea of the search for ways to justify the basic methodologic approaches (Merdjanova, 2014: 12) as portable and relevant for all training methods as the results of their application in education, namely the transversal competencies, are decisive for the development of each person.

In order to be able to realize the cognitive functions of learning in the best possible way in the course of developing the problem-solving competence, it is necessary to determine the didactic conditions for this to happen, characterized in detail in the context of the opportunities for development of transversal competences (Tsankov, 2017: 134-141). The goals and the results determined through the education curriculum for science school disciplines (in which the survey has been carried out) in secondary education include not only the acquisition of certain knowledge, the formation of skills and relations, but also actions for their absorption and formation that are directly linked to the development of students' cognitive abilities by solving problems. This requires, in addition to observing the basic principles of education based on constructivism as its philosophy and the principles derived from the realization of the development of competence for solving cognitive problems, also taking into account the specificities of the cognitive activity. At the core of the design of problem-solving based education is the idea of constructivism that in problematic situations the basic functioning of the student's knowledge is to establish the relation between teaching and learning and that these situations give specific value to the student's knowledge that is being applied into real-life situation, empowered in the concept of competence approach and having transversal identity. It is these problematic situations that imply the use of knowledge, redirect to natural development through learning, and provide a junction point between evolving knowledge and already existing knowledge available through the application of a series of research procedures in the process of solving integrated problems.

Although in the context of problem-based training teachers change their traditional functions (Radev, 2005: 280), organizing the environment for the implementation of problem-based training, the selection of different problems and the tasks related to them, remains their main responsibility. From the

point of view of the principles of constructivism as a philosophical paradigm whose main idea is related to the active position of the subject who knows the world in and through the situations he lives in (i.e. a specific context), within the problem-based training there is a demand for cognitive learning tasks that provoke situations to enable the transition from knowledge to putting into practice. Despite the application of the ideas and principles of constructivism, according to which the student and his/her experience are at the core of the training, the role of the teacher in problem-based learning is not to be neglected.

The conditions for developing competence to solve learning and cognitive problems and the requirements of the environment should be considered synergistically as an integration between the material (those which carry information), socio-psychological (socio-psychological climate, comfort, creativity and teamwork), psychological (interests, motives, incentives, readiness for action and preparedness) and pedagogical (effectiveness, adaptability and performance) conditions in the context of the activity.

In the course of implementing the competence based approach, efforts need to be made to encourage adults to learn in order to enhance the quality of orientation systems and making the education process altogether more attractive. Such efforts may include developing new education forms and applying new techniques of teaching and learning. (Vladeva, 2013: 96). When practicing refection activities, various opportunities for the forming of some competences - experimental, exploratory, health-and-ecology related, evaluative, etc. emerge in school practice (Galcheva and Hineva, 2016).

In characterizing a reflective technology in the context of the modernizing of an intellectual reflection (reflection on one's own cognitive activity) and praxiological reflection (reflection on the application of knowledge) there are the following processes: problem defining and problem solving. Problem defining being: (1) "transformation" of a particular phenomenon in the subject of reflective analysis, (2) a process of the subject's rationalizing the contradictions causing obstacles in the course of knowledge, the process of drawing up and formulating problems and sub-problems (in psychological context); (3) a process of interpersonal interaction, in which the trainer creates the conditions discovery and formulation of problems in order to stimulate students' learning (in a pedagogical context), (4) providing conditions for a purposeful transition to more intense intellectual and creative activities to mobile and develop cognitive abilities of the student, placing him in the position of an actual subject of these activities. Problem defining requires: (1) a subjective point of view on the problem - the students' authorship in defining and formulating the problem, the acceptance of the problem as being their own, and (2) an objective point of view (externalization) of the problem – putting it into speech form and discussing of the proposed problem definition with another subject involved in the same problem situation (Vassilev and Dimova and Kolarova-Kancheva, 2005: 99). According to the authors, problem defining is related to the didactic notion of problem and the discovering of the didactic core of problem - the problematic situation (with a clearly existing contradiction between the known and the unknown, between knowledge and lack of knowledge). In their opinion, psychologically, contradiction is "born" in the subject's head in the absence of *information in the course of cognitive activity or when there is difficulty in communication with other subjects,* thus, cognitive and communicative problem situations are distinguished. In the context of a cognitive problem situation, the student (either alone or with the help of a more experienced subject) can understand and formulate a learning problem (knowledge of not knowing, turning to one's subjective experience, the beginning of a reflective act).

According to Vassilev and Dimova and Kolarova-Kancheva, 2005, problem solving includes: (1) de-problematization (transforming the problem into task), (2) conceptualization (ideal designing-forecasting, discovering the possible solutions) and (3) solving the problem itself. In the context of the opportunities for activation of intellectual and praxiological reflection in the course of turning the problem into a task, the authors distinguish between mediating and evaluative problem situations. In these analyzes, some valuable observations for the educational practice have been made:

Most teachers formulate learning problems in terms of their perception of the subjective experience of the average student and provide students with the opportunity to solve these problems in such a way, thus omit-ting the valuable opportunity for activating the student's reflection.

According to the principles of the Reflective Approach, learning problems should be formulated not by the teacher but by the

students. In order for this process to be productive, the teacher should train the students to "discover" and define problems, as well as to prepare tasks for their solution.

In the learning process of the specific school subjects, problem solving most often begins as an interpersonal interaction, in which the teacher "hints" the path of turning the formulated learning problems into tasks and encourages only the unconscious reflective acts of the students, thus missing the best opportunity for joint thinking/brainstorming effort to activate conscious reflection in all students (Vassilev and Dimova and Kolarova-Kancheva, 2005: 100-101).

The approach to integrating information from different learning disciplines when **solving an integral problem** relating to a specific subject that is actually the basis of the present study of the transversal nature of the competence to solve learning problems is of interest. The integral problem has the characteristics of the learning problem, but success in solving it cannot be ensured by the available knowledge of the student and the way this knowledge exist (its structure) and the strategy of its use in solving the problem. The specificity of problems of integral type lies in the semantic heterogeneity of the information that is used to solve them. The problem of an integrated type may arise at the boundary of two disciplines; it can, when necessary, switch to a new cognitive context or require the "entanglement" of categories from one science into the category of another (in case of abstract object integration), or it can refer to the functioning of a complex system, the elements of which are studied by two or more subjects (upon integration on a particular object). In science education, such an integral problem is defined, for example, by key concepts (reflecting certain abstract objects, defined within a particular scientific area): "cell" and "metabolism" (biology), "molecule" and "electrolyte dissociation "(chemistry)," pressure "and" heat "(physics). In the systematic study conducted by R. Peicheva among high school students with respect to the application of the knowledge from different school subjects (natural sciences - chemistry, physics and biology) the following conclusions were made regarding the solving of integral problems:

The higher the degree of integrity of a discipline, the fewer students are able to cope with the integral problem in its field;

The high achievements in tests as-sessing knowledge acquired in the learning process in the respective subjects is not a prerequisite for the application of the knowledge in practice, and that the students with lower achievements can better implement a strategy to solve an integrated problem;

Success in solving an integrated problem depends not only on the knowledge of the concepts involved in formulating it, but also on other factors - knowledge about strategy itself and the qualities of student thinking;

The lack of dependence between the knowledge of individual concepts and the ability to apply them to a non-standard cognitive situation, i.e. lack of a strategy to integrate information from different scientific fields into solving integrated problems;

Students who successfully go out of the context of the respective scientific field and can apply their knowledge in non-standard cognitive situations, can relatively easily solve integrated problems (Peicheva, 2002: 200).

All of this is in line with the specifics in the development of high-school students as subjects in the process of developing problem-solving competences in cognitive learning. Those accents have been discussed in detail by N. Tsankov in previous studies and can be summarized in the following main points:

In summary, adolescent students generally share the following characteristics:

1. Their personality has already been formed. The psychological systems of sensory perception, attention, reasoning, and imagination are stable. A higher level of the development of basic psychological functions has been reached.

2. The structure of mental processes and cognition has changed. As a result, 9th and 10th graders are more likely to focus not on the types of problems to be solved but on the means for their solution.

3. The changed social situation in the development of the 9th and 10th graders generates internal prerequisites for essential personality traits.

4. The stable psychological systems increase the efficiency of psychological processes related to the adaptation and the retentive power of memory.

5. Educational abilities belong to these stable psychological properties the way educational competencies do.

The social situation in secondary schools is specific in that it is the threshold to adulthood. This places students in a new position characterized by:

• the emergence of a necessity for professional orientation and making choices of

future life goals;

• the self-awareness of students in the 9th and 10th grade of secondary school is vital for their future and comes to form the psychological centre of the social situation of their own development;

• the psychological center thus asserted, establishes a unique position which is manifested as a specific future orientation;

• the student starts to see the present trough the future perspective and not the other way around;

• the new social situation of students changes the significance of their education, their values and their attitude to tasks, goals, the content and methods of educational activities.

These characteristics create new formations in the social and psychological development of 9th-10th graders which are related to: the formation of an outlook, self-dependence in reasoning, increased ethic requirements, development of self-esteem, aspiration to self-perfection, self-education and self-control. Regardless of the pending social and psychological change, they continue to study, but their **educational cognition** is characterized by a variety of **specific properties**:

• Study activities continue to be basic but students' attitude to different subjects changes.

• The situation structure of studying is different because of the motives related to self-awareness, the choice of profession and the preparation for a self-sustained life. Thus motives come to increase in strength, stability along with students' interest in cognition, its content and methodology, as well as the educational process in general.

Some of the other important changes in students' cognitive dynamics include:

• It is very rarely that they find it difficult to define the semantic properties of concrete an abstract concepts;

• their mental operations are facilitated;

• they employ their own methods and means of memorizing;

• the motivational structure of educational and cognitive activity has been formed;

• there is a prominent aspiration to orientation in a multitude of view points and a formation of one's own stand;

• there is and increased strife to search and establish the truth;

• an interest in the very process of analyzing situations, views and assertions occurs;

• the aspiration to the employment of new methods for arguing one's own position is rather prominent;

• the reasoning efficiency increases, which results in proposing daring suggestions, generalizations and original ideas;

• the readiness for self-education and self-perfection is improved.

All the peculiarities in **the personal development of adolescents** are related to the specifics of the learning tasks and allow the deployment of a more comprehensive technology for the development of competence for solving cognitive problems in high school students.

5. DESIGN OF THE EMPIRICAL STUDY

The empirical study consists of a several stages: a pilot study, the survey itself, a didactic experiment, and final survey; the study of the effectiveness of the applying of the developed technology for enhancing the competence to solve learning problems is presented according to the main stages (and the sequence) of their conduct:

• planning and development of a study concept;

• conducting and analyzing the results of the empirical study.

Planning as an essential element of each activity suggests a detailed presentation of the path to be taken when conducting the study.

The main components of the research methodology are directly related to its design and realization. **The object of the study** *is the problem-based science education in the high school stage of the secondary education and the competence to solve problems*.

The study of t*he transversal nature of problem-solving competence in problem-based* education has been carried out over two school years, the contingent of the study being *142 students in the first high school stage. T*he goal of the study is *to diagnose the portability of problem-solving competence across the various subjects and activities*.

In order to realize the research goal and to solve the assigned tasks, a specially developed *system of problem-based tasks* (integrated problems) and *tests for assessment* of the progress through the different stages of the research were used. The evaluation of effectiveness is made on the basis of the results of the training in natural sciences and ecology in both the control and experimental groups and is verified through a reliable test system.

For reliability check (reliability being the main feature of the accuracy of task measurement and the stability of the results of the problem solving), the same contingent was tested a month later. For the calculation of reliability ratios that quantify the reliability of the questionnaire, the Pearson correlation coefficients were used, with values ranging from 0,816 to 0,969, which is the reason for believing that the reliability factor is very good and the questionnaire can be used as a reliable tool for reporting achievement and development.

The analysis of the data on the main characteristics of the tasks shows that they allow distinguishing the excellent from the average/poor students and after the partial editing of some of the tasks, the questionnaires can be finalized and become part of the diagnostic tools of the study. Therefore, the developed tools for diagnosing the high school students' skills for solving cognitive problems can be successfully used as one of the criteria for assessing the extent of competence development for problem solving and its transversal nature.

For the current experimental study, the traditional method of distributing the students in two groups: control and experimental one was used, and the students in the control group were trained without systematic and purposeful solving of integrated learning problems, whereas the students in the experimental group were put in the conditions to solve such learning tasks at each stage of their training.

The following basic indicators were used when forming the groups:

• the average annual grade of the students for previous school year;

• the average grade from the preliminary test used to form the groups (test to assess the current student knowledge in the particular school subjects).

A statistical survey was used to check whether or not the distribution of random variables was normal or not in order to choose statistical methods to use - parametric or non-parametric. The distribution check was done through the Kolmogorov-Smirnov criterion, both for the total test results and for each of the groups individually. For the total test, the empirical value λ_{exp}=0,527 (p (sig.)=0,465>0,05 shows normal distribution), the Skewness empirical asymmetry factor is -0,124, and the Kurtosis empirical coefficient for excess is -0,256. Both parameters characterizing the distribution are within the normal distribution range of –2 to +2.

The results of the group distribution check for the experimental group are as follows: the Kolmogorov-Smirnov criterion has an empirical value λ_{exp}=0,297(p (sig.)=0,468>0,05 - normal distribution), the Skewness empirical coefficient of asymmetry is –0,307 the Kurtosis coefficient of excess is –0,279. For the control group λexp =0,472 (p(sig.)=0,699>0,05 - normal distribution), the empirical Skewness asymmetry coefficient is 0,032 and the empirical Kurtosis coefficient is – 0,043. It is obvious that the variables' distribution is normal in both experimental and control groups.

In conclusion, the verification of the empirical distribution of the results of the group formation test shows that the empirical data in both the experimental and control groups are normally distributed. Consequently, there is a requirement for further testing using parametric methods.

The verification of comparability of the results of the group formation test can be done by comparing the average values that characterize the test results with Student's t-criterion for independent samples (for both experimental and control groups) when comparing the average level of the same attribute in both groups. A zero hypothesis H0 was formed, which states that there is no significant difference between the average level of the attribute in the two groups. The alternative hypothesis H1 is that there is a significant difference between the average marker level in both groups (experimental and control).

The empirical value of Student's temp-criterion is 0,138, and the tabular value is at a significance level α=0,05 is tα=1,98. It can be seen that $\mathbf{t_{emp} < t_{\alpha}(0,138<1,98)}$, (p (sig.)=0,675>0,05 - insignificant differences). The decision is made after comparing the empirical and tabular values of the criterion, and in the event that **temp <tα**, it is assumed that there is no reason to reject the null hypothesis, i.e. there is no significant difference between the average level of the attribute in the two sets. Thus, the mean values of the experimental and control groups are statistically indistinguishable in the group forming test.

From the statistical survey done, it can be summarized that the distributions of the random variables characterizing the learning achievements of the students surveyed in the two groups do not differ and the groups thus formed can be used in the realization of the main study and in the obtaining of reliable information from the whole pedagogical experiment.

The developing didactic experiment represents the realization of the research with

respect to the previously developed concept and the project for developing the competence for problem-solving in the education of the secondary school students using a system of tasks requiring solving of integrated problems. It is related to the initial motivation of the students and the implementation of the developed technology for the improvement of competence for solving problems.

At the core of the developing didactic technology is the idea that the observation of the already discussed conditions and the purposeful solution of the subject-oriented integrated problems (from a particular scientific field) realize the development of the competence for solving of learning problems. All this is related to a specific internal structuring of the curriculum content for natural science subjects at school to solve integrated problems and to bring them into a learning context so as to ensure the necessary functionality of knowledge and its transversality. The development of the problem solving system in turn is related to the identification of integrated links at the level of the curriculum and their full design by the teachers in a methodological context with respect to the conditions for the full development of the problem-solving competence.

Based on the studies made, a number of features have been outlined in the application of the technology for the development of the competence for solving learning problems. These include:

• In the process of solving learning problems, the student is in the active position of a person working purpose-fully, consciously and systematically, i.e. is motivated and aware of what s/he is doing and why;

• students' activity is directly aimed at solving tasks and problems creating cognitive situations through which competence is developed;

• conditions are created to help establish the relation between the already existing situations and the possible future ones, i.e. awareness is developed for the possible application of knowledge and skills in new situations requiring problem-solving competence;

• the activity is ensured by providing students with cognitive problem that have various difficulty levels and topics included in them to stimulate their positive attitude towards the activity and its results;

• conditions are created to enhance self-sufficiency by sequentially complicating the tasks within cognitive levels frameworks.

6. TRANSVERSAL NATURE OF THE COMPETENCE TO SOLVE PROBLEMS (EMPIRICAL STUDY)

The results of the final study (priority skill survey) by solving integrated problems are presented by comparing the average level of the same attribute in two groups – the experimental and the control one. The comparison should also be supported by appropriate statistical reliability. When the criteria have a normal distribution and the samples are independent, Student's t-criterion for independent sampling is used to verify hypotheses. If the null hypothesis (H0) states that there is no significant difference between the average levels of the attribute in the two groups, a decision is made after comparing the empirical and tabular values of the criterion. The empirical value of Student's criterion is t_{emp}=4,29 and the tabular value at a the significance level α=0,05 is t_{α}=1,98. It was established that $t_{emp} > t_{\alpha}$ (4,29>1,98), (sig.(p)=0,01<0,05 – significant differences). Consequently, the zero hypothesis is rejected and the alternative is true, namely, that the average values of the experimental and control groups are statistically distinctive (there is a significant difference) in the final study on the development of cognitive skills through the systematic and purposeful use of integrated problems in the course of the training.

For the present study, it is of interest that the developed competence for problem solving can be transferred through different activities and subjects, i.e. that it is transversal.

As the skill is seen as an applied expression of competence, the tasks of the questionnaires for verifying the transversality of problem-solving competence are aimed at assessing the portability of the skills underlying this competence. The learning (developing) experiment was conducted within the framework of science education, and the portability of competence was verified by solving problems (integrated problems) on the curriculum in the field of social sciences.

The students' results are summarized through representing the average success rate in Table 2.

Table 2. Average success rates based on the skill criterion in the experimental and control groups

Average success rate K_x		
Control Group	Experimental Group	Difference
0,27	0,56	0,29

In order to study the relation between the results in the experimental group in the two subject areas (i.e. the relation between the developed problem solving skills and their portability in solving problems within given school subject content) correlation analysis is used - a statistical method for studying the relationship between variables to reveal the power of dependence. The indicators that provide quantitative information on the degree of dependence are called correlation coefficients. In the study, Pearson's coefficient for an ordinary linear correlation was used. In the present case, Pearson's correlation coefficient is r=0,714, which shows a significant degree of dependence between the degree of competence development for cognitive modeling and the degree of its portability. This gives grounds to believe that a competence developed in one subject area for solving learning problems is transferable in other subject areas. It has been established that the power of this relationship is significant when it comes to teaching subjects from a single area of scientific knowledge. When verifying the portability of skills within the study.

The results obtained to some extent prove the existence of competence as an intention, a point of view, an approach, a manner, a style that can be formed pedagogically and further developed as transitive, portable through ages and activities (Merdjanova, 2002: 101). Thus the subjects (the students) "carry their attitude, their style, and their approach" and give sense to their competence as transversal. Pedagogically analyzed, the results of the study suggest that the implementation of a system of integrated problems for the development of competence for solving problems in the education of the students in the upper secondary school stage also reflects the possibility of its portability (transversality), but in a more personality-related aspect (directly related to the subjects of the activity) and has a positive influence on the motivation and the overall cognitive behavior of the students.

The overall study confirms the author's conviction of the multitude of ways in which the key competences affect the individual; the open perspectives, and the need to integrate the efforts of various research paradigms and approaches to supporting young people's development - and this is done jointly with their teachers, because enhancing competences has neither age nor role limits. The perspectives in this direction are: (1) **extending the research agenda to other subjects**, (2) extending and continuing the research program towards studying students' personalities in relation to the **correlations between the main competences for solving problems as a basis for identifying personal profiles**, (3) a follow-up **factor analysis of key competencies** and their "relative weight" within the competence to decide (4) **studying the correlation** between the degree of competence development for solving cognitive problems and **the success of students in solving the problem of real prob-lems, as well as changes in their professional orientation.**

7. TEACHING TEACHERS HOW TO CREATE A PROACTIVE EDUCATIONAL ENIRONMENT AS A PREREQUISITE FOR THE DEVELOPENT OF PROBLEM-SOLVING COMPETENCE

A proactive learning environment is an investment in human resources and a capitalization of knowledge. Its purpose is the active strategies for personal development. The very concept is based on several key ideas, such as: (1) emotional intelligence of the personality; (2) multiple- intelligence; (3) social intelligence.

Human behavior is a unity of "emotions and intellect", of "rational and irrational", of "sensory and cognitive". This statement of psychology has its pre-scientific and scientific history, which is the basis of the current scientific concept of "emotional intelligence" as a scientific focus of the idea of balance between "emotion" and "intellect" as a condition for proactive human behavior. This becomes further evident from the main features of "emotional intelligence", as well as the conditions and skills/capabilities required for its realization. Among these, we can point out the relations: "emotionwill-intellect." Its operationalization implies the need for control, management, reflection every time we rely on our emotions. In this sense, it is justified to put the notion of "emotional intelli-

gence" as a condition for successful professional conduct.

At the end of the twentieth century, Howard Gardner developed the theory of "multiple intelligences." According to Gardner (1983) they are:

- Logical-mathematical intelligence;
- Linguistic intelligence;
- Spatial intelligence;
- Bodily-kinetic intelligence;
- Naturalist intelligence;
- Interpersonal (interactive) intelligence;
- Intrapersonal (for self-understanding) intelligence;
- Musical intelligence;
- Existential intelligence (Gardner, 1983).

Gardner's theory deserves attention with several of its accents:

- the globality (integrity) of the manifestation of the intellect and at the same time the differentiation of this manifestation;
- connecting the intellect with the possibility of solving problems of different cultural fields;
- the distribution of intellect as available to and outside of the human through the impact and incentives of the environment and its means;
- the role of education in the relation between intellect and with the solving of morally significant tasks.

This is all to help in the designing of a proactive educational environment which is to develop a problem-solving competence, first in teachers and then in their students. This competence is the basis of alternative educational models which put the students in the position to alter the environment as they need to and which allow the teacher to constantly adapt his/her teaching strategies (Achkovska-Leshkovska, E., and Spaseva, M. S. 2016: 65). A proactive learning environment at school provides the opportunity on one hand for the development of new values and attitudes in students and on the other, becomes a motivation factor for teachers (Cvetković, B. N., and Stanojević, D. , 2017: 55).

So far, the nature of the moral domain has not been defined on the basis of human intelligence. We can speak about "moral judgments" in the terms of psychology. Psychological methods are based on asking people how they would react in certain situations. The main component in the moral sphere is the sense of personal responsibility, and the role you take and perform. Each of these roles is associated with a certain type of intelligence, but intelligence or lack of such in person does not seem to determine a person's will and character. Thus, a person's intellect is morally defensible in any life or professional situation.

For David Wexler, social ineligibility is "normal intelligence" applied in a social situation" (Wechsler, 1955). Some psychologists are still arguing, which human abilities are social and which - emotional. Daniel Goleman consolidates the concept and defines the components of social intelligence by dividing them into two: social sense (what we "perceive" in others) and social skills (the ways we take advantage of the immediate awareness). Social sense covers a wide range of experiences, from sensing the inner state of the other person to understanding their feelings and thoughts; orientation in social situations. Social skills include cooperative abilities such as Synchronization - Self-Presentation, Influence, Active Position (Goleman, 2006).

A synergizing of "emotional", "multiple" and "social intelligence" is a precondition for proactive personality, proactive behavior and a proactive educational environment. The latter is impossible outside the person, as an investment in itself through spiritual development and creative entrepreneurship. Knowing the potential of a person and stimulating one's expression at all code levels are the most important factor for developing a proactive learning environment.

In a research perspective all of this requires: (1) to specify the boundary between the reactive and proactive educational environment necessary for the development of the students preparing for pedagogical specialists, so that they themselves can learn how to create such an environment for students in the conditions of formation and development of transversal competences; (2) to identify the main proactive qualities, skills and abilities of pedagogical specialists and the ways in which these skills and abilities are formed and developed as a basis for their proactive behavior in a real educational environment; 3) to operationalize proactive educational technologies in the training of students preparing for pedagogical specialists; (4) to develop an educational strategy for proactive thinking and behavior of students preparing for pedagogical specialists; to help form proactive values and attitudes in the future pedagogical specialists qualification so that they can become highly effective people and professionals.

All this should be based on the ideas of constructivism and pragmatism, as well

as moral philosophy, social psychology, and modern management. Their integration and synergy allows a wider methodological platform to be set up, aimed at training future pedagogical specialists in optimal mode. The motives for a **well-grounded methodology for realization are**:

1. Identification of the educational environment as a proactive one through a system of criteria and indicators;
2. Typology and technologicalization of the educational environment as proactive;
3. Educational design of the proactive environment for motivation and stimulation of the pedagogical specialists;
4. Educational design of the proactive environment for professional realization and career development of pedagogical specialists;
5. Educational design of the proactive environment for assessment and self-assessment of teachers;
6. Good practices to help the realization of a pro-active educational environment and highly effective people and professionals;
7. Emotional, social and moral intelligence of the pedagogical specialists as a personal factor for a proactive educational environment;
8. Strategies for a pro-active educational environment for sustainable development and professional growth of pedagogical specialists.

8. DISCUSSIONS AND CONCLUSION

The stage of education development and the state of educational practice draw attention to the search for a comprehensive way of solving the problems related to the unsat-isfactory educational results, the lack of in-terest and motivation of the students in the process of cognitive activity and the lack of correspondence between the requirements of the labor market and education provided. The central approach to solving this problem is the overall approach to identifying and operationalizing problem-solving competence (as a system of competencies - integrated knowledge and skills) as an expected outcome of the training and the designing of the educational environment to fully form, develop and prepared the pedagogical specialists accordingly.

This article offers an attempt at such an integrated approach to problem-solving competence development and solving cognitive problems, which are also subjects of PISA research by: (1) justifying the research interest in the context of international research and results for Bulgarian students, (2) analysis of conceptual grounds for distinguishing competence as a personal characteristic, and competences as normative requirements and expected learning outcomes in the context of the competency approach to education, (3) the clarification of the transversal nature of problem-solving competence, (4) the design of the educational environment and the basic requirements for it so as to ensure the full-value development of this competence (5) conducting an empirical study on the effectiveness of this development; and (6) drawing up guidelines for the training of pedagogical specialists so as to ensure the quality formation and development of problem-solving competence.

Conflict of interests

The author declare no conflict of interest.

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