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Problem-Based Questions in the Development of Theoretical Thinking

Preguntas basadas en los problemas de desarrollo del pensamiento teórico

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ABSTRACT

Problem-based questions (PBQs) are mastered in the process of learning the subject matter and developing the ability to think. Constructing PBQs enabled students to develop their ability to consciously handle notions, formulate statements, make conclusions, and reveal contradictions. The ability to operate a system of notions while posing questions and looking for answers to them encourages meaningful communication.The findings were used to develop and implement an advanced training course for university teachers. The booster of theoretical thinking helps to switch from declarative knowledge given by a teacher to its joint discovery with learners.

Keywords: Cognition, dialectics, problem-based question, theoretical thinking.

RESUMEN

Las preguntas basadas en problemas (PBQ) se dominan en el proceso de aprender el tema y desarrollar la capacidad de pensar. La construcción de PBQ permitió a los estudiantes desarrollar su capacidad para manejar conscientemente nociones, formular declaraciones, sacar conclusiones y revelar contradicciones. La capacidad de operar un sistema de nociones mientras se plantean preguntas y se buscan respuestas fomenta la comunicación significativa. Los resultados se utilizaron para desarrollar e implementar un curso de formación avanzada para profesores universitarios. El refuerzo del pensamiento teórico ayuda a pasar del conocimiento declarativo proporcionado por un profesor a su descubrimiento conjunto con los alumnos.

Palabras clave: Cognición, dialéctica, pensamiento teórico, pregunta basada en problemas.

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INTRODUCTION

What can explain the ever-dwindling fundamentality of education in the era of exponentially amassed information? How does acquired comprehension shape the development of theoretical thinking and ability to reason? Why do PBQs serve as a means of developing theoretical thinking and knowledge? In search of answers to these questions, the authors suggest first analyzing the development of the ability to reason, handle notions and ideas – in other words, to master theoretical thinking.

Some researchers come up with cognitive learning programs that focus on inductive reasoning, phonological awareness and sensible reading. However, it is worth objecting to developing inductive reasoning without its opposite – deductive reasoning, since mere induction may be misleading – results of deductive reasoning must be proven by facts that are generated by means of induction. Therefore, it is necessary to master both faculties of thinking in tandem, which will help reveal the opposites, and thus draw reliable conclusions.

There are studies aimed at developing design-oriented thinking as a tool to hone 21st-century skills in collaborative problem-solving and working with information, looking for evidence and refutation, considering empirical data as a basis for theoretical conclusions as well as extrapolating these technologies to various professional areas. The disadvantages of such thinking are revealed through the study of the theoretical structure of project-oriented thinking and its comparison with the theoretical structure of design-oriented thinking (Laursen & Haase: 2019, pp.813–832). However, applied tools remain unclear.

The potential of operational thinking is viewed in terms of methodology and as an analytical tool of cognition in the pedagogy of collaborative creativity. The widespread discussion of the idea of critical pedagogy associated with critical thinking and conducting a dialogue proves its increased relevance in terms of knowledge, social values, and the impacts of the digital culture, which is defined as the philosophy of education that aims to integrate forms of education with the political agenda, viewing critical thinking as social practice, and the key skill for modern-day higher education students (Villalobos et al.: 2018; Hernández et al.: 2019; Ramírez et al.: 2019; Franco & Vieira: 2019).

The problem of unleashing the development of theoretical thinking and practical wisdom is in the disconnect between theory and practice in the training of medical students. The theoretical structure is revealed by means of identifying the early probabilistic thinking and its two independent cycles (Groth et al.: 2019). Technology that serves as a pragmatic tool and concept shaper and the tools opted for by a math teacher define the development of theoretical thinking and formation of inductive and deductive reasoning, abductive inferences. The variety of viewpoints on the development of thinking, including theoretical thinking, is equalized through the transformation of training that involves knowledge-comprehension, acquisition of new skills and tools to work with information that will allow learners to prepare for the future that is highly unpredictable. Given that thinking is a process of conscious reflection on the real world with its objective properties, connections, and relationships directly inaccessible to senses, it gives rise to the problem of means. However, methodologies of some studies do not prove to reflect on the historical and logical context of the problem.

Clack J. characterizes various types of thinking as opportunities and draws a distinction between macro and micro thinking to get a clearer understanding of creative processes and better ways to instil creativity into learners' thinking culture (Clack: 2017). Some authors believe that theoretical thinking should be developed alongside critical thinking, which they define as one of its types (Erikson & Erikson: 2019, pp.2293-2303). In our opinion, there is a discrepancy in what is chosen as a division basis for various types of thinking. Namely, thinking is divided into theoretical and practical in terms of tasks it deals with. In terms of control efficiency or how critical the mind is – it can be critical or non-critical. In its turn, the inclination of theoretical thinking towards the exploration of laws, concepts, and entities based on the means of thinking (criterion) – it can be described as notion-centred or image-centred theoretical thinking. This kind of classification makes it possible to define and work out various means aimed at various kinds of thinking. Psychologists of the California State University

reported interesting findings in their study on the impact of developed critical thinking ability on prevention of negative life events; researchers advocate for critical thinking instruction as a way of creating a better future (Butler et al.: 2017, pp.38-46). Another study (based on a survey) found that certain education strategies applied by a teacher could improve the youth's chances of success in their studies and determination after experiencing failures. In fact, it characterizes the interrelation between evolving mathematical thinking and creativity accompanied by inventing and solving complex mathematical problems. The findings of our research confirm that a didactic system that rests on the key principles of the dialectical approach, ideas of Classical Philosophy, revamps how the cognitive process is organized and takes learners to a place where they can discover knowledge in their joint effort (Ishchenko: 2019, pp.31-38) and boost theoretical thinking. The development of theoretical thinking in students is viewed in light of the increasingly acute issues of the 21st century that stem from the deteriorating quality of education, fundamental knowledge, consistency of thinking and demands of the economy for finding effective solutions to complex problems that are interdisciplinary in nature.

LITERATURE REVIEW

The increasing information load accentuates the problems of comprehension and means of achieving the result. The key contradiction in education is between the nature of the content of a given subject and means chosen by agents of the education process, and it apparently outlines the road map to resolving the issue and referring to methodological foundations of developed thinking as they have been elaborated on by the historical evolution of thought. Due to the impact of web technologies on the development of thinking, some researchers put forward a hypothesis about two mechanisms of content thinking: "external mechanism – spontaneously unfolding content", and "internal mechanism – reflection". Other scientists propose such thinking-ability boosters as problems, tests, and smart cards (Kuleshova et al.: 2019, pp.97–109;). The distinctive feature of our research is in the elaboration of tools for subject comprehension, and cognitive apparatus to promote theoretical thinking based on the key principles of contradiction, unity of the historical and the logical, activity mediation.

Cognitive maturity in students is defined by the interrelation of evolving culture of thought and problem-based learning in the process of a collective search for solutions to problems, implementing the theory of reflexive thinking and action, and upgrading the empirical learning. However, it is still unclear which tools should be used to promote such transformations.

In works conducted by Alonzo & Kim (2018), Shafto, Goodman and Griffiths (2014) they brought up the impact of discussions on encouraging higher levels of thinking, as well as the impact of virtual teamwork on enhanced creativity. The discussion method is capable of resolving the issue of the development of thinking only when it is correlated with the content. Another study carried out by S. E. Msonde, J. V. Aalst stands out in a particularly prominent way, since it is associated with investigation and development of cognitive abilities in students through reasoning, analysis as a tool to study materials, the introduction of discussion forums that cater to more advanced levels of social interaction, and the ability to reason (Msonde & Aalst: 2017, pp.1389–1413). It gives rise to questions: to what extent are these means compliant with the laws of formal and dialectical logic and how well do organizational forms go with the content of the subject matter under study. We view a meaningful dialogue as a way to develop learners' skills based on the embedded didactic, social-psychological and value-centred components of the didactic system.

Questions appear "as an inquisitive thought moves along, rising up before the mind in the form of contradictions within definitions in the theoretical expression of facts" (Ilyenkov: 1984). Therefore, the key principle in the development of the thinking ability is a contradiction reflected in a well-thought question. In the context of our study, we looked at a unique theoretical-thinking booster in the form of PBQs of two types:

embedded-notion and embedded-statement questions. Such questions reflect the universals of the external world (structure, motion, evolution, interrelation) and go along with the laws of dialectical logic.

Vasily Davydov studied various types of generalization and drew the following conclusions: "theoretical thinking has its own content which is different from that of empirical thinking, – it is within the realm of objectively interconnected phenomena that comprise a coherent system"; "theoretical knowledge primarily manifests itself in ways of the cognitive activity and then in various symbolic-semiotic systems, particularly, by means of the natural and artificial language" (Davydov: 1996). We can claim that theoretical thinking constitutes mediated, reflective thinking that can handle abstract notions with the unity of the image and notion in its content, which is actually what notion-based theoretical (abstract) thinking is about.

Sensible conditions in the cognitive process can be prompted by the first essential quality of a modern-day lesson – the transition from immediate training to training with double mediation that implies a release of cognitive energy in learners who are able to think in images and notions (Goncharuk: 2002). The second essential quality is represented by PBQs of two types: embedded-notion and embedded-statement questions. The third feature of a modern lesson is cognitive competitiveness. Once the education process is arranged in accordance with these features, it can develop flexibility of thinking, and the ability to reason, which is crucial in the ever-changing times. This study is centred around the identification of didactic means of cognition, development of theoretical thinking, and the role of PBQs in the successful acquisition of comprehension.

Let us look at how the topic of Thinking and Theoretical Thinking is tackled through the following PBQs that help to expose the core of the subject matter. Particularly, to address the topic of thinking, we should pose questions of the first type: What do we mean by 'thinking'? What is practical thinking? What does theoretical thinking stand for? What is the basis for the division of thinking into practical and theoretical? What constitutes image-based and notion-based thinking? What serves as an indicator of developed theoretical thinking? What is the contradiction? What are the properties of thinking? What are the types of thinking? What is the essence of the thinking process?

The second type of PBQs with embedded statements require two or more notions to be articulated with their interrelations and interdependencies. These questions are structurally more complex and require a certain level of logical preparation, since logic boils down to the laws and forms of thinking, logical operations, and rules of their implementation, both in the context of formal and dialectical logic. Why it is that theoretical thinking is inaccessible to senses? Why is it that theoretical thinking is contrasted with practical thinking? When is theoretical thinking equal to image-based theoretical thinking? How does contradiction signpost the derivation of a new notion? Why is it that the ability to utilize notions presupposes the ability to reason? Why do PBQs reveal both the level of comprehension and the level of generalization? Why is it that constructing PBQs serves as an indication of learners' internal motive in the process of cognition and their level of comprehension of the subject matter?

Constructing PBQs and searching answers to them characterize learners as able to utilize notions, make comparisons, analyze, synthesize, and generalize ideas. The depth of comprehension is reflected in the content of questions, and thus in the understanding of the subject matter itself. Since a question presupposes an answer, an addition to the answer, a well-grounded objection, therefore, a question is a tool of cognition and construction of meaningful communication, and an indicator of a learner's cognitive activity. Considering the method of dialectical training, knowledge is measured by the thought that is manifested in a PBQ, which constitutes a demand for thought. A PBQ often reflects a contradiction in the subject matter, phenomenon under study, and thus it carries the potential for personal growth. Acquired structure of PBQs does not yet guarantee penetration into the core of the matter under study, since the disconnect between the form and content is associated with the revealed formalistic knowledge in learners. Given that PBQs with embedded statements reflect the structure and motion of involved notions, as well as their evolution and interrelations, whenever they are constructed deliberately, it demonstrates the level of comprehension capacity and knowledge of the logic laws.

METHODS

On one of the seminars that was aimed at identifying the causes of knowledge formalism in students and prospective ways of overcoming them, young researchers had to prepare reports on PBQs with embedded statements that were suggested by the teacher, and on those they constructed on their own. While reports were being presented by the speakers, they were asked questions, which demonstrated their level of expertise in the area and prompted both individual and collective search of solutions to problems. Let us give an exemplary set of PBQs from the seminar on Formalism of Knowledge as a Problem of the Education Process:

1. How can we explain that students only having formalistic knowledge characterize modern education?

2. When does a student become a knower in the process of education and what resolves the problem of formalism?

3. How shall we transform the education process to enable the transmission from formalistic knowledge to true knowledge of the objective reality?

4. Why does comprehension presuppose the acquisition of true knowledge, and general ideas mainly lead to formalistic knowledge?

5. Why is it that education technology that rests on profound scientific foundations enables learners to acquire true knowledge about the world and develop cognitively?

Throughout the class, suggested ideas, constructed PBQs, and the level of comprehension were estimated together with students estimating themselves (materialized auto-evaluation). They came up with the criteria for evaluating the ability to reason, acting as experts themselves. Such conditions stimulated vividly expressed cognitive competitiveness and provoked an internal motive for further research. Enhanced cognitive involvement, materialized auto-evaluation, mediated training, application of PBQs, and diversified activities (that prevents fatigue) in the process of the seminar created conditions for extended reproduction of knowledge, learners' self-expression, and higher involvement in the discussion – it all encouraged the development of agency and emergence of subjectivity. There were various forms of individual and collective work involved throughout the class, with better subject-subject relationships. The teacher, in this case, is more of a conductor in a one-of-a-kind orchestra of personalities that are free from prejudices and narrow-mindedness, and capable of making discoveries through recycling mundane ideas into a form of a notion.

Theoretical thinking is nurtured in the process of cognition through the active use of logical cognitive operations and, most certainly, PBQs with embedded statements that allow learners to determine the gist of a given text, contradictions and ideas, and formulate their own statements while answering them. Let us trace the development of QA skills looking at an example of the analysis of a short piece by Mikhail Prishvin and outline the algorithm for constructing PBQs with embedded statements. "Sunny. All is melting. "Me! Me! Me!" chimes every drop before it dies: the life of a drop lasts a fraction of a second. With pain and powerlessness, "Me!" Another drop falls onto a thousand-year-old boulder, "Me!" But now the sound carries reaffirmed strength and hope to leave a footprint, "Me!" "Constant dripping wears away a stone, prompts the memory. How many drops like these, in unison, not only wear away stones but carry them away, turning into rapid streams!" "Me! Me! Me!" rejoices the thaw." Let us look at how the text is handled to identify the opposites, establish interrelations between them, and on their basis – construct a line of reasoning and PBQs with embedded statements.

1. Opposites (life vs. death) – contradiction (despite the fact that a drop has just appeared, it is about to die) – resolved contradiction (a drop lives a fraction of a second – it is the law of nature) – a question with an embedded statement: Why is it that a drop dies soon after its birth?

Opposites (one word vs. wordiness) – contradiction (even though "me" is a short word but it contains an entire lifetime that can be talked about endlessly) – resolved contradiction (one can talk about life in a beautiful way, though life itself may be long and unremarkable; on the contrary, the life of a droplet is short and beautiful.

The only word it says contains its entire lifetime) – How can we prove that the short word 'me' may hide inside an entire lifetime?

2. Opposites (weakness vs. power) – contradiction (despite the fact that a drop is weak, its voice sounds powerful) – resolved contradiction (a small drop that falls on a stone blends with the sound of other drops and thus becomes strong) – When does a drop become strong?

3. Opposites (short life vs. managed to do a lot of good) – contradiction (a drop has a short but dignified life) – resolved contradiction (life, even if it lasts an instant, can and should be lived with dignity) – a question with an embedded statement: How is a helpless drop hoping to leave its footprint on the earth?

4. Opposites (small drop vs. large stone) – contradiction (even though a drop is small, it wears out a large and strong stone) – resolved contradiction (one drop that merges with others becomes so strong that it can destroy stones) – a question with an embedded statement: Why is it that a drop triumphs when it dies?

Opposites (drop vs. human) – contradiction (even though the writer is talking about a drop, readers understand that it is about human and human life) – resolved contradiction (humans against the backdrop of life that lasts for centuries, eternity, are like drops; the life of a human is similar to that of a drop – one instant; it is important to live this instant with dignity) – questions with embedded statements: Why is a drop chosen as the main character of this text? Why can't one drop leave as deep a footprint on the earth as a thaw?

PBQs with embedded statements enabled the following:

– Identify the topic of the text, its gist;

– See the role of figurative and expressive means of the language used to convey the gist;

– Make a conclusion about how the writer resolves the identified contradictions and how you would resolve them, compare your own viewpoint with the writer's while resolving the contradictions.

Applying this technique to text analysis reveals its main ideas, nurtures keener mind and eloquence and encourages ultimate generalizations at the level of categories. The study into the development of the ability to handle notions by means of questions embedded with statements was drawn on the data from a pool of students with majors in the humanities. Dynamically speaking, in terms of how the ability to make PBQs with embedded statements develops in students, it turns out that the first stage is about mastering the structure of questions (with the occasional distraction from the content). The second stage is marked by the synthesis of the form and content. It is in the third stage when questions begin to reflect a more profound comprehension of the subject matter under study, which entails opting for more complex content of questions and thus answers.

The study drew on the target group of 46 second-year students (Didactics and Rhetoric), 26 post-graduate students, and 18 teachers on the advanced training program. The findings are presented below. For the sake of the set goals, students and teachers were interviewed, and the study involved the project-oriented methods of unfinished sentences and feedback survey. The feedback survey asked the respondents to explore the given topic or text through PBQs, and then the most intelligent question was identified during the lesson. The teachers tested PBQ technology in their technical and humanitarian subjects during seminars and lectures. All lessons were centred on the structure of questions and logical means of cognition while working with information. We believe that PBQs constructed by students demonstrate their level of comprehension, ability to identify meaning because of synthesizing the given notion and image, and skills at identifying consistent patterns while studying given material, building their own tasks.

Limitations and study forward

The suggested approach has certain pitfalls in its realization one of which is the problem of teacher training. It requires advanced didactic competence to be built in further training, which entails fundamental changes:

- How the content of a given subject is structured;
- Mastery of didactic and logical means of cognition;

– Choice of scientific methods of cognition, organization of the learning process to be based on the key principles, forms and functions of learning;

– Introduction of evaluation criteria in accordance with the logical and didactic tools of learning applied by students.

We believe that ignoring formal and dialectical logic proves to be a serious hurdle in the academic process. It leads to formalist knowledge in students, and as a result their inability to form their own inferences, make well-grounded objections, assert their point of view, or take another person's point of view with all awareness. It reflects the modern-day problem of preparing younger generations for the future. Our findings prove the abovementioned. In fact, tests that check the ability to define notions are only passed by about 30 % of respondents, whereas division of notions (specifying the division basis) is successfully performed by 18 % at the first stage of realization of the suggested technology and operation methods (more detailed analysis is to be given in the next article).

It is worth pointing out that the first limitation lies in systematic and consistent mastery of the structure of PBQs. The second has to do with synthesis of the content and logic of questions and their form (unity of content and form). The third limitation is tied with uniformity of tasks that entail PBQs in the development of theoretical thinking.

The technology proves to be more efficient once both students and teachers have mastered the structure of questions in regard to the content, are able to prepare various tasks in logical terms, and apply this tool in different conditions while penetrating the essence of the matter under study (ideas, categories, notions) for real-world transformation of the subject. Its systematic application in the learning process together with continuous (and not episodic) feedback will empower students' thinking and enable them to maintain meaningful communication.

If a teacher is capable of using the suggested tools to engage learners in the process of revealing problems, eliciting new knowledge, applying analysis and synthesis in working with information, constructing PBQs and tasks to texts, in this case the academic process will produce future professionals, well-rounded personalities able to generalize information and refer to objective knowledge while solving theoretical and practical problems in the process of individual and collective labor. Some teachers who have completed the program share that "one can teach so much after mastering this method." Learning in such conditions coincides with the evolution of thought, dialogue, and active cognitive competitiveness of learners, which eventually leads to the evolution of theoretical, dialectical thinking. This approach has a potential of creating sensible psychological and pedagogical environment for learners who will be well-equipped to resolve social issues and respond to the challenges of their time. Creativity of a teacher can inspire active thinking activity in students and not only arm them with intellectual tools but also show them how they can develop their own. Such conditions allow for both direct communication and feedback in the teacher-student relationship and make the student-student relationship productive and meaningful as well. We believe that in case a flexible didactic system is put in place with components working towards solving the indicated problems and pursuing the set goals, the entire academic process will be aimed at conscious transformation of real-life activities as they are viewed through the lens of their theoretical foundation, at discovery, and self-exploration. It rules out thoughtless enforcement of skills without theoretical foundation underlying any given activity in the information era.

RESULTS

The first goal of the acquisition of PBQs in exploring the content of a given subject and the development of thinking required the observation findings and interview results to be evaluated from the point of view of students and teachers alike. The rates ranged from 1 (low level of acquisition) to 5 (high level of acquisition). The purpose of this stage is to evaluate how well the tools have been mastered and what difficulties arise in

the contrasting processes of training and learning. The level of acquisition of stages in constructing PBQs can be seen in Tables 1-2.

Levels of PBQs mastery	Average rate
Acquisition of PBQ structure	4.19
Finding answers to PBQs in texts	3.89
Construction of PBQs about practical and theoretical texts	2.99

Source: own materials, 2018.

Table 1. Level of students' acquisition of stages in constructing PBQs

Levels of PBQs mastery	Average rate
Acquisition of PBQ structure	4.67
Finding answers to PBQs in texts	4.17
Construction of PBQs about practical and theoretical texts	3.91

Source: own materials, 2018.

Table 2. Level of teachers' acquisition of stages in constructing PBQs

Some of the teachers pointed out that questions do engage the students into the process of learning, however, before that, they have to master their structure, as well as didactic patterns, principles, components of the didactic system, and laws of logic that define a meaning organization of the academic process. Others emphasized the transformation of the content of their subjects in compliance with the logic, which is very time-consuming. However, they did acknowledge the soundness of the approach that enables students to develop their theoretical thinking through a system of tasks as well as master a number of cognitive tools.

As soon as the students overcome the difficulties in acquiring the cognitive tools, they became more involved, the logical constructions improved their speech, as well as the process of comprehension, their ability to handle notions and participate in discussions, build meaningful communication and work in groups to study texts. "To work out notions is to know how to think," pointed out Ekaterina M., one of the students. While studying the abovementioned disciplines, the students prepared studies aimed at the development of logical memory, imagination, keys to exploring the world (image and notion), building meaningful communication, and then presented their findings at research-to-practice conferences (2018-2020), demonstrating the theoretical grounds of their studies. Some of the students ended up taking part in major social projects. A few teachers developed books of notions in their disciplines that reflected their content and bases for logical division into notions.

The essence and content of PBQs have been elaborated on in text analysis, acquisition of the content of the subject matter, deduction of new knowledge and notions; the study suggests a technique for mastering the content of a given text through identifying the opposites, contradictions and constructing PBQs. The article gives an outline of the logically coherent tasks that are aimed at fostering comprehension, acquisition, and consequent application of given material. The study helped to crystalize a technique for high-quality acquisition of the subject matter that also nurtures individuality and independence of thinking. The development of learners' theoretical thinking and other cognitive skills is based on specific didactic and logical means of cognition the most prominent of which are the PBQs with embedded notions and statements.

DISCUSSION

The second goal of the influence of PBQs on the development of theoretical thinking was attained by means of feedback surveys (they contain independently constructed PBQs about a topic under study). The way texts are handled is seen in the logic of identifying the opposites, contradictions, constructing the key PBQ, which is shown by a specific example, – the third goal has been discussed in the previous chapter. The feedback on PBQs was given by students in relation to working with information, and teachers as it concerned the organization of the academic process – it constituted the fourth goal – and it points at the fact that this cognitive tool is acquired by learners at a number of various levels. Tables 3-4 show the advantages and disadvantages of the suggested cognitive tools identified by the students and teachers.

Advantages	Disadvantages
"Collaborative discussion of problems, no place for moralizing" "There is a freedom to share your own thoughts and take part in the dialogue" "Well-grounded objection brought up in class boosts confidence" "Questions reveal both sides to everything that is in contradiction to one another. It leads to understanding" "The acquired knowledge can be used in studying other disciplines"	"It is tricky to use the suggested method" "It is important to have knowledge of logic" "It was difficult to master the structure of questions and put them in consistency with logic"

Table 3. Advantages and disadvantages of using PBQs as tools of cognitions from the students' point of view

Advantages	Disadvantages
"The material is studied through the work with notions together with students" "This technology reveals the most essential points, as well as numerous pedagogical problems" "Questions reveal contradictions, and encourage collective discovery of new knowledge" "Conditions are never the same, as each student is engaged in work, and productive activity" "It develops logical speaking" "Student are compelled to be mentally competitive"	"It takes a lot of time to prepare for the lessons" "It is hard to identify contradictions in scientific texts together with students" "It takes more time to develop the didactic tools of learning"

Table 4. Advantages and disadvantages of using PBQs as tools of cognitions from the teachers' point of view

Such conditions are prerequisite to the development of thinking ability in a human being. A learner is encouraged to demonstrate their abilities as a thinker and agent. They do not only bring up the abilities to acquire material, but also to elaborate on logical and didactic means of cognition, as well as transfer this ability to the learners. The ideal activity, which means the activity of thinking, is directed towards transforming the image of any given item and the idea of its transformation, which leads further to conscious transformation of practice based on ideas. These two sides of cognition play a substantial role in the development of the thinker, sensible organization of the education process, and release of pedagogical talents. The indicated disadvantages suggest the need in further research and set a tone to a purpose-oriented cooperation of

students and teachers applying this technology. If we are interested to form a need in building logical PBQs, such questions serve as a gateway to an entire culture of thinking and meaningful communication. Development of theoretical thinking through PBQs takes learners to the level of logical cognition, where the world is explored by purpose-driven sensible transformation of human activities.

A number of researchers addressed the problems of traditional education that have to do with the underdevelopment of thinking by applying technologies that encourage critical thinking, nurture inquisitive minds, and make the whole process more interactive. Others develop and introduce programs and strategies that are aimed at this kind of thinking, with assignments and tasks that consider students' requests, as well as a system that evaluates the skills of critical thinking based on such identified components as communicative abilities, logical operation, and argumentation analysis. Since theoretical thinking seeks to discover laws, properties of objects, and unfolds mentally through notions and statements, it is characterized by handling abstract notions, establishing unity between illustrative images, mental pictures and notions, handling images that perform a generalizing function and combine sensory and logical components. Therefore, we deal with notion-based and image-based theoretical thinking that are promoted by suggested methods and technologies of introducing PBQs into the learning process. Neglecting the importance of thinking skills in students builds up into the problem of means that would facilitate the acquisition of the content of a given subject. We agree with Welling (2007) in terms of identifying ways to research the essence of creative learning through cognitive operations: analogy, matching, and abstraction. We believe that cognitive (logical) operations should be combined with appropriate didactic tools, such as PBQs (analysis) and relevant answers to them (synthesis). A question establishes connections and relations between notions, ideas, and explores every notion in its interconnectedness with others. It is how the material is studied through analysis and comparison. No answer can be given without synthesis, generalization of the subject matter under study in compliance with its structure, eliciting conditions of its change and the mechanism of its transformation into a new qualitative state when possible, identification of interrelations. While eliciting contradictions, constructing PBQs that reveal the essence of matters under study one turns to logical operations, didactic means of cognition, which sparks cognitive activity and competitiveness in students in a meaningful way. At the same time, it develops both speaking skills (language structure, form), and the ability to think (handle the content by means of notions, statements, and inferences). The nature of human cognition is conditioned by the relationship between culture, language, and thinking. Inner speech (verbalized thinking) performs important functions in learning (Alderson-Day & Fernyhough: 2015, pp.931-965), the interrelation between speech and thinking was grounded by Lev Vygotsky. As long as students are faced with difficulty understanding and acquiring information (Heras & Ruiz-Mallén: 2018), effective development of theoretical thinking should be centered around making sure that learning leads to understanding (de Boer et al.: 2018, pp.98–115), development (improvement) of logical thinking, productive learning strategies that support "conceptual understanding" (Darling-Hammond *et al.*: 2020, pp.97-140). It is based on cognitive operations involved in the formation of notions, with an effect on comprehensive cognitive processes, as well as on the development of proactive and thinking abilities. Texts are increasingly important in boosting learning efficiency and getting feedback through their analysis, with model texts serving as a feedback method. In our article, PBQs are presented as a tool of getting feedback. Once in place, these components of the didactic system facilitate extended reproduction of knowledge and higher efficiency of individual and collective work of learners.

The necessity of teaching and development science for education, creation of pedagogical conditions (Darling-Hammond *et al.*: 2020, pp.97-140), formation and improvement of learners' abilities to analyze and synthesize required for logical and creative thinking, conscious application of analysis, synthesis, and generalization in the development of thinking (Ahmad et al.: 2017, pp.1-8), and creative operations (Welling: 2007, pp.163–177), development of system-based thinking and reflection as a method of reasoning (Schrüfer et al.: 2020, pp.152-174) – all of it defines methods and approaches to solving the existing problems in education, improving learners' abilities to make inferences and act independently. In addition, changes in global industries, evolving technologies of production require design thinking and mature ability of graduates

to identify and solve problems, including in the situation of collective learning. That said, the role of metacognition as cognition of a higher order that requires learners to manage their cognitive activity. The suggested methods and PBQs when applied while working with texts in lectures, seminars, and during individual work facilitate both theoretical thinking and the ability to think out of the box, critically, creatively; they lay out a road map to independent opinions, identify and implement the mechanism of transition from declared to elicited knowledge that is obtained by means of the mature ability to handle notions, make generalizations and conclusions. For this approach to unfold, teachers have to master the laws of logic and operations of cognition, as well as didactic tools, so they can consciously transform the learning process and learners themselves. Besides, the education process itself must be didactically restructured to involve content- and subject-based, cognitive, organizational and methodical, and assessment-based and regulatory components. Viewed in this context, didactics is a synthesis of psychological and philosophical knowledge that reflects patterns of psychological and logical (thinking) nature, scientific grounds for the culture of thought to form and develop. Apart from theoretical thinking, this approach nurtures critical thinking as well. Learners develop their ability to react critically both to superficial knowledge and main media reports, show creativity in such an area as ecological sustainability (Cheng: 2019, pp.100-567). When preparing their own tasks to scientific texts, learners become independent and free to formulate their opinions and inferences. However, while the focus is on strengthening critical thinking and theoretical thinking, emotional aspects should also be kept in mind. In conditions of cognitive competitiveness based on analysis and synthesis, generalization and division of notions, application of law of logic and PBQs that reflect them, unfolding the technology of dialectical learning, – learners experience a sense of intellectual satisfaction (they are able to discover new knowledge collectively, express freedom of thinking, succeed each in their own activity) and emotional fulfilment (joy of discovery; curiosity as an intellectual force (according to John Dewey); forming questions and well-grounded objections and additions instills confidence), that enriches their activity and facilitates the sense of achievement.

CONCLUSION

One of the central problems inherent to the process of emerging notions and sensible activity by Lev Vygotsky is the problem of means (Vygotsky: 2017). One of such means has been studied in the context of the development of theoretical thinking. By acquiring a system of notions, a student gets an ability to look at problems or tasks from different angles and set conditions for transforming any given piece of reality from the point of view of its essential features.

Establishing the correlation between the image and notion, mediated training, reflecting the content of a given subject matter in PBQs, all promote seasonable and purposeful mediated agency in learners. Utilization of notions in such conditions is equal to mastered comprehension. Didactic means of cognition with firm foundation in formal and dialectical logic, scientific methods of cognition in coherence with the content of the subject matter, and PBQs facilitate conditions for development of agency and the thinker (Ishchenko: 2019, pp.31-38).

In the set conditions, we can speak of genuine intellectual freedom of the knower. While setting out with the purposes of theoretical pedagogy, philosopher Gennadiy Lobastov concludes that “formation of human personality boils down in its entirety to formation of human forms of agency”; the notion is spelt out as “a universal comprehensive ability of a human being, which predefines a relevant form of their agency” (Lobastov: 2012). In the implementation of the suggested method PBQs serve as both “an intellectual means of cognition, a way to resolve the learner’s alienation from the content of learning, and a way to resolve the alienation between the learners themselves” (Ishchenko: 2010, pp.92-101). To address the challenge, one needs a creative interdisciplinary approach to teaching, skills in project-oriented thinking in teachers, and original ways to tackle problems, transition from intuitive problem-solving to more effective analytical and

theoretical way in any professional area, development of theoretical methodological thinking for addressing the social agenda (Griffy-Brown: 2019).

The development of subjectivity in students is hindered by their inefficient knowledge of theoretical basics of a given subject and insufficient mastery of their cognitive functions. Besides, overestimating the practice-based thinking in the current conditions of knowledge-driven economy, confirms that building skills without any theoretical foundation will not help us to navigate sensibly situations of uncertainty. Only partially realized approach to reorganizing the process does not bring the desired effect, the same holds true regarding this technology.

Our earlier studies highlighted the structure of questions and acquisition of logical tools of cognition. They were further expanded to explore the organizational forms of the education process, and ways to acquire various types of learning-related functions (individual labor, simple cooperation, complex cooperation). At this point, the study investigated the principle of feedback at three levels: methodological, psychological-didactic, and technological, with philosophical and methodological grounds to share a methodology that will be compliant with the demand of our time, conditions for the learner's development, classical philosophy, and the technology of acquiring a subject in question by means of PBQs. The indicated problems inherent to the acquisition of notions, as well as the tolls of cognition by students and the organization of the education process by teachers shape the direct the further vector of research into: the development of theoretical thinking based on further findings and elaborations, and implementation of an up-to-date didactic system; logical and didactic foundations of the cognitive process in teachers of all education tiers alike.

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