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Research into the effectiveness of the empirical pedagogical method “practical and innovative work”

Abstract. This article deals with the problem of increasing the effectiveness of empirical pedagogical research. This study was motivated by the infrequent use of the practical assessment of didactic materials in pedagogical studies devoted to the theory and methodology of teaching and upbringing. To determine the effectiveness of practical and innovative work when assessing the quality of didactic materials developed for teaching physics at secondary school based on an activity-oriented educational approach. This study is part of a larger research project focused on the didactic basis of problem-based learning. The project is based on the principles of personality-oriented developmental education and system approach. In this particular study, the following empirical methods were used: literature review, expert evaluation and survey. It was found that the method of practical assessment of didactic materials is rarely used in pedagogical studies on the theory and methodology of teaching and upbringing. However, numerous researchers apply a hybrid method combining pedagogical experiment and practical testing. The necessity of using the method of practical assessment of didactic materials as the final stage of the empirical part of pedagogical research was substantiated. The method of practical and innovative work showed a high level of effectiveness when assessing the didactic characteristics of the educational materials developed by the author for teaching physics at secondary school (the didactic complex of problem-based learning “Physics – 7–9 form”). Practical assessment of didactic materials should be applied more widely as part of empirical pedagogical research on the theory and methodology of teaching and upbringing.

Keywords: empirical methods of pedagogical research; effectiveness of practical and innovative work; didactic complex.

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Introduction. Relevance of the Research.

Responding to the needs of society, modern education systems are becoming active participants of broad societal transformations, such as the design of “schools of the future” (Engeström, 2020, p. 42). Experts continue to emphasize the significance of investments in education, which is becoming an essential factor in the context of global competition (Horváthová & Čajkova, 2018, p. 422).

In order to bring the educational process into a new level, particular attention should be paid to the qualification of teachers, their level of training and orientation towards providing high-quality educational services to each student (Barber & Mourshed, 2008, p. 8). In an effectively functioning education system, there are no significant differences in the quality of teaching between schools. Inequality in educational outcomes may indicate the negative impact of reforms carried out in a national education

system. “Hence, it is essential to disentangle the different factors affecting schools results to design adequate policy responses” (André, Pareliussen & Hwang, 2020, p. 9). Reasonable suggestions for changes in the educational process can be made only on the basis of deep scientific theoretical and (or) empirical research in the fields of psychology and pedagogy, considering the specifics of these disciplines and applying suitable methodology (Feldstein, 2011, p. 8).

A researching teacher who uses empirical methods should take into account the so-called Hawthorne effect: “Most research participants in the spirit of trying to help the experimenter, ... begin to behave depending on what participants are expecting and what they believe their role should be in the study” (Goodwin, 2004, pp. 233–234). The aberrations of the results due to the Hawthorne effect can be particularly significant

during pedagogical experiments. When carrying out an experiment, the teacher does his or her best; as a result, the students participating in the experiment do not want “to let the teacher down and fail”. For this reason, in most cases, the empirical part of pedagogical research should be completed with practical work, which aims at checking the project itself rather than the proposed theoretical concept. Thus, it is relevant to assess the effectiveness of practical work as an empirical method.

Bibliographic Study. One of the most significant areas of pedagogical research is associated with theoretical understanding of the conditions for creating didactic tools that ensure the educational process of various academic subjects and disciplines at different levels of education. The Belgian educational scientist E. De Corte, whose scientific interests include the assessment of educational spaces and problem-based learning (PBL), noted that when creating an educational space, it is necessary to maintain a balance between constructive perspective on learning and direct instruction (De Korte 2019, p. 34). At the same time, various studies indicate a higher didactic effectiveness of constructive teaching.

A constructive (constructivist) cognitive environment can be implemented through problem-based learning, which deservedly attracts the attention of researchers, both in terms of theoretical understanding and at the level of developing strategies and methods of application in certain subject areas (Savin-Baden, 2020; Barak, 2020). The didactic value of problem-based learning is grounded on its correlation with the laws of cognitive development – learning follows the «natural differential-integrational path of cognition development» (Chuprikova, 2016, p. 24). By stimulating the cognitive activity of students, problem learning leads to the formation of new and more consistent cognitive structures, increasing their differentiation and integration, «building on» new current levels of development.

Obviously, the practical implementation of problem-based learning and other forms of personality-oriented developmental learning should be supported by certain didactic tools.

Assessment of recently developed educational and methodological complexes and other didactic elements of the cognitive environment requires conducting a special empirical pedagogical research

and specifying effective research methods in determining the qualitative characteristics of teaching techniques. However, Russian experts note that there are no works devoted to problems of «the influence of modern educational technologies on the achievement of learning outcomes» (Lelchickii, Purysheva & Tryapitsyna, 2017, p. 42). According to Western researchers, government funding and sponsorship often go to those scientists who, while conducting research in familiar and “settled” areas of pedagogical science, “regularly yield products and findings with little relevance to educational practice.” (Penuel Riedy & Barber, 2020, p. 627). A critical review of 1,096 papers published in Chinese pedagogical journals performed by Chinese experts showed that many articles are characterised by «inadequately grounded recommendations for translating research into practice» (Zhao, Beckett & Wang, 2017, p. 583].

This situation multiplies the relevance of our research, the purpose of which was to determine the effectiveness of practical work in assessing the quality of didactic tools intended for organising personality-oriented developmental education.

Research Methodology. Research Base. The study was based on a didactic complex of problem-based teaching physics at school. The reasons to choose the «problematic focus» of the complex were the following:

- firstly, in this case, the educational process unfolds in accordance with the principle of systemic differentiation, providing developing education (Andryushechkin1, 2020);

- secondly, the physics-oriented thinking of students is formed efficiently;

- thirdly, such valuable qualities of thinking as critical thinking – «intellectual value, which remains as such in all areas of research» (Facione, 2020) and dialectical thinking – «the type of thinking that provides the process of intellectual creativity» are formed (Belolutsкая, 2017, p. 51).

- fourthly, productive tasks are widely used in problem-based learning. Performing productive tasks which are «tied» to the real-life context causes difficulties for Russian students at school (Pentin, Kovaleva, Davydova & Smirnova, 2018, p. 97). Problem-based learning can remove such difficulties by equipping students with the appropriate “knowledge, skills and tools” (Mróz, Ocetkiewicz, Tomczyk, Walotek-Ściańska & Rott, p. 184);

– Fifthly, the ability to define and solve problems should be developed at school. Otherwise, the underdevelopment of this skill «inhibits» the cognitive activity of students at the subsequent stages of education (Lazarev & Nosova, 2020).

Research Methodology

The main empirical method of the current study was practical work as “a method of making deliberate changes and innovations in the educational process with the expectation of obtaining higher results with their subsequent verification and assessment” (Novikov, 2010, p. 4). The term «innovation» is interpreted here as a process of introduction into use, development of new elements of tangible or intangible cultures. At the same time, we share the opinion that instead of being imposed on the pedagogical community, innovations should be accepted by it (Usoltsev & Antipova, 2019, p. 15).

The created didactic complex was introduced to physics teachers through methodological seminars and webinars. For this reason, we defined our research method as practical and innovative work, that is the work of familiarising physics teachers with the concept of a didactic complex and its elements in order to increase teachers' competence in implementing an activity approach when teaching physics at school and using problem-based learning as a basic pedagogical method.

In the course of the practical and innovative work, the following empirical methods were used: bibliographic study, expert evaluation, and questionnaire.

Research Stages. At the initial stage of the research, a pedagogical experiment was carried out to assess didactic effectiveness of the complex. The effectiveness criteria were determined by the keynotes of the «Physics» subject:

- formation of the scientific worldview and physics-oriented thinking;
- designing and observing natural phenomena using the necessary measuring tools;
- the dialectical cognition of nature;
- development of intellectual and creative abilities;
- application of the acquired knowledge and skills to solve practical problems in everyday life.

The main stage of the research involved practical and innovative work in the form of two-three-day methodological seminars for physics teachers in secondary schools. The seminars were held

in sixteen Russian cities. The seminar program included:

- introduction to the methodological basis for the didactic complex of problem-based learning (principles of personality-oriented developmental education, ideas of a systematic approach, educational technology, mental and moral development of students by means of the subject of study);

- analysis of the elements of the «Physics – 7–9» complex: curriculum, textbooks, «Physics Lessons» teaching aids, thematic workbooks, collections of multiple tasks, collections of tests and quizzes for individual and class work, thematic tests, optional courses «Physics experiments and tasks», books for additional reading «On physics and physicists»;

- conducting a professional simulation game (creating a problem situation within the framework of a certain topic and developing a fragment of a lesson for its effective resolution);

- questionnaire survey of teachers participating in the seminar. This allowed for clarifying the attitude of the teachers to personality-oriented developmental education in general and problem-based learning in particular, as well as for obtaining an assessment of the didactic complex. A total of 247 questionnaires were processed.

The final stage involved analysing the abstracts of dissertations for the degree of EdD in theory and methodology of teaching and upbringing (code of scientific speciality – 13.00.02) in order to find out which methods are preferred for the empirical part of pedagogical research. Some foreign researchers divide empirical methods, roughly, into «quantitative» and «qualitative» methods. «Quantitative research» inclines towards the problem of optimisation through establishing the relationship between costs (financial, resource and time investments) and learning outcomes. «Qualitative research» investigates the influence of the nature of the educational environment (system) on the results achieved by students (Kingdon, 2006). Academician of the Russian Academy of Education Novikov A.M. proposed to divide empirical methods into two groups: methods-operations and methods-actions (Novikov, 2006, pp. 92-113). We used this classification.

Results. Initial stage of the research. The pedagogical experiment revealed a high didactic efficiency of the complex. The values of the

effectiveness criteria were determined by the assessments and productive tasks performed by the students of experimental and control groups, the solution of experimental problems, and the performance of the psychological test. The results were processed using well-known statistical methods (χ^2 test, Wilcoxon – Mann – Whitney test). The results of the experiment showed the didactic feasibility of using the complex in school practice and allowed for switching to practical and innovative work.

Main stage of the research. In the course of practical and innovative work in the process of joint «brainstorming» with practicing teachers at methodological seminars, and processing the questionnaires, several proposals arose for improving the didactic complex.

First, in addition to the author's teaching aids «Physics Lessons», which provide methodological instructions for each of the lessons in accordance with the thematic planning in the program, it was proposed to develop lesson scenarios. This proposal has been implemented and scenarios for all physics lessons have been prepared and published (indicating the equipment necessary for the lesson, the lesson goals within keynotes defined in the curriculum, indicating the planned subject, meta-subject and personal results) (Andryushechkin2,2020; Andryushechkin3,2020; Andryushechkin4,2020).

Secondly, physics teachers noted the lack of methodological literature considering the aspects of project activities. For this reason, a webinar has been prepared and conducted with consideration of the features of the organisation of optional classes and project activities in physics (Andryushechkin, 2016).

Thirdly, it was proposed to develop a manual that would contain a detailed presentation of the concept of a didactic complex, its model and a description of its elements. This recommendation is reflected in the monograph (Andryushechkin, 2018).

Final stage of the research. The author has studies 85 abstracts of dissertations for the degree of EdD in theory and methodology of teaching and upbringing (the code of scientific speciality – 13.00.02), defended in 2012–2020. The analysis has showed that candidates mostly use several methods for the empirical part of the research. The application frequency of empirical methods in dissertation research is presented in table.

Application frequency of empirical methods in dissertation research

Empirical method	Application frequency, %
Methods-operations	
Study of literature, documents and results of activities	100
Observation	75
Oral survey (conversation, interview)	69
Written survey (questionnaire)	79
Expert evaluation method	39
Testing	54
Methods-actions	
Survey	28
Monitoring	14
Study and generalisation of pedagogical experience	59
Practical work	8
Experiment	79
Practical and experimental work	9
Lack of indicated empirical methods in the dissertation synopsis	5

Controversial issues. In addition to Novikov's classification, we were compelled to put the method called «practical and experimental work», which is mentioned in 9% of dissertation synopsis and is appearing in other scientific literature, in a separate line in table 1. Such a combination of «practical + experimental» into a single empirical method seems controversial. The aim of the experiment is to obtain new pedagogical knowledge and to establish new relationships between pedagogical objects, which suggests new educational systems and didactic tools. The practical work is aimed at testing the effectiveness, accessibility, optimality of the newly created pedagogical systems and tools.

We also note that the data given in table 1 highlight a rare application of such an empirical method as practical work. This threatens the researcher with getting trapped with «Hawthorne effect.» This is probably one of possible explanations for the well-known paradoxical situation when “most dissertations demonstrate an exclusively positive impact of the results of the performed research on educational practice” (Lelchickii, Purysheva & Tryapitsyna, 2017, p. 46).

Discussion and conclusion. Practical pedagogical work acquires the status of a scientific method, “when it transforms reality, creates new pedagogical phenomena, when ... conclusions are drawn from it and theoretical generalisations are created” (Novikov, 2010, p. 4). The creation of what

“new pedagogical phenomena” was stimulated by our practical and innovative work? What were the “lessons learned”?

The results of the research showed the high efficiency of the method «practical and innovative work» for assessing the didactic quality of teaching tools. Thus, in terms of practical and innovative work carried out at the final stage of the empirical

part of the research on the didactic qualities of the complex of problem-based learning «Physics – 7–9», several significant proposals were generated to increase the didactic efficiency of the complex, which were successfully implemented. This infers a recommendation for a wider application of practical work in the course of pedagogical research devoted to the study of the effectiveness of didactic means.

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Исследование эффективности применения эмпирического метода «опытно-инновационная работа»

Аннотация. Актуальность исследуемой проблемы обусловлена задачей повышения эффективности эмпирической части педагогических исследований. Цель исследования: выяснить, насколько эффективно применение метода опытно-инновационной работы в случае оценки качества вновь созданной системы дидактических средств, обеспечивающих изучение курса физики основной школы на основе деятельностного подхода. Исследование является частью общего педагогического исследования дидактического комплекса проблемного обучения, методологическую основу которого составили принципы личностно ориентированного развивающего образования, системный подход. Данное конкретное исследование осуществлялось с использованием следующих эмпирических методов: изучение литературы, метод экспертных оценок, анкетирование. В ходе исследования выявлено, что такой эмпирический метод, как опытная работа, при проведении педагогических исследований по теории и методике обучения и воспитания используется редко. Дополнительно также выявлено использование значительным числом исследователей «гибридного» метода: «опытно-экспериментальная работа». Обоснована необходимость применения в большинстве случаев метода опытной работы как завершающего элемента эмпирической части педагогического исследования. Установлена высокая эффективность применения метода опытно-инновационной работы в случае исследования дидактических качеств разработанной автором системы средств обучения для курса физики основной школы (дидактического комплекса проблемного обучения «Физика – 7–9»). Результаты работы указывают на необходимость более широкого применения опытной (опытно-инновационной) работы при проведении эмпирической части педагогических исследований по теории и методике обучения и воспитания.

Ключевые слова: эмпирические методы педагогических исследований, эффективность опытно-инновационной работы, дидактический комплекс.

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