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THE USE OF ACTION RESEARCH IN PREPARING FUTURE PHYSICS TEACHERS FOR THE DEVELOPMENT OF FUNCTIONAL LITERACY OF STUDENTS

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Abstract. In the context of the transformation of the education system and the transition a competency-based model, the importance of developing students' functional literacy as a key learning outcome is increasing. Functional literacy is understood as the ability to apply subject-specific knowledge and skills in various educational and real-life contexts, analyze information and make well-founded decisions. In the field of science education, particularly in physics teaching, the development of functional literacy requires future teachers to master modern methods of organizing the educational process focused on practical application of knowledge, interdisciplinary integration and research-based activities. The purpose of this article is to substantiate the potential of the Action Research method as an effective tool for the professional training of future physics teachers aimed at developing students' functional literacy in the context of updated educational content. The study employed methods of analysis and synthesis of scientific and pedagogical literature, comparative analysis international experience in teacher education, pedagogical modeling and qualitative analysis of the results of

implementing Action Research elements in physics teacher education programs. The findings indicate that the systematic use of Action Research contributes to the development of sustainable research skills, professional reflection, and the ability to critically analyze one's own pedagogical practice among future physics teachers. The main directions for integrating Action Research into educational programs were identified, including the development of practice-oriented interdisciplinary tasks, the implementation of contextual problem-based situations modeling really educational and life contexts, using the formative assessment tools. The practical significance of the study lies in the possibility of applying the obtained results in the development of teaching and learning materials, elective courses, and professional development programs for teachers, as well as in improving the system of training future physics teachers aimed at enhancing the quality of science education and ensuring teachers' readiness for continuous professional development.

Keywords: functional literacy, training of future teachers, teaching physics, Action Research, pedagogical research, natural science education

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БОЛАШАҚ ФИЗИКА МҰҒАЛІМДЕРІН ОҚУШЫЛАРДЫҢ ФУНКЦИОНАЛДЫҚ САУАТТЫЛЫҒЫН ДАМЫТУҒА ДАЙЫНДАУДА ACTION RESEARCH ПАЙДАЛАНУ

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Аннотация. Білім беру жүйесінің трансформациялануы және құзыреттілікке бағдарланған модельге көшу жағдайында функционалдық сауаттылықты білім алудың негізгі нәтижесі ретінде қалыптастырудың маңызы арта түсуде. Функционалдық сауаттылық пәндік білімдер мен біліктерді

әртүрлі оқу және өмірлік жағдаяттарда қолдана алу, ақпаратты талдау және негізделген шешімдер қабылдау қабілеті ретінде қарастырылады. Жаратылыстану-ғылыми білім беру саласында, атап айтқанда физиканы оқыту үдерісінде, функционалдық сауаттылықты дамыту болашақ педагогтардың білім беру процесін ұйымдастырудың заманауи әдістерін меңгеруін, білімді практикалық тұрғыда қолдануға, пәнаралық интеграцияға және зерттеушілік қызметке бағдарлануын талап етеді. Мақаланың мақсаты – білім беру мазмұнын жаңарту жағдайында білім алушылардың функционалдық сауаттылығын дамытуға бағытталған болашақ физика мұғалімдерін кәсіби даярлауда Action Research әдісінің әлеуетін тиімді құрал ретінде негіздеу. Зерттеу барысында ғылыми-педагогикалық әдебиеттерді талдау және жинақтау, педагог кадрларды даярлаудың халықаралық тәжірибесін салыстырмалы талдау, педагогикалық модельдеу, сондай-ақ Action Research элементтерін физика мұғалімдерін даярлау бағдарламаларына енгізу нәтижелерін сапалық талдау әдістері қолданылды. Action Research әдісін жүйелі пайдалану болашақ физика мұғалімдерінің тұрақты зерттеушілік біліктерін қалыптастыруға, кәсіби рефлексиясын дамытуға және өз педагогикалық қызметін сыни тұрғыдан пайымдау қабілетін арттыруға ықпал ететіні анықталды. Білім беру бағдарламаларына Action Research әдісін интеграциялаудың негізгі бағыттары айқындалды, олар практикалық-бағдарланған пәнаралық тапсырмаларды әзірлеуді, нақты білім беру және өмірлік контекстерді модельдейтін контекстік проблемалық жағдаяттарды енгізуді, сондай-ақ қалыптастырушы бағалау құралдарын пайдалануды қамтиды. Зерттеудің практикалық маңыздылығы алынған нәтижелерді оқу-әдістемелік кешендерді, элективті курстарды және педагогтардың біліктілігін арттыру бағдарламаларын әзірлеу барысында қолдану мүмкіндігімен, сондай-ақ жаратылыстану-ғылыми білім берудің сапасын арттыруға және педагогтардың үздіксіз кәсіби дамуға даярлығын қамтамасыз етуге бағытталған болашақ физика мұғалімдерін даярлау жүйесін жетілдірумен айқындалады.

Түйін сөздер: функционалдық сауаттылық, болашақ мұғалімдерді даярлау, физиканы оқыту, Action Research, педагогикалық зерттеулер, жаратылыстану білімі

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ИСПОЛЬЗОВАНИЕ ACTION RESEARCH В ПОДГОТОВКЕ БУДУЩИХ УЧИТЕЛЕЙ ФИЗИКИ К РАЗВИТИЮ ФУНКЦИОНАЛЬНОЙ ГРАМОТНОСТИ УЧАЩИХСЯ

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Аннотация. В условиях трансформации системы образования и перехода к компетентностно-ориентированной модели возрастает роль формирования функциональной грамотности обучающихся как ключевого образовательного результата. Функциональная грамотность рассматривается как способность применять предметные знания и умения в разнообразных учебных и жизненных ситуациях, анализировать информацию и принимать обоснованные решения. В сфере естественнонаучного образования, в частности при изучении физики, развитие функциональной грамотности предполагает владение будущими педагогами современными методами организации образовательного процесса, ориентированными на практическое применение знаний, междисциплинарную интеграцию и исследовательскую деятельность. Целью статьи является обоснование потенциала метода Action Research как эффективного инструмента профессиональной подготовки будущих учителей физики к развитию функциональной грамотности обучающихся в условиях обновления содержания образования. В исследовании применён комплекс методов, включающий анализ и обобщение научно-педагогической литературы, сравнительный анализ международного опыта подготовки педагогических кадров, педагогическое моделирование, а также качественный анализ результатов внедрения элементов Action Research в образовательные программы подготовки учителей физики. Установлено, что системное использование метода Action Research способствует формированию у будущих учителей физики устойчивых исследовательских умений, развитию профессиональной рефлексии и способности к критическому осмыслению собственной педагогической деятельности. Определены ключевые направления интеграции Action Research в образовательные программы, включая разработку практико-ориентированных междисциплинарных заданий, внедрение контекстных проблемных ситуаций, моделирующих реальные образовательные и жизненные условия, а также использование инструментов формирующего оценивания. Практическая значимость определяется возможностью применения полученных результатов при разработке учебно-методических комплексов, элективных курсов и программ повышения квалификации педагогов, а также при совершенствовании системы подготовки будущих учителей физики, ориентированной на повышение качества естественнонаучного образования и готовность к непрерывному профессиональному развитию.

Ключевые слова: функциональная грамотность, подготовка будущих учителей, преподавание физики, Action Research, педагогические исследования, естественнонаучное образование

Introduction. Modern education is focused on the formation of functional scientific literacy of students, which implies the ability to apply knowledge in real-life situations and participate in public discussions on scientific issues. Physics, as an academic subject, has a high potential for developing analytical thinking and problem-solving skills related to everyday life. However, the effective implementation of this task requires high-quality training of future physics teachers with not only deep subject knowledge, but also methodological competencies focused on practice-oriented learning. Research shows that the inclusion of sociocentric issues in teaching contributes to the development of functional scientific literacy of students (Bossér, 2023). In addition, the professional development of teachers, including active learning and reflection, contributes to the improvement of teaching practice and, as a result, to the improvement of functional literacy of students (Buabeng, Conner and Winter, 2018).

One of the most productive approaches in this area is the Action Research methodology, which is aimed at the continuous improvement of teaching practice through systematic analysis, reflection, experimental implementation, and subsequent adjustment of educational actions. The particular value of this approach lies in its practice-oriented nature, which enables future teachers to act not only as transmitters of knowledge but also as researchers of their own professional practice. The integration of Action Research into the system of professional training for future teachers opens up broad opportunities for developing their research, analytical, and critical-reflective skills that are essential for the effective development of students' functional literacy. Through the cyclical stages of planning, action, observation, and reflection, future teachers master the mechanisms for identifying learning difficulties, analyzing their underlying causes, and selecting optimal pedagogical solutions aimed at improving the quality of education.

Studies show that the use of Action Research contributes to the development of future teachers' ability to integrate theoretical knowledge with practical skills, apply the results of pedagogical analysis to improve teaching content and methods, and adapt the educational process to the real needs of students. This very ability to meaningfully connect theory and practice is regarded as one of the key factors in the formation of functional literacy, as it ensures students' readiness to apply knowledge in real-life and professionally significant situations.

Related works. Despite the increasing attention to the development of functional literacy of students in educational policy and practice, approaches have not been sufficiently developed in the system of training future physics teachers to ensure the formation of their professional competencies necessary for the purposeful and effective development of functional literacy in schoolchildren by means of physics. Thus, the relevance of this article is due to the need to develop effective methods of preparing future physics teachers for the formation of functional literacy of students using the Action Research approach. Action Research is a cyclical process involving planning, action, observation, and reflection aimed at solving problems in educational practice.

As Stefan Kemmis points out, these "moments" should not be perceived as strictly sequential steps, but rather as interrelated components of a dynamic and nonlinear process consistent with the nature of learning activities.

Initially, the participants in the study tend to perceive the process of action research as a linear sequence of stages, which is reflected in their ideas and schemes. However, after completing the relevant training module, significant changes in their understanding are observed: participants begin to imagine the process as a spiral or circle, where the stages of observation and action are interrelated, which indicates the development of a deeper and iterative understanding of the method of action research (Rabgay and Kidman 2023).

From the point of view of Geoffrey E. and Robert B. (Mills and Butroyd, 2014), Action Research is considered as a structured approach to professional training that allows formalizing and deepening pedagogical reflection. It offers a meaningful cycle: "reflection – action – assessment – improvement", which allows the teacher to improve his practice without disrupting the main learning process. This approach contributes not only to the growth of pedagogical competence, but also to the systematic improvement of the quality of education.

The article "I Practice Teaching" (Schutz and Hoffman, 2017) highlights that Action Research helps teachers develop professional identities and improve literacy teaching practices through critical reflection and adaptation of teaching methods. And also in research, (Bersh et al., 2011) three teachers from Florida who used Action Research, integrating technology, poetry and multicultural elements, significantly increased the literacy of students from at-risk groups and contributed to the professional growth of teachers. A study (Cherner and Curry, 2017) focuses on how Action Research helps future teachers effectively use technology to develop literacy by improving their teaching practices. The UNESCO (2020) report also highlights the importance of Action Research in youth and adult literacy programs, especially in the context of developing and adapting educational materials and teaching methods. These sources confirm the effectiveness of Action Research in the development of functional literacy of students, allowing teachers to adapt and improve their teaching methods based on analysis and reflection.

In Kazakhstan, a number of scientists are actively researching the impact of international standards such as PISA and TIMSS on the development of functional literacy of students and the modernization of the education system. Below are some of them:

Kunakbayeva M.Z. in her article "Overview of Kazakhstan's educational achievements in PISA" analyzes the country's participation in the PISA program from 2009 to 2022. She emphasizes that the introduction of international standards has contributed to the reform of national educational standards and the transition to 12-year results-oriented education. It also notes the need for further reforms to improve the quality of education and reduce the gap from the OECD average.

Also, Kaidar N. a senior analyst at the Astana Information and Analytical Center, in collaboration with international researchers (Courtney et al., 2022),

studied the impact of the use of ICT and related installations on students' academic performance in mathematics and natural sciences based on PISA data. The study revealed that the effective use of ICT can have a positive impact on students' academic achievements.

In her works, Abykasymova A.E. analyzes the impact of OECD studies, such as PISA, on the education system in Kazakhstan (Sarmurzin et al., 2021). She notes that participation in international assessments has stimulated radical changes, including the transition to 12-year education, the revision of curricula and the introduction of the concept of "lifelong learning." Also, the National Academy of Education named after Y. Altynsarina used the TIMSS conceptual model in the development of educational programs and textbooks. In addition, national experts conducted an in-depth analysis of TIMSS assignments, which contributed to the improvement of curricula in mathematics and natural sciences.

These studies highlight the importance of Kazakhstan's participation in international assessments such as PISA and TIMSS to improve the quality of education and develop students' functional literacy. They also demonstrate the commitment of Kazakh scientists and educational institutions to integrate international standards and practices into the national education system.

The research is aimed at identifying pedagogical conditions, methodological approaches and the content of teaching future physics teachers that contribute to the formation of students' readiness to develop functional literacy through Action Research.

The purpose of the study: to develop and substantiate a pedagogical model and methodological recommendations for the preparation of future physics teachers for the effective formation of functional literacy through Action research.

Research questions:

1. What pedagogical conditions and methods are most effective for preparing future physics teachers to develop students' functional literacy?

2. What competencies should a future physics teacher have in order to effectively develop students' functional literacy?

Research methodology. The conducted research is qualitative and has a descriptive and interpretative character. Its purpose is not to establish causal relationships between variables; instead, it aims at a generalized assessment of the current situation with an emphasis on the characteristics of the research object of interest. This approach allows for a deeper understanding of the issues under study, highlights key aspects and trends, and identifies possible areas for further research or practical action. Interpretative content analysis, which was used in his scientific work as a methodological basis. This method is a systematic procedure for analyzing text material based on its preliminary categorization followed by quantitative and qualitative consideration of the data obtained. At the first stage, the categorical research apparatus is developed and refined, within the framework of which text units — words, phrases, semantic blocks or statements — are correlated with predefined analytical categories. At the next stage, the frequency

of occurrence of each of the selected categories in the analyzed corpus of texts is calculated, which makes it possible to quantify the degree of their representation and significance. The calculation of frequencies makes it possible to identify dominant and secondary categories, establish patterns of distribution of meanings and trace trends in the studied material. The use of this method ensures reproducibility and transparency of the analytical procedure, as well as increases the reliability of the results obtained due to a formalized approach to data processing. As the author of notes (Ahuvia, 2001), the combination of categorization of textual material and frequency analysis makes it possible to effectively integrate qualitative and quantitative elements of research, which makes this method especially in demand in pedagogical, sociological and interdisciplinary research focused on the analysis of complex social and educational phenomena.

Also in the monograph (Faggiano, 2023) used the method of content analysis as a flexible and multilevel research method. In his work, the author combines qualitative and quantitative techniques to study communication in a digital environment. The author emphasizes that modern content analysis goes beyond simple counting of words and categories, including interpretation of meanings and context analysis, which is especially important when working with social media and online platforms. Faggiano focuses on the need to integrate traditional techniques with digital tools (for example, big data analysis software), which increases the accuracy and representativeness of the results.

The researchers take into account that content analysis is one of the fundamental methods in the arsenal of social sciences. Its distinctive feature is the analysis of texts based on their contextual meaning, which allows not only to identify the structure and content of messages, but also to interpret them within a specific social, cultural or communicative situation. This is its difference from other empirical methods, mainly focused on quantitative data processing without deep interpretation of meanings. Due to its flexibility and analytical productivity, content analysis is widely used in public opinion research, media discourse, political rhetoric, and other fields where text acts as the main source of data.

Our proposed scientific research is part of a doctoral dissertation, and in our research, we used an empirical method of content analysis and received an interpretation of specific answers on this topic.

The study participants represent different regions of Kazakhstan and study in educational institutions of various levels and status, including both national and regional universities. This territorial and institutional diversity increases the generalizability of the results and ensures a broader coverage of the country's educational environment. The study mainly involved second- and third-year students of the "Physics Teacher Training" educational program. The sample included 304 respondents. The gender distribution of participants was as follows: 217 women (71.4%) and 87 men (28.6%).

The present study focuses exclusively on a sample consisting of second- and third-year students of higher education institutions. This targeted selection is due to

the fact that students in these courses have already mastered the basic fundamentals of pedagogical and subject training, but at the same time continue to actively master more in-depth professional knowledge and skills that are formed at the final stage of training. This makes them a particularly suitable group for studying the formation of future physics teachers. Researcher (Walters, 2021) emphasizes the importance of thoughtful sampling design and control over sources of bias in survey research.

Participation in the survey was carried out on a voluntary basis, without any external pressure or coercion. The anonymity of the respondents was strictly observed, and all personal data was securely protected in accordance with the principles of research ethics and confidentiality.

The study used open-ended questions that provided respondents with the opportunity to express their thoughts in detail. The proceeds from the position that this approach contributes to a deeper understanding of the participants' views and allows them to identify specific aspects that are difficult to cover with standard closed-ended questions. Below are some questions from our student survey:

1. What skills in physics should students develop in the development of functional literacy?

2. The readiness of future physics teachers to develop students' functional literacy.

3. What is the difference between Action research and other research?

4. What methods can be used to develop students' functional literacy through Action Research?

The purpose of this survey is to prepare future physics teachers to develop students' functional literacy. Future teachers should understand that functional literacy includes the skills of applying knowledge in various situations, critical thinking and the ability to solve problems. In the process of teaching physics at school, students acquire skills in analysis, critical thinking, problem solving and practical application of knowledge, resulting in the formation of scientific functional literacy in order to reveal their practical abilities in applying the acquired theoretical knowledge in everyday life.

In order to ensure the most objective and reliable results, the respondents were informed in advance that the final research report would contain only generalized information, without disclosing personal information. The observance of the principle of anonymity is a fundamental provision of the ethics of social research and research practice.

The content analysis method can be used in both qualitative and quantitative research contexts to study texts. It is a systematic approach that includes several stages of content analysis. At the first stage, a sample is selected — a subset is selected from the total set of texts for analysis. This selection is not random: preference is given to texts containing the most relevant information. Then the texts are divided into separate fragments or "units of analysis" according to certain rules. Then each fragment is assigned codes — one or more, depending on the context. At the final stage, the codes are analyzed in order to identify the most common

ones. The final stage of the analysis can be both quantitative and qualitative. The processing of the collected verbal data was carried out in four stages using generally accepted methodological principles of classical content analysis.

- Re-familiarization with the response texts.
- Identification of semantically similar statements and significant (key) words.
- The formation of subcategories with subsequent grouping into more generalized categories.
- Analysis and interpretation of the generated categories and subcategories.

During the content analysis, the respondents' responses were carefully analyzed and grouped into subcategories, taking into account their semantic similarity and semantic connection. At this stage, the content of the responses was reviewed multiple times and repetitive or similar thoughts were identified. Each subcategory described a specific group of values, and they were organized into categories corresponding to the purpose of the study. Thus, the obtained system of categories allowed to reveal the essence of the studied socio-pedagogical phenomenon more deeply, to systematize the views of the respondents.

In the process of creating categories, an inductive approach was used, i.e. semantic units came directly from the data, which ensured the reliability and meaningful completeness of the study.

Research Results. The data analysis led to significant results. Based on the results of the analysis of the issue of necessary skills in physics in the development of functional literacy, the category "Skills formed by students in physics" was identified (Table 1).

Table 1 - Necessary physics skills for the development of functional literacy

Category	Subcategory	N (%)	Subcategory components	N (%)
Skills developed by students in physics	Skills of applying theoretical knowledge in practice and in life	186 (61.2)	Mathematical literacy	70 (23)
			Natural science literacy	116 (38.2)
	Educational and cognitive skills	118 (38.8)	Reading literacy	15 (4.9)
			Financial literacy	4 (1.3)
			Creative thinking	99 (32.6)

Note: Compiled by the author(s) based on the source (Lamanauskas, 2024)

As shown in table 1, the subcategory "Skills of applying theoretical knowledge in practice and in life" is the most significant, covering 61.2% of respondents (186 people). This suggests that a significant proportion of students are developing the skills to apply theoretical knowledge of physics in the context of mathematical calculations and natural science concepts, which corresponds to the goal of forming functional literacy through the practical use of theoretical knowledge.

The second subcategory covers 38.8% of respondents (118 people). The data demonstrate the importance of developing cognitive skills and creative thinking in the process of developing functional literacy in physics. Low indicators of financial literacy and reading skills indicate that they are less of a priority in this context, but

they are still taken into account. In this block, the main focus is on the application of theoretical knowledge in practical and life situations, which is confirmed by the high proportion of respondents who identified mathematical and natural science literacy. The development of cognitive and creative skills is also an important aspect contributing to the comprehensive formation of functional literacy. The lower representation of skills such as financial literacy and learning skills indicates their supporting role in teaching physics at this stage.

The analysis of the readiness of future physics teachers to develop functional literacy of students was also carried out and two categories were identified: preparation for the development and application of interdisciplinary connections, readiness to implement an integrated educational process.

Table 2 - Readiness of future physics teachers for the development of functional literacy of students.

Category	N (%)	Subcategory	N (%)	Subcategory components	N (%)
Preparation for the development and application of interdisciplinary communications	167 (54,9)	Mastering interdisciplinary connections	38 (12.5)	I am well versed in how to connect physics with other disciplines.	16 (5.3)
				I know effective ways to use interdisciplinary connections in teaching physics.	22 (7.2)
		Skills of applying acquired knowledge in practice	129 (42.4)	As a future physics teacher, I am confident that I will introduce interdisciplinary approaches into the learning process.	129(42.4)
Willingness to implement an integrated educational process	137 (45,1)	The level of coverage of the University's educational program	83 (27.3)	The educational program at the university teaches how to adequately implement interdisciplinary connections in teaching physics	83 (27.3)
		Demand for additional education	54 (17,8)	I want to gain additional knowledge on methods of teaching physics based on interdisciplinary connections	54 (17,8)

Note: Compiled by the author(s) based on the source (Lamanauskas, 2024)

Based on the survey data, an assessment was made of the readiness of future physics teachers to master and apply interdisciplinary approaches in educational practice. Based on the data, the main category was identified — "Preparation for the development and application of interdisciplinary communications", covering 54.9% of respondents (167 people). As shown in Table 2, the subcategory "Mastering interdisciplinary relations" reveals the level of students' awareness of the possibilities of integrating physics with other academic disciplines (12.5%). Despite the relatively small proportion, these indicators demonstrate the existence of basic concepts of interdisciplinarity, but also indicate the need for its further development in teacher training.

A significant number of future physics teachers expressed confidence in their own willingness to apply interdisciplinary approaches in practice. All 129 respondents (42.4%) agreed with the statement: "As a future physics teacher, I am confident that I will introduce interdisciplinary approaches into the learning process." This result indicates a high level of motivation and a positive attitude of students towards the idea of integrating knowledge into the educational process.

In the second category, more than a quarter of the participants (27.3%) noted that their educational program provides adequate training in implementing interdisciplinary connections in physics teaching. This reflects a certain degree of effectiveness of university programs, but also indicates the potential for improving the content and methodological components. Also, a significant part of the respondents expressed interest in additional training in physics teaching methods using interdisciplinary connections. This confirms the existence of an internal need for professional development and the desire to improve the quality of future teaching practice.

The next stage of the study was the analysis of the distinctive features of action research in comparison with other types of scientific research. The importance of Action research category was identified and, accordingly, three subcategories on this topic were identified.

Table 3 - Features of Action research in comparison with other types of scientific research.

Category	Subcategory	N (%)	Subcategory components	N (%)
The importance of Action research	An action aimed at solving problems in the learning process and a cyclically flexible structure	177 (58,2)	This method allows the teacher to identify the problem he faces in the daily learning process and perform several circular actions to solve it (before reaching the goal).	164 (53.9)
			The study may consist of several cycles	13 (4.3)
	Cooperation and professional community	29 (9,5)	Two or more teachers can participate in one study.	12 (3.9)
			Research work can be carried out within a school, in a team of teachers from several schools.	17 (5.6)
	Targeted research	98 (32,2)	The teacher takes actions aimed at solving a specific learning problem, and the research continues until the result is achieved.	98 (32.2)

Note: Compiled by the author(s) based on the source (Lamanauskas, 2024)

Within the framework of this study, the main category was identified — "The importance of Action research", which reflects the key aspects and characteristics of this method. The results of the first subcategory indicate that the majority of participants are aware of the cyclical nature of Action research and its focus on practical solutions to specific problems in the educational process (58.2%). In the next subcategory, the components demonstrate that the study participants understand

the importance of collective and interschool interaction in the implementation of Action research, but this aspect is less widely represented than individual practical experience (9.5%). The respondents also understand the essence of Action research as a process focused on practical improvement and continuous improvement of educational practice.

The fourth aspect was analyzed: the methods used to develop functional literacy of students through Action Research, a category was identified: types and features of the application of teaching methods.

Table 4 - Methods used to develop functional literacy of students through Action Research

Category	Subcategory	N (%)	Subcategory components	N (%)
Research and teaching methods	Empirical research methods	50 (16,4)	Conversation, discussion, discussions	50 (16,4)
	Research-based and action-based methods	171 (56,3)	Problem-based learning	133 (43,8)
			Project-based learning method	38 (12,5)
	The relationship between teacher and student	40 (13,2)	Interactive method	40 (13,2)
	Digital methods	27 (8,9)	The virtual method	27 (8,9)
	Innovative technologies	16 (5,3)	Other methods (such as the gaming method, STEAM, etc.)	16 (5,3)

Note: Compiled by the author(s) based on the source (Lamanauskas, 2024)

The analysis of the data presented in Table 4 indicates a clear dominance of the subcategory "research and practical methods" in the structure of the pedagogical approaches used. This subcategory occupies a leading position, which is primarily due to the high proportion of problem-based and project-based learning, the total representation of which is 56.3%. This indicates a steady orientation of educational practice towards methods that involve active cognitive activity of students, independent solution of educational and practice-oriented tasks, as well as the formation of research and analytical skills.

Considerable attention in the analyzed materials is paid to methods aimed at actively involving students in the educational process using interactive forms of learning and digital educational technologies, the share of which is 13.2%. The use of these methods helps to increase educational motivation, develop information skills and form digital literacy, which meets modern requirements for learning outcomes and the demands of the digital educational environment.

At the same time, innovative pedagogical approaches are represented to a lesser extent and account for 5.3% of the total recorded methods. Despite their relatively low prevalence, these approaches reflect promising areas of educational development focused on the personalization of learning, the integration of interdisciplinary solutions and the use of modern educational technologies. This allows us to consider them as a potential basis for further updating the methodological tools of teachers.

It is important to note that all the fixed components strictly correspond to their subcategories, while there are no intersections between them. This fact indicates

that the classification used is clearly structured and the data distribution is correct, which increases the reliability of the results obtained and the validity of the conclusions drawn.

Discussion. The purpose of our research was to prepare future physics teachers to develop students' functional literacy through Action research. The results of the study show that when teaching physics, the main focus is shifting towards the application of theoretical knowledge in practical and life contexts, which is confirmed by the high proportion of respondents who identified mathematical and natural science literacy as key components. Significant importance is also attached to the development of cognitive and creative skills that ensure the holistic formation of functional literacy of students. At the same time, the relatively low level of representation of such components as financial literacy and learning skills may indicate their supporting role in the educational process in physics at the current stage, as well as the need for further rethinking their importance in the structure of educational priorities.

The results, comparable with the presented data, are recorded in the works of other authors. For example: Researchers (Brahmia et al., 2021) has developed the Physics Inventory of Quantitative Literature (PIQL), which reveals the poor use of mathematical reasoning by students even after traditional physics courses, emphasizing the need for quantitative literacy. The results of using PIQL have demonstrated that a significant proportion of students, even those who have successfully completed basic physics courses, have difficulty using mathematical apparatus in the context of physical problems. In particular, students often demonstrate a fragmentary understanding of numerical relationships and tend to use formulas mechanically, without understanding quantitative relationships. These data emphasize the importance of systematic and purposeful formation of quantitative literacy as an integral component of functional literacy in physical education, especially in the context of the transition to a practice-oriented learning model. Similarly, the work of researchers (Hudha et al.,2019) uses the inquiry STEM approach in the topics "work and energy". Research shows that it significantly increases the understanding of concepts compared to traditional teaching, although the effect on scientific literacy is less significant.

When analyzing the readiness of future physics teachers to develop students' functional literacy, it can be seen that more than half of future physics teachers show a conscious willingness to apply interdisciplinary connections in their professional activities. A high level of confidence in the need for integrative approaches is combined with recognition of the need for additional methodological training. Despite the availability of basic knowledge, the degree of methodological equipment of students remains insufficient, which indicates the need to deepen the interdisciplinary component in the educational programs of pedagogical universities. Researchers Feser and Krumphals note that: "One of the main difficulties for future physics teachers is the integration of subject knowledge and pedagogical substantive knowledge in the process of diagnosing student perceptions. "This highlights the

importance of developing future teachers' ability to recognize and correct students' erroneous concepts as part of the formation of functional literacy.

The study by Montalbano and Benedetti focuses on the role of active forms of education in the professional training of future physics teachers. The authors note that the implementation of the course, based on the principles of active learning in a physical laboratory, has demonstrated high efficiency in forming a stable understanding of modern didactic approaches among students of pedagogical specialties. During the training, future teachers not only got acquainted with the theoretical foundations of active methods, but also were directly involved in their practical application, performing laboratory tasks focused on independent research, hypothesis formulation, analysis of experimental data and collective discussion of the results. The results obtained indicate that the systematic use of active forms of learning, including laboratory work of a research nature and the organization of educational space in the format of converted, interactive classrooms, contributes to the formation of future teachers' readiness to implement these methods in school practice. This experience allows educators to consciously apply active learning strategies to develop students' cognitive and quantitative skills, including the ability to analyze information, work with measurements and data, interpret experimental results, and solve practice-oriented tasks. In a broader context, the results of the study confirm the expediency of integrating active learning into physics teacher training programs as one of the key conditions for improving the quality of science education and developing students' functional literacy.

In addition, analyzing the features of Action research in comparison with other types of scientific research, it can be seen that Action research is a cyclical and flexible method that allows teachers to identify and solve pressing problems in the learning process. The overall assessment of the importance of Action research indicates a high awareness of the participants about its importance in pedagogical practice and the potential to improve the quality of education. Similar conclusions confirm that research in action differs significantly from traditional scientific approaches in its focus on the practical transformation of pedagogical activity. The researchers note that within the framework of Action research, the teacher is not an object of study, but an active agent of change, which makes this approach especially valuable in a dynamic educational environment. In addition, research shows that this approach contributes not only to the professional development of teachers, but also to the formation of reflective thinking and a research culture, which traditional research models achieve to a lesser extent.

This study has a number of limitations. First of all, it was carried out within the framework of a qualitative approach and the sample included only students enrolled in the educational program "Physics Teacher Training", which limits the possibility of applying the conclusions to other students of the curriculum. In addition, the small sample size suggests caution in interpretation and does not allow generalizations to be made without due critical assessment.

Conclusions. In the context of the modernization of the education system and the transition to a competence-based approach, functional literacy is considered as one of the key learning outcomes, reflecting the willingness of students to apply acquired knowledge, skills and abilities in a variety of life and learning situations. Functional literacy goes beyond the simple assimilation of subject content and presupposes the ability to analyze information, interpret data, make informed decisions and solve practice-oriented tasks. In this context, natural science education is of particular importance, focused on the formation of a holistic scientific picture of the world and the development of students' research thinking.

Physics as an academic subject has significant potential for the formation of functional literacy due to its applied orientation, experimental nature and close connection with real processes and phenomena of the surrounding world. The study of physics involves the active use of observations, experiments, modeling and quantitative analysis, which creates favorable conditions for the development of logical, critical and analytical thinking of students, as well as their ability to apply knowledge in non-standard situations.

The results of the conducted research indicate that the existing system of training future physics teachers is insufficiently focused on the formation of professional skills necessary for the purposeful development of functional literacy of schoolchildren. The emphasis in educational programs is on substantive training, while the issues of methodological support for practice-oriented and interdisciplinary learning remain insufficiently developed. This necessitates the updating of the content and technologies of teacher training, the introduction of innovative pedagogical approaches aimed at integrating functional literacy tasks into the teaching of physics.

The research revealed the theoretical foundations of the concept of functional literacy in the context of natural science education, and identified the key professional competencies of a future physics teacher, including research, reflexive, design, and analytical components. Special attention is paid to substantiating the expediency of using the Action Research method as an effective means of developing students' functional literacy. This method is focused on the practical solution of pedagogical tasks, a reflexive analysis of one's own activities and the achievement of specific educational results. Unlike quantitative and experimental methods, which are primarily aimed at testing hypotheses and obtaining generalizable data, Action Research is based on the active participation of the teacher in the research process and is aimed at improving his own pedagogical practice in real learning environments.

Thus, the preparation of future physics teachers for the development of functional literacy of students should be considered as a priority area of teacher education, requiring a systematic approach, interdisciplinary interaction and a sustainable practice-oriented orientation of the educational process.

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