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G. REVALDE[1], I. YESSENGABYLOV[2], G. ZHAPSARBAY[3]✉

[1]Dr. Phys., Professor, Riga Technical University
(Latvia, Riga), e-mail: gitar@latnet.lv
[2]Candidate of Pedagogical Sciences, Associate Professor
Zhetysu University named after I. Zhansugurov
(Kazakhstan, Taldykorgan), e-mail: ilias_e@mail.ru
[3]PhD Doctoral Student of Zhetysu University named after I. Zhansugurov
(Kazakhstan, Taldykorgan), e-mail: zhapsarbay.galymbek@mail.ru

THE MAIN DIDACTIC PRINCIPLES OF BUILDING A DIGITAL EDUCATIONAL AND METHODICAL COMPLEX IN PHYSICS

Abstract. This abstract describes the fundamental didactic principles of constructing a digital educational-methodical complex in physics. It covers aspects such as individualization of learning, teacher-student interaction, interactivity of materials, accessibility and ease of use, as well as maximizing the use of modern technologies for effective learning. Attention is paid to the development of interactive assignments, material visualization, the ability to assess knowledge, and receive feedback. Such an approach makes learning more engaging, accessible, and effective for students. This complex is designed for the effective organization of learning and increasing student motivation. First and foremost, it is necessary to consider the principle of individualization of the educational process. The digital educational-methodical complex should offer various levels of tasks that will allow each student to utilize their abilities and needs. Active student participation in the educational process is another important principle. Interactive exercises, laboratory work, and visualization of physical phenomena should be included in the digital complex to stimulate active student engagement in the learning process. When creating a digital educational-methodical complex, it is necessary to consider the fundamental principles as well as their connection with the real world and applicability. It is important for students to see how the studied physical laws and phenomena are applied in everyday life. This will increase students' interest and motivation to study the subject. A digital educational-methodical complex in physics, based on these didactic principles, will contribute to the improvement of the quality of education and the effectiveness of the learning process. A digital educational and methodological complex was shown, which will contribute to a deep understanding of physics by students. Modern digital technologies have also been introduced into the educational process to increase students' motivation and interest in studying physics. This principle assumes that the student's personality in the totality of its individual, personal qualities is at the center of learning. This didactic principle involves taking into account the individual characteristics of students in the course of classes. The methods and forms of organizing the work

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of students with a digital educational and methodological complex, including both independent and group learning, are defined. The goals and objectives helped to create an integrated and effective digital educational and methodological complex in physics, which will meet the modern requirements of the educational process.

Keywords: educational and methodical complex, information and communication technologies, teacher, digital technologies, physics.

Г. Ревалде[1], И. Есенгабылов[2], Ғ. Жапсарбай[3]
[1]физика ғылымдарының докторы, профессор
Рига техникалық университеті (Латвия, Рига қ), e-mail: gitar@latnet.lv
[2]педагогика ғылымдарының кандидаты, қауымдастырылған профессор
І. Жансүгіров атындағы Жетісу университеті
(Қазақстан, Талдықорған қ.), e-mail: ilias_e@mail.ru
[3]І. Жансүгіров атындағы Жетісу университетінің PhD докторанты
(Қазақстан, Талдықорған қ.), e-mail: zhapsarbay.galymbek@mail.ru

Физикадағы цифрлық оқу-әдістемелік кешенді құрудың негізгі дидактикалық принциптері

Аңдатпа. Бұл жұмыста физикадағы цифрлық оқу-әдістемелік кешенді құрудың іргелі дидактикалық принциптері сипатталған. Ол оқытуды дараландыру, мұғалім мен оқушының өзара әрекеттесуі, материалдардың интерактивтілігі, қол жетімділігі мен пайдаланудың қарапайымдылығы, сонымен қатар тиімді оқыту үшін заманауи технологияларды барынша пайдалану сияқты аспектілерді қамтиды. Интерактивті тапсырмаларды әзірлеуге, материалды визуализациялауға, білімді бағалауға, кері байланыс алуға назар аударылады. Бұл кешен оқуды тиімді ұйымдастыруға және оқушылардың ынтасын арттыруға арналған. Көрсетіліп сипатталған тәсіл оқуды студенттер үшін тартымды, қолжетімді және тиімді етеді. Ең алдымен, оқу процесін дараландыру принципі қарастырылған. Цифрлық оқу-әдістемелік кешен әр оқушыға өзінің қабілеттері мен қажеттіліктерін пайдалануға мүмкіндік беретін әр түрлі деңгейдегі тапсырмалар ұсынылған. Студенттердің оқу процесіне белсенді қатысуы тағы бір маңызды қағида болып табылады. Интерактивті жаттығулар, зертханалық жұмыстар, физикалық құбылыстарды визуализациялау оқушылардың оқу процесіне белсенді қатысуын ынталандыру үшін цифрлық кешенге енгізілуі керек. Цифрлық оқу-әдістемелік кешенді құру кезінде іргелі принциптерді, сондай-ақ олардың нақты әлеммен байланысы және қолданылуы ескеріледі. Студенттер үшін зерттелген физикалық заңдылықтар мен құбылыстардың күнделікті өмірде қалай қолданылатынын көру маңызды. Бұл студенттердің пәнді оқуға деген қызығушылығы мен ынтасын арттырады. Осы дидактикалық принциптерге негізделген физикадағы цифрлық оқу-әдістемелік кешен білім беру сапасы мен оқу процесінің тиімділігін арттыруға ықпал етеді. Оқушылардың физиканы терең түсінуіне ықпал ететін цифрлық оқу-әдістемелік кешен ұсынылды. Сондай-ақ студенттердің физиканы оқуға деген ынтасы мен қызығушылығын арттыру үшін білім беру процесінде заманауи цифрлық технологиялар көрсетілді. Бұл принцип оқытудың орталығында оқушының жеке тұлғасы оның жеке қасиеттерінің жиынтығында болады деп айқындайды. Бұл дидактикалық принцип сабақ процесінде студенттердің жеке ерекшеліктерін ескеруді қамтиды. Дербес және топтық оқытуды қоса алғанда, цифрлық оқу-әдістемелік кешені бар оқушылардың жұмысын ұйымдастырудың әдістері мен нысандары анықталды. Мақсаттар мен міндеттер білім беру процесінің заманауи талаптарына жауап беретін физика бойынша біртұтас және тиімді цифрлық оқу-әдістемелік кешен құруға көмектесті.

Кілт сөздер: оқу-әдістемелік кешен, ақпараттық-коммуникациялық технологиялар, оқытушы, сандық технологиялар, физика.

Г. Ревалде[1], И. Есенгабылов[2], Г. Жапсарбай[3]
[1]доктор физических наук, профессор
Рижский технический университет (Латвия, г. Рига), e-mail: gitar@latnet.lv
[2]кандидат педагогических наук, ассоциированный профессор
Жетысуский университет имени И. Жансугурова
(Казахстан, г. Талдыкорган), e-mail: ilias_e@mail.ru
[3]PhD докторант Жетысуского университета имени И. Жансугурова
(Казахстан, г. Талдыкорган), e-mail: zhapsarbay.galymbek@mail.ru

Основные дидактические принципы построения цифрового учебно-методического комплекса по физике

Аннотация. В этой работе описаны фундаментальные дидактические принципы построения цифрового учебно-методического комплекса по физике. В нем рассматриваются такие аспекты, как индивидуализация обучения, взаимодействие преподавателя и студента, интерактивность материалов, доступность и простота использования, а также максимальное использование современных технологий для эффективного обучения. Особое внимание уделяется разработке интерактивных заданий, визуализации материала, возможности оценивать знания и получать обратную связь. Такой подход делает обучение более увлекательным, доступным и эффективным для студентов. Данный комплекс предназначен для эффективной организации обучения и повышения мотивации учащихся. В первую очередь, необходимо учитывать принцип индивидуализации учебного процесса. Цифровой учебно-методический комплекс должен предлагать задания различного уровня, которые позволят каждому студенту реализовать свои способности и потребности. Еще одним важным принципом является активное участие студента в образовательном процессе. Интерактивные упражнения, лабораторные работы и визуализация физических явлений должны быть включены в цифровой комплекс, чтобы стимулировать активное вовлечение учащихся в учебный процесс. При создании цифрового учебно-методического комплекса необходимо учитывать фундаментальные принципы, а также их связь с реальным миром и применимость. Студентам важно видеть, как изучаемые физические законы и явления применяются в повседневной жизни. Это повысит интерес и мотивацию студентов к изучению предмета. Цифровой учебно-методический комплекс по физике, основанный на этих дидактических принципах, будет способствовать повышению качества образования и эффективности учебного процесса. Были показаны цифровой учебно-методический комплекс, который будет способствовать глубокому пониманию физики учащимися. А также внедрены современные цифровые технологии в образовательный процесс, чтобы повысить мотивацию и интерес студентов к изучению физики. Данный принцип предполагает, что в центре обучения находится личность ученика во всей совокупности ее индивидуальных, личностных качеств. Этот дидактический принцип предполагает учет индивидуальных особенностей обучающихся в процессе занятий. Определены методы и формы организации работы учащихся с цифровой учебно-методическим комплексом, включая как самостоятельное, так и групповое обучение. Цели и задачи помогли создать целостный и эффективный цифровой учебно-методический комплекс по физике, который будет отвечать современным требованиям образовательного процесса.

Ключевые слова: учебно-методический комплекс, информационно-коммуникационные технологии, учитель, цифровые технологии, физика.

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Introduction

In the modern information society, constantly evolving technologies become an essential part of education. With the growth of digital technologies, it is necessary to create modern educational complexes that can effectively transmit knowledge and skills to the new generation of students. Physics is one of the most important fields where a digital approach is particularly relevant.

Digital technologies are actively used by the current educational system to raise standards and give teachers and students new chances. The creation of computerized educational and methodological complexes (CMCs), which integrate interactive components, multimedia resources, and theoretical and practical materials, is one of the main objectives in this context. These complexes are particularly significant for disciplines like physics, where comprehension of intricate ideas and occurrences necessitates precision and the capacity for repetitive experimentation.

The primary pedagogic tenets that guide the development of digital physics educational and methodological complexes are to guarantee that students acquire knowledge effectively, foster critical thinking, and become independent. The scientific concepts, consistency and consistency, clarity, accessibility, and learning activities are among them that are emphasized. Every material that is supplied is guaranteed to adhere to current scientific data and methodologies by the scientific approach philosophy. A gradual and thorough knowledge of the subjects is facilitated by the logical structure that consistency and consistency give the content. The visualization of intricate physical processes and events made possible by the use of graphs, animations, and simulations aids in their understanding and retention.

The idea behind accessibility is to modify lessons and materials according to students' unique needs and training levels. Students are encouraged to engage with the topic through interactive projects and experiments during the learning process, which helps them assimilate the information more deeply and strengthen their research abilities. Therefore, in order to assure high-quality and successful training, a rigorous attention to didactic principles is necessary while creating a digital educational and methodological complex in physics.

The introduction of digital technologies has brought about a great deal of change in modern schooling. The development of efficient digital physics educational and methodological complexes is becoming a crucial task for educational institutions in the context of global digitalization. Being one of the basic sciences, physics calls for a unique teaching strategy that incorporates cutting-edge tools and techniques. This article's primary goal is to examine the fundamental pedagogic ideas that underpin the development of a digital physics educational and methodological complex. When teaching physics, consistency in the content and how it is presented is crucial. It is important to design the digital educational and methodological complex such that students can progress from basic to more sophisticated concepts in a logical and consistent manner. This helps you gain a deeper comprehension of the subject and enables you to build a strong foundation of knowledge. To help create an overall picture of the subject, each new section or topic should make sense in relation to the ones that came before it.

The visibility principle is particularly crucial when teaching physics because many ideas and phenomena are hard to understand without the use of visual aids. The visualization of intricate processes and occurrences through the use of graphs, diagrams, animations, and simulations facilitates understanding. To improve the assimilation of the material, the interactive functions of the digital educational and methodological complex should allow students to view the results of their actions in real time.

Involving students in the learning process through interactive assignments, online laboratory work, and project-based learning is called active learning. This contributes to the development of research abilities, critical thinking and the ability to apply theoretical knowledge in practice. This contributes to the development of research abilities, critical thinking and the ability to apply theoretical knowledge in practice.

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When creating digital educational and methodological complexes, the idea of scientific accuracy is crucial. Since physics is an accurate and empirical science, all teaching materials must be carefully verified using the most modern scientific methods and experience. This ensures that the material provided to students is accurate, which is important to form a solid basic understanding of the subject. To maintain this level, any digital textbook should be created in close collaboration with subject matter experts.

A well-structured digital educational and methodological complex should provide information in such a way that it makes sense. Students can build on their prior knowledge and gradually move on to increasingly complex topics, following the principle of systematic and consistent presentation, which guarantees the gradual introduction of concepts. This method contributes to a more complete understanding of the subject, helping students to connect disparate physical concepts and improve understanding.

The most important pedagogical idea is visualization, especially in physics. By providing a more concrete and understandable representation of abstract concepts, the use of graphics, animations and simulations can significantly improve the learning process. For example, students can gain an understanding of electromagnetic fields or atomic structures by visualizing things that are difficult to get just by reading. Through hands-on learning, students can also experiment with variables and observe the results through interactive modeling, which helps them understand concepts more deeply.

The idea of accessibility highlights how important it is to modify the learning material according to the unique needs and skill level of each student. When developing a digital educational and methodological complex, different learning styles and levels of prior knowledge should be taken into account. This can be achieved by using accessible technologies for students with disabilities, offering numerous information opportunities and introducing personalized learning. Ensuring the readability of the material contributes to the creation of an inclusive classroom in which all students can succeed.

Another important concept in the construction of digital educational and methodological complexes is active learning. Through interactive exercises, problem solving, and virtual experiments, this method allows students to interact directly with the material. Active learning methods develop critical thinking and allow students to use what they have learned in the classroom to solve real problems. For example, virtual laboratories can reproduce real physical experiments, giving students the opportunity to conduct research and draw conclusions in a safe virtual environment. Teachers can create digital educational and methodological complexes that improve students' understanding and assessment of physics, following the principles of scientific accuracy, systematic and consistent presentation, visualization, accessibility and active learning. These recommendations help students to assimilate the material more easily, as well as prepare them to use the knowledge they have gained, to think critically and apply the knowledge they have gained in real situations. The potential for creating cutting-edge and useful teaching resources in physics will only increase as digital technologies develop, offering exciting new directions in teaching and studying this fundamental topic.

In the creation of a digital educational complex for physics, the key principles are sequence, accessibility, and interactivity. First and foremost, the complex should be organized in such a way that students can systematically absorb the material. They should start with the simplest subjects and gradually move on to more complex topics. Each topic should be presented in simple and understandable language, avoiding unnecessary complexity and technical jargon. To achieve this goal, various formats can be used, such as texts, graphics, videos, and interactive assignments.

Accessibility also plays a crucial role in creating a digital educational complex. It should be accessible to every student, regardless of their level of preparation and abilities. A complex that can

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be used on various devices and platforms will allow students to choose a convenient time and place to study the material.

Interactivity, finally, is one of the most important principles. The ability for students to interact with the material will enable them to actively engage in the learning process. Interactive models, simulations, and virtual laboratories can help with this. This method will allow students to conduct experiments, observe their results, and draw conclusions, significantly enhancing their understanding and retention of information.

Sequence, accessibility, and interactivity are the core concepts of a digital educational complex in physics. These concepts are crucial for successful learning. They enable students to become engaged in physics, develop skills, and effectively absorb the material. We can provide students with a better educational program and prepare them for future achievements using modern technologies, such as a digital educational complex.

Research methods and materials

The digital educational-methodical complex was constructed based on fundamental didactic principles, with a focus on individualization of learning, interactivity, accessibility, ease of use, and integration of modern technologies. The complex included interactive assignments, laboratory work simulations, visualizations of physical phenomena, and formative assessments. This stage involved collaboration with educational technologists, physics educators, and content developers to ensure the materials aligned with curriculum standards and learning goals. The study sample included students from various grade levels within a physics course. Participants were selected to represent a range of abilities and backgrounds to evaluate the complex's effectiveness in addressing diverse learning needs. Additionally, physics teachers who integrated the digital complex into their instruction participated in the study to provide feedback on its usability and impact on student engagement.

The theoretical part

Education in all its forms is didactics' goal as a science. The system of relationships, such as “teacher-student, student-study material, and student-other students”, is the subject of higher education. It is the responsibility of the teacher to evaluate and integrate the learning process and the conditions required for its execution. They also have to develop new teaching strategies and resources and enhance the way that instruction is organized [1–8].

The primary challenge resides in choosing the course content to be included in the computer-based instructional and methodological complex in a way that is consistent with the plans, policies, and procedures of the educational establishment as well as the intended use and mode of delivery. In order to do this, the computer-based instructional and methodological complex's material must follow the educational tenets of comprehensive professional informativeness, scientific rigor, accessibility and systematicity.

The information approach variant [9–11] entails building block structures of educational material in the form of graphs, identifying and presenting blocks in a unified conceptual form, analyzing the semantic structure when planning the content of the computer-based instructional and methodological complex, and calculating the informational volume of each individual block.

Semantics, entropy, and abstraction are used in this method to calculate the informative volume of each block. In accordance with this calculation methodology, we think it's critically to take into account the following significant indicators: complexity of creativity, challenges with epistemology, and others.

The informational volume of each kind is measured using a unique form in M.V. Vyaldin's method [9], which accounts for the informational capacity of each block and its order. The distribution of the instructional materials also complies with the laws of cognition and memory.

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M.V. Vyaldin uses the criterion of minimizing the informational volume to compare several presentation alternatives; the one with the least amount of information is deemed to be the best.

We do not question the applicability of this approach, but we think the standard ought to be modified to, say, minimize the challenges of researching the subject while preserving a constant degree of general knowledge.

Professional education is a process of learning, upbringing, professional formation, and personal growth that facilitates self-realization, self-expression, and self-affirmation, according to the work of A.M. Novikov [12]. In the labor market, work enables an individual to function primarily as a kind of capital that they control, while a professional education guarantees social adaptation within the framework of a market economy.

The computer-based educational and methodological complex uses mechanical analogies for many ideas, facts, and theories in accordance with this understanding of the principle of visual clarity.

It is suggested in the study [12] to separate an individual's knowledge about the environment into two categories based on their activity-related information. Knowledge of physical laws, material properties, etc. is related to the first, whereas knowledge of technologies, work operation regulations, safety procedures, etc. is related to the second.

It should be acknowledged that, despite the division's obviousness and certain conditionality - the majority of knowledge should fall into both the first and second categories - the classification stage also enables A.M. Novikov to address a significant problem in professional education: the separation of theoretical knowledge from practical application. This is because knowledge of actions is not logically connected to theoretical knowledge.

In order to bridge this gap, the computer-based instructional and methodological complex makes use of a set of specialized exercises that make use of constructors, virtual laboratories, and unique exercises to put theoretical knowledge into reality.

Taking into consideration each student's unique demands, the issue of individualizing education can now be addressed with the help of modern computer technologies.

In this instance, we think it's important to take into account the following kinds of personal traits:

a) mental qualities linked to physiological and psychological qualities, and so forth;

b) levels of expertise, including personal knowledge related to emotions and other factors;

c) the individual value system of the trainee;

d) worldview.

The primary objective is to enhance students' knowledge base, which is both essential and sufficient for grasping the fundamentals of professional activity. The objective is to strengthen the framework of knowledge about activity, its purposes, means, and conditions, as well as the relationship between sensory and intellectual (theoretical) knowledge that underpins mastery of the action.

The second objective is to figure out how to fit student practical demands and ideals with the academic knowledge they have learned. Additionally, they must figure out how to incorporate students' practical learning activities into theoretical knowledge. This mostly entails setting up instructional and practical scenarios where students actively use their theoretical knowledge to complete predetermined objectives.

We think that the only approach to overcome the issues raised by A.M. Novikov in the sphere of professional education is to employ contemporary computer technology in professional education.

The creation of didactics, methodology, and procedures for use in the teaching process is also necessary for this.

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Furthermore, we think that even university professors, even those with enough experience, frequently display subjectivism and empiricism, lack systematicity, adhere to templates, and show narrow-mindedness. They also seem to lack the knowledge and expertise necessary to apply current developments in higher education and the potential provided by modern computer technologies.

Results and discussion

Under the umbrella of continuous education, teacher training and retraining currently take place primarily at advanced training colleges once every five years. It is obviously unacceptable that the systematization of this process has been hindered in recent years due to issues with material and financial resources. We suggest including a section devoted to departmental faculty training within the scope of the continuous education idea. This component will encompass contemporary trends in higher education pedagogy, innovative teaching methods, modern educational technologies, as well as relevant professional skills and competencies. The ability to produce new lecture materials, instructional and assessment systems, and laboratory and practical session designs for the courses they teach will be a key component.

The latter is crucial because of the extensive experience of integrating ICTs in education also referred to as the "second teacher effect" in schools and universities. This includes the use of cutting-edge teaching technologies, pre-made educational computer systems, and other techniques that have shown to be highly effective. However, these approaches frequently turn out to be harmful as well as inefficient.

This is obviously connected to the teacher's failure to recognize the significance of personal traits, abilities, and knowledge among the most crucial components of a successful pedagogical effect on pupils.

The faculty of the department develops particular educational and cognitive activities based on the features of the department's continuous education component.

After putting everything together, we have concluded that continuing education is a separate component with its own subject matter and instructional strategies.

This article discusses the methodological, methodical, and didactic issues of continuous education in the department. The work is based on the modern educational paradigm and utilizes computer technologies for teaching. The method for choosing instructional materials that N.S. Puryshov suggested in the study is depicted in Figure 1 [13].

When developing the computer-based instructional and methodological complex, we used Figure 1 because, in our opinion, it more accurately depicts the process of content production than any other figure

The content of education is defined by the following principles:

- the guidelines for matching social needs to educational content.

The main focus of this principle's implementation in the computer-based instructional and methodological complex was on moving away from the outdated knowledge-based paradigm of education and toward the more current active paradigm, which better serves the needs of the modern world

- the idea of consistency in learning procedures and content.

Within the computer-based instructional and methodological complex, integrated usage is the primary mode of education. This includes both conventional teaching techniques like lectures and practical sessions as well as cutting-edge laboratory work including virtual laboratories and multimedia lecture demonstrations. Each time, a cohesive relationship is formed between the instructional strategies and the subject matter.

- the fundamentals of organizational unity throughout all stages of schooling.

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As a result, the foundation of the computer-based educational and methodological complex is this principle. It is used in postgraduate education (master's, doctorate studies, departmental components, etc.), student involvement, and pre-university preparation.

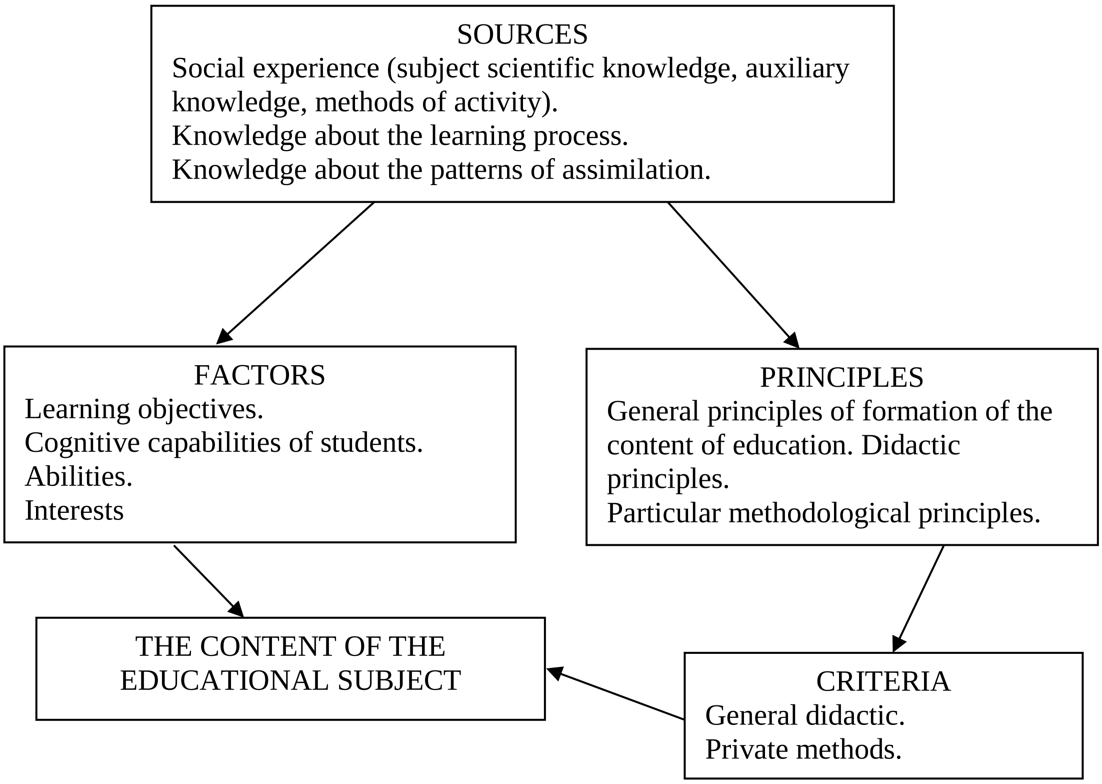

Figure 1 - The use of general pedagogical principles in a computer-based educational and methodological complex

The following should be considered in order to ensure these principles in a computer-based educational and methodological complex: the most recent developments in physics, technology, engineering, and other fields; the alignment of educational knowledge with contemporary scientific knowledge; the continuous and prompt updating of educational materials on learning systems, CD-ROMs, etc. Second, in line with the activity-based educational paradigm and the unique requirements of professional education, the main emphasis is on the development of general physical scientific cognitive skills and their application to the resolution of particular technical challenges. Virtual laboratories and a set of specific exercises are part of the computer-based educational and methodological complex designed to achieve this goal.

To apply this basic didactic principle in the computer-based educational and methodological complex, the content has been separated into discrete chunks. As a result, the content can be divided into discrete blocks for physics instruction in different faculties. Additionally, learning opportunities are maintained even while changing the focus of instruction (e.g., by adding or subtracting hours, moving some courses from one course to another, etc.). Common theories, laws, and concepts across fields are studied together wherever possible.

The question of transdisciplinary links is crucial and intricate when studying physics. It has to do with the way the educational process is set up in the particular institution and how many hours are allotted. Expanding upon the fundamental field of physics and allocating the course load among semesters, courses, etc. (Figure 2)

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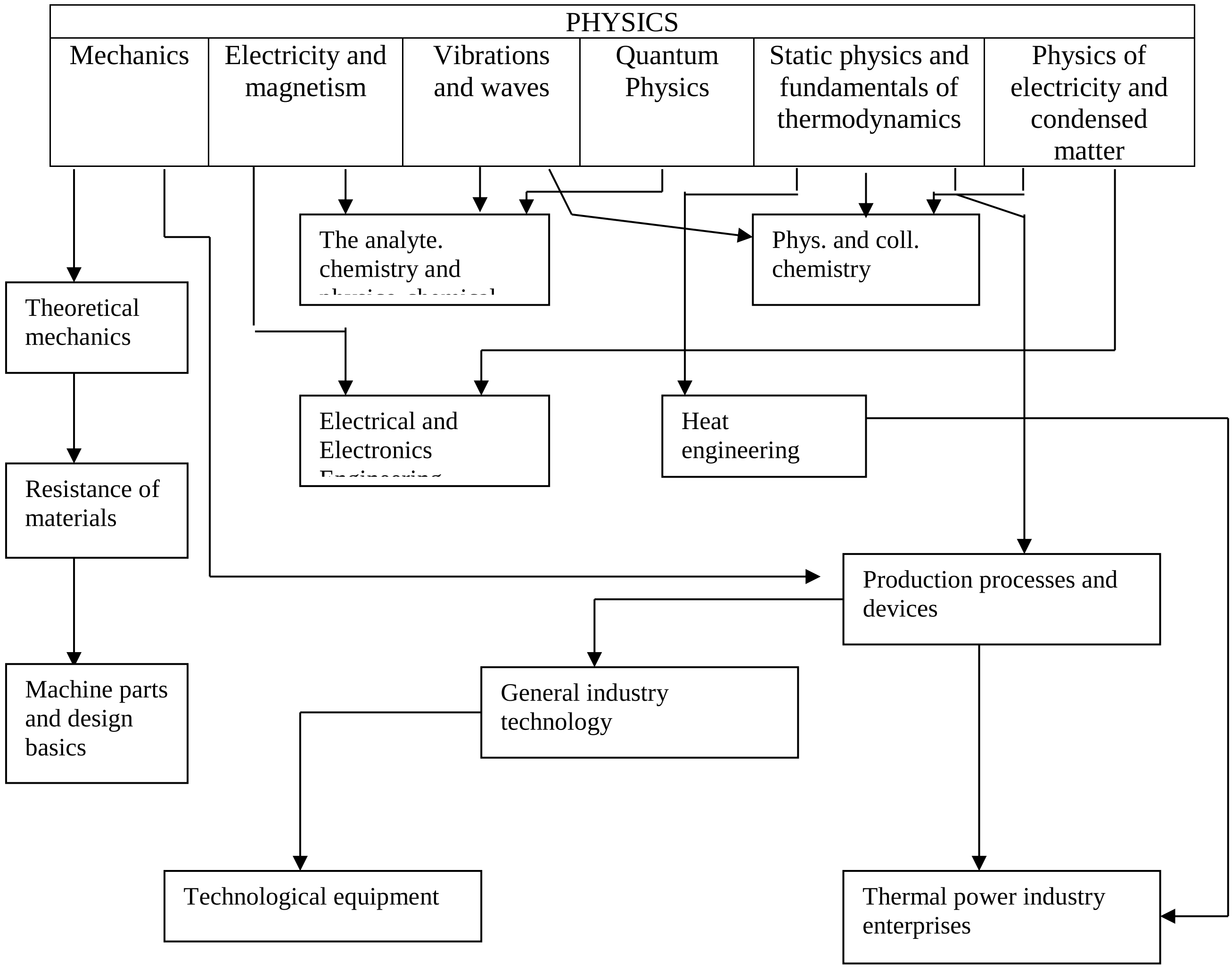

Figure 2 – Analysis of interrelations between subjects

It is important to highlight that, based on our observations, students frequently approach the study of natural phenomena with a common sense or "common" knowledge rather than a thorough understanding of the underlying physical rules and concepts.

Thus, the crucial problem of developing a scientific worldview in physics is linked to this fundamental didactic premise. N.V. Sharonov [14] points out that the triadic structure of the system of generalized knowledge, attitudes, and beliefs about nature, society, and their cognitive processes forms the basis for the examination of this issue. Students' ability to think dialectically is aided by this.

Several papers [15–17] have been written about this problem, analyzing its causes and suggesting fixes. The rise of this issue in universities is partly due to the fact that many instructors do not think it is necessary to concentrate on learning motivation, do not highlight the practical and personal significance of the subject, and do not promote student discussions with materials on recent accomplishments, unresolved issues, and how the accomplishments of the taught scientific discipline can be utilized for future engineering and professional growth.

Conclusion

This scientific article examines the fundamental didactic principles necessary for creating a digital educational and methodological complex in physics. Through the analysis and exploration of various pedagogical methods and technologies, several key principles have been identified that should be considered in the development and implementation of this complex.

First and foremost, it is necessary to consider the individual characteristics of students. The digital educational-methodical complex should be adaptive and flexible, allowing teachers to adapt the educational process to different learning styles and levels of student preparedness.

Secondly, it is important for students to actively participate in the learning process. Digital technologies such as interactive activities, e-textbooks, virtual experiments and simulations increase student interest and motivation, making learning more interactive and effective.

The third principle is the use of various teaching aids. Visualization tools such as video, audio and graphics significantly improve students' perception of information, making the learning process more visual and memorable.

Constant interaction between teachers and students is the fourth principle. Digital teaching and learning systems should facilitate effective communication and feedback between teachers and students. Teachers must be able to monitor students' progress and provide them with individual support and assistance.

In conclusion, it can be said that the creation of digital educational and methodological complexes in physics, taking into account fundamental didactic principles, is an important and promising direction in education today. Their use can significantly improve the quality of education, contributing to more effective learning and contributing to the development of key skills and competencies in students.

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