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METHODS OF FORMING PROBLEM-SOLVING COMPETENCE IN PHYSICS

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Abstract: This article explores methods for developing problem-solving competence in physics education. In modern teaching, it is essential to cultivate students' abilities to think independently, analyze problems, and find solutions in challenging situations. The article discusses problem-based learning, project-based instruction, experimental approaches, and interactive pedagogical technologies as effective ways to foster problem-solving skills in physics students.

Keywords: problem-based learning, problem-solving, physics, competence, interactive methods, project-based learning, experiment

Introduction

The ability to solve problems in physics is crucial not only for mastering theoretical knowledge but also for developing logical thinking, analysis, and synthesis skills. Contemporary education encourages active learning where students engage in independent reasoning and creative approaches. Therefore, educators focus on creating problem situations that enhance students' problem-solving competence. Developing problem-solving competence in physics involves multiple interconnected strategies that actively engage students in the learning process. One of the most widely used and effective methods is **Problem-Based Learning (PBL)**. PBL situates students in realistic scenarios where they face complex, open-ended problems without predetermined solutions. This approach encourages students to identify what they know, determine what they need to learn, and apply their knowledge creatively. In physics education, this could mean analyzing real-world phenomena or designing experiments to explore physical principles. PBL fosters critical thinking and deeper conceptual understanding because students must integrate theory with practice. Forming problem-solving competence in physics requires the implementation of diverse and effective teaching methods aimed at developing both conceptual understanding and practical skills. One of the most effective approaches is inquiry-based learning, where students engage in exploring physical phenomena through questioning, investigation, and evidence-based reasoning. This method encourages curiosity, critical thinking, and a deeper engagement with the subject matter.

Problem-based learning is another widely used approach, in which students are presented with real-life or complex theoretical problems that require collaborative efforts to solve. This not only enhances their understanding of physics principles but also fosters teamwork, communication, and analytical skills. In conjunction with theoretical instruction, experimental and laboratory work plays a key role in problem-solving development. Through

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hands-on experiences, students learn to design experiments, collect and analyze data, and draw logical conclusions based on empirical evidence, thereby strengthening their practical and cognitive competencies.

Modern physics education also increasingly incorporates information and communication technologies (ICT). The use of simulations, virtual laboratories, and interactive models helps students visualize abstract concepts, test hypotheses in safe environments, and receive immediate feedback. These tools make learning more engaging and accessible, especially when physical resources are limited.

Another important strategy is the use of modeling and visualization techniques. By constructing physical, conceptual, or mathematical models, students can better understand complex systems and the relationships between variables. This encourages logical thinking and the ability to apply theoretical knowledge in various contexts. Complementing this, heuristic methods such as analogical reasoning, simplification strategies, and structured algorithms help guide students through unfamiliar problems, enhancing their strategic thinking and self-reliance.

Differentiated instruction is essential in addressing the diverse needs and skill levels of students. Tailoring tasks to individual abilities allows each student to progress at their own pace while being appropriately challenged. In the same vein, collaborative learning environments enable students to share ideas, debate concepts, and learn from one another, which supports the development of social as well as cognitive skills.

Continuous practice with a variety of problem types, including standard, non-standard, and multi-step problems, is critical for developing flexibility and resilience in problem-solving. This not only reinforces learned concepts but also prepares students for complex tasks they may encounter in exams or real-life scenarios. Finally, fostering metacognitive skills—such as the ability to plan, monitor, and evaluate one's own thinking process—helps students become more independent, reflective, and effective learners. Through the integration of these diverse methods, students can build a strong foundation in physics problem-solving that w ill serve them in both academic and practical applications.

Project-Based Learning (PjBL) complements PBL by involving students in extended projects that require planning, research, and collaboration. In physics, projects may include designing a working model, conducting long-term experiments, or investigating technological applications of physics concepts. This method cultivates not only problem-solving skills but also teamwork, communication, and project management abilities. Moreover, PjBL helps students connect physics to everyday life and future careers, increasing motivation and engagement.

Experimental and Laboratory Work is fundamental in physics education. Hands-on experiments allow students to observe principles in action, test hypotheses, and troubleshoot unexpected results. Conducting experiments sharpens analytical skills and teaches students to handle data rigorously, including error analysis and uncertainty. Experimental work also reinforces the scientific method, encouraging iterative problem-solving cycles of hypothesizing, testing, analyzing, and refining.

The integration of **Interactive Technologies and Simulations** in physics teaching has significantly enhanced problem-solving development. Digital simulations can model complex systems and phenomena that are otherwise difficult to visualize or experiment with in the classroom. These technologies enable students to manipulate variables, visualize effects in real-time, and test multiple hypotheses efficiently. Virtual labs and interactive software provide safe, scalable environments for exploration, which supports diverse learning styles and paces.

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Metacognitive Strategy Training is another vital component. Teaching students to think about their thinking — to plan their approach, monitor progress, and evaluate outcomes — strengthens their ability to solve problems independently. Metacognition helps students identify gaps in understanding and adjust strategies accordingly, fostering lifelong learning skills.

Finally, promoting **Collaborative Learning and Peer Instruction** enhances problem-solving competence. Working in groups encourages students to verbalize their reasoning, critique ideas constructively, and learn from different perspectives. Peer discussions and teaching moments consolidate understanding and build communication skills necessary for scientific discourse.

In conclusion, a multifaceted approach combining problem-based and project-based learning, experimental work, interactive technologies, metacognitive training, and collaborative learning creates an enriched physics education environment. This environment not only improves problem-solving competence but also prepares students to face future academic and professional challenges with confidence and creativity.

Problem-based learning (PBL) is a pedagogical approach aimed at enabling students to independently seek knowledge and identify ways to solve complex problems. In this method, the teacher does not simply deliver theoretical information but poses questions that stimulate students to analyze the problem and seek solutions collaboratively. This approach encourages students to express their ideas, listen to others, and work cooperatively to reach conclusions.

Project-based learning methods require students to work in groups addressing practical physics problems. This involvement helps students develop research skills, planning abilities, and presentation techniques. Project work effectively promotes independent and systematic thinking.

Experimental methods play a significant role in developing problem-solving competence. By observing physical phenomena and conducting experiments, students consolidate theoretical knowledge and acquire the necessary tools for problem resolution. This hands-on experience enhances students' abilities to conduct experiments, process data, and draw conclusions.

Interactive pedagogical technologies such as simulations, virtual labs, and educational software further support problem-solving skill development. These tools provide dynamic environments where students can manipulate variables, test hypotheses, and visualize complex concepts, thus deepening understanding and engagement.

In addition, fostering metacognitive strategies helps students monitor and regulate their own learning process. Teaching students how to plan, monitor, and evaluate their problem-solving steps improves their autonomy and efficiency.

Modern physics education also emphasizes collaborative learning, where students engage in discussions and peer teaching, thereby developing communication skills and deeper conceptual understanding.

Conclusion

Developing problem-solving competence in physics is essential for preparing students to tackle scientific and real-world challenges. Employing diverse methods such as problem-based learning, project work, experiments, and interactive technologies enriches the learning process and promotes critical thinking, creativity, and independent inquiry. Integrating these approaches supports holistic development and equips students with competencies required for success in the 21st century.

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