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DIFFERENTIATED PHYSICS EDUCATION FOR FUTURE ENGINEERS

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Abstract: This article explores methods for enhancing the professional development of future engineers through differentiated instruction in lectures, practical training, and laboratory sessions. It emphasizes the use of targeted teaching strategies that foster skills in engineering design and project-based activities.

Keywords: paradigm, didactic principle, synergetic principle, methodology, concept, nonlinear learning trajectories, differentiated education, innovative learning.

The deliberate and context-sensitive selection of appropriate teaching methods, or their effective integration, allows educators to address specific didactic objectives by considering the individual characteristics and needs of students. One instructional strategy involves encouraging students to submit written questions related to the topic during lectures. These questions are formulated approximately 2–3 minutes after the topic is introduced. The instructor then spends an additional 3–5 minutes grouping and interpreting the questions based on semantic meaning. The lecture proceeds without directly answering the individual questions but is instead developed in a structured, logical, and coherent manner that indirectly addresses the students' inquiries. At the end of the session, the instructor reflects on the submitted questions as a measure of the learners' understanding and interest in the topic.

In our view, using social media platforms such as Telegram, Facebook, or Instagram to facilitate active learning outside the classroom is highly effective. Moderators are selected from among students to oversee these group discussions. This strategy helps to optimize classroom time by shifting theoretical exploration into students' self-paced study environments, allowing the class to focus on the more complex and essential aspects of the subject. Additionally, this model enables repeated access to lecture materials, supports differentiated instruction, and caters to various learning styles and cognitive processing speeds.

Practical lessons can also be structured using active methodologies that promote critical thinking and real-world problem-solving skills. These include:

- **Project-Based Learning (PBL):** An instructional model where students gain knowledge and skills through the completion of progressively more complex tasks. These tasks are carried out independently or in groups under the guidance of the instructor and involve various formats such as research, planning, design, and graphical work. PBL is a powerful blend of both active and interactive teaching strategies that cultivates students' initiative, responsibility, and creativity.
- **Portfolio Method:** This method serves as both an assessment tool and a developmental resource, compiling selected student works over time. It allows for an evaluation of the student's academic progress, alignment with learning goals, and readiness for professional practice.
- **Game-Based Learning:** A pedagogical strategy that encourages collaborative, scenario-based problem-solving. Rather than simply testing knowledge, this method transitions students from passive to active learning modes, helping them develop soft skills such as communication, teamwork, and decision-making.
- **Training Sessions:** These consist of structured combinations of exercises and educational games that promote active participation, cooperation, and the development of new competencies, both academic and professional.

- **Case-Based Learning:** This method immerses students in analyzing practical, ambiguous real-world situations, thereby enhancing their capacity for critical thinking, reasoning under uncertainty, and applying theoretical knowledge to practical contexts.

After conducting an introductory assessment to evaluate students' baseline understanding of the theoretical content, learners are invited to solve physics problems individually or in pairs. These may involve reviewing correct solutions presented on the board or engaging in independent problem-solving without guidance. To conclude the practical lesson, a formative assessment is implemented using tiered tasks of varying complexity. Students select their preferred challenge level, encouraging self-regulated learning and strategic problem-solving. Tasks at higher difficulty levels require a deeper application of logical reasoning and analytical operations.

Interactive education differs in essential ways from traditional pedagogical models. In modern interactive courses, approximately 86% of instructors prefer using interactive whiteboards or digital presentation tools to engage students. From a psychological standpoint, interactive learning is based on the dynamics of interpersonal relationships. It recognizes both the teacher and the student as active agents in the knowledge creation process. Beyond enhancing memory, attention, and perception, interactive instruction fosters creativity, communication, behavior modulation, and critical thinking.

Additional interactive strategies include:

- **Brainstorming:** A collaborative technique in which group members generate ideas by posing questions and counterexamples. The instructor facilitates the creation of problem scenarios, and students actively participate in their resolution, promoting group creativity and cognitive flexibility.
- **Synectics Method:** This method promotes creative thinking by drawing analogies and metaphors. It requires broad intellectual engagement and fosters the development of imaginative and divergent thinking skills. The method facilitates instruction through operational mechanisms that utilize comparisons to generate innovative ideas.
- **Expanded Use of Case Methods:** Beyond transmitting knowledge, case-based instruction promotes the formation of practical and professional competencies by placing students in situations similar to those encountered in real-life engineering contexts.

Thus, students must first be familiar with the diverse formats in which academic discussions may be conducted and secondly understand the distinct features and pedagogical purposes of each method. However, organizing and facilitating meaningful academic discussions requires significant time and preparation from both students and instructors. Consequently, the implementation of such strategies must be reconciled with the reduced duration of bachelor's programs and the need to streamline subject matter and optimize the use of instructional time.

Conclusion. Differentiated and interactive teaching methods play a pivotal role in enhancing students' academic engagement and professional competencies in engineering disciplines. By incorporating digital tools, scenario-based learning, and student-centered strategies, educators can create a dynamic and inclusive learning environment tailored to the diverse needs of future engineers.

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