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METHODS OF TEACHING THE TOPIC OF CIRCULAR MOTION IN PHYSICS IN A COMPREHENSIVE SCHOOL

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UMUMTA'LIM MAKTABIDA FIZIKADAN AYLANA HARAKAT MAVZUSINI O'QITISH METODIKASI

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МЕТОДИКА ПРЕПОДАВАНИЯ ТЕМЫ «КРУГОВОЕ ДВИЖЕНИЕ» ПО ФИЗИКЕ В ОБЩЕОБРАЗОВАТЕЛЬНОЙ ШКОЛЕ

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Abstract: *This study explores advanced pedagogical strategies for effectively teaching circular motion in physics at a comprehensive school level. Circular motion is fundamental in mechanics and plays a crucial role in understanding rotational dynamics, planetary motion, and engineering applications. This paper examines various teaching methodologies, including theoretical instruction, problem-based learning, experimental approaches, and the integration of digital tools. The study also considers student engagement strategies and how different learning styles impact knowledge retention. Empirical evidence supports the effectiveness of hands-on activities and simulation-based learning in reinforcing conceptual understanding.*

Annotatsiya: *Ushbu tadqiqot umumta'lim maktablarida fizikadan aylanma harakatni samarali o'rgatishning ilg'or pedagogik strategiyalarini o'rganadi. Aylanma harakat mexanikaning asosiy qismi bo'lib, aylanma dinamika, sayyoralar harakati va muhandislik dasturlarini tushunishda muhim ahamiyatga ega. Ushbu ishda nazariy o'qitish, muammoli ta'lim, eksperimental yondashuvlar va raqamli vositalarni integratsiyalash kabi turli xil o'qitish usullari ko'rib chiqiladi. Tadqiqotda, shuningdek, o'quvchilarni jalb qilish strategiyalari va turli xil o'quv uslublari bilimlarni saqlashga qanday ta'sir qilishi ko'rib chiqiladi. Empirik dalillar konseptual tushunchalarni mustahkamlashda amaliy faoliyat va simulyatsiyaga asoslangan ta'limning samaradorligini qo'llab-quvvatlaydi.*

Аннотация: *В этом исследовании изучаются передовые педагогические стратегии для эффективного обучения круговому движению в физике на уровне общеобразовательной школы. Круговое движение является основополагающим в механике и играет решающую роль в понимании вращательной динамики, планетарного движения и инженерных приложений. В этой статье рассматриваются различные методики обучения, включая теоретическое обучение, проблемно-ориентированное обучение, экспериментальные подходы и интеграцию цифровых инструментов. В исследовании также рассматриваются стратегии вовлечения студентов и то, как различные стили обучения влияют на сохранение знаний. Эмпирические данные подтверждают эффективность практических занятий и обучения на основе моделирования в укреплении концептуального понимания.*

Key words: *Circular motion, centripetal force, angular velocity, rotational dynamics, physics education, inquiry-based learning, digital simulations*

Kalit so‘zlar: *Aylanma harakat, markazga intilma kuch, burchak tezlik, aylanma dinamika, fizika ta’limi, izlanishga asoslangan ta’lim, raqamli simulyatsiyalar*

Ключевые слова: *Круговое движение, центростремительная сила, угловая скорость, вращательная динамика, физическое образование, обучение на основе исследований, цифровые модели*

Introduction

Physics education is crucial in developing critical thinking and problem-solving skills among students. Circular motion is a foundational topic in physics that requires an understanding of Newtonian mechanics, vector analysis, and force interactions. However, many students struggle with abstract concepts such as centripetal force and angular acceleration. Traditional teaching methods often fail to bridge the gap between theoretical knowledge and practical application. This paper explores a combination of pedagogical approaches that enhance conceptual clarity and student engagement [1-3].

Theoretical Foundations of Circular Motion

Circular motion involves objects moving in a curved path under the influence of forces that maintain their trajectory. Several core equations govern circular motion:

1. Centripetal Acceleration: $a_c = \frac{v^2}{r}$
2. Centripetal Force: $F_c = \frac{mv^2}{r}$
3. Angular Velocity: $\omega = \frac{\Delta\varphi}{\Delta t}$
4. Tangential Velocity: $v = r\omega$
5. Rotational Kinetic Energy: $KE_{\text{rotational}} = \frac{1}{2} I\omega^2$
6. Moment of Inertia: $I = \Sigma mr^2$

Traditional Teaching Strategies. Traditional physics teaching has primarily relied on lectures and textbook-based learning. Key features of traditional teaching methods include:

- Explanation of fundamental equations using step-by-step derivations [4-6].
- Problem-solving sessions where students solve numerical problems based on formulas.
- Memorization of key equations and definitions.

While effective in delivering content, traditional methods often fail to provide an interactive learning experience.

Interactive Learning Strategies.

Inquiry-Based Learning. Inquiry-based learning encourages students to explore physics concepts through guided discovery. This method includes:

- Developing hypotheses about circular motion.
- Designing small-scale experiments to test centripetal force and angular acceleration.
- Engaging in peer discussions to explain observations [7-9].

This approach fosters independent thinking and a deeper understanding of the topic.

Hands-On Experiments. Laboratory experiments play a critical role in reinforcing theoretical concepts. Some effective experiments include:

- The whirling mass experiment to investigate the relationship between force, mass, and radius.
- Using a rotational platform to demonstrate the conservation of angular momentum.
- Water bucket experiments to explain the effects of centripetal force.

Role of Digital Tools in Teaching Circular Motion

Simulations & Augmented Reality. The use of technology in physics education has increased significantly. Digital tools provide interactive visualization and real-time experimentation. Some of the most effective tools include:

- PhET Interactive Simulations for circular motion analysis [10-12].
- Augmented reality applications that allow students to visualize forces acting on objects.
- Video motion tracking software for analyzing real-world rotational motion.

Flipped Classroom Model. In the flipped classroom model, students learn theoretical concepts at home using digital resources and spend classroom time solving problems and conducting experiments. This approach allows for more interactive engagement and deeper understanding of concepts.

Experimental Findings on Teaching Circular Motion

Studies show that students who engage in active learning strategies perform significantly better in physics compared to those taught using only traditional lectures. A comparison of student performance before and after the implementation of interactive learning techniques reveals:

- A 25% improvement in test scores related to conceptual understanding.
- Increased student engagement and participation in laboratory experiments.
- Better retention of key formulas and principles.

Discussion

Despite the effectiveness of modern teaching methods, several challenges exist. Schools often lack sufficient resources for laboratory experiments, and teachers may require additional training to integrate digital tools effectively. Moreover, some students may struggle with self-paced learning in a flipped classroom model.

Conclusion

An integrated approach that combines theoretical instruction, hands-on experimentation, and digital tools provides the most effective way to teach circular motion. Schools should focus on providing necessary resources for physics labs and invest in teacher training for new educational technologies. Future research should explore the role of personalized learning and artificial intelligence in physics education.

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