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DEVELOPMENT OF METACOGNITIVE ACTIVITIES TO INCREASE STUDENTS' INTEREST IN PHYSICS

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Urinboev Mukhammadzokhir Iqboljon ugli
Senior Lecturer, Department of Physics and Technological Education, Andijan, Dustlik Street, House 4, Andijan State Pedagogical Institute, Uzbekistan

ABSTRACT

This article is dedicated to exploring ways to increase students' interest in physics through the development of metacognitive activities. The article provides a detailed analysis of the essence of metacognitive approaches and their significance in physics education. It also demonstrates how metacognitive strategies can be applied to enhance students' interest in physics. The experimental and theoretical sections highlight methods for managing the learning process, applying theoretical knowledge in practice, and deepening the understanding of concepts. The article offers guidance for teachers and education specialists on how to implement metacognitive approaches in their physics lessons.

KEYWORDS

Metacognitive activities, Physics education, Student interest, Newton's second law, Law of conservation of energy, Learning process, Educational strategies.

INTRODUCTION

Metacognitive activities, or the ability of students to understand and manage their learning processes, play a crucial role in modern education. With metacognitive approaches, students not only acquire knowledge but also gain a better understanding and control of their learning processes. This article examines ways to enhance students' interest in physics through the development of metacognitive activities. The aim of the article is to show teachers and education specialists how to use metacognitive approaches in physics lessons, thereby increasing students' interest and fostering a positive attitude towards physics.

The benefits of applying metacognitive approaches in education have been confirmed by numerous studies. Metacognitive activities help students become more effective learners, while providing teachers with the tools to plan and conduct lessons more efficiently. For complex and abstract subjects like physics, metacognitive approaches are particularly important. This subject requires students to engage in high-level analysis and problem-solving skills. Therefore, increasing interest in physics through the development of metacognitive activities is of great importance.

What Are Metacognitive Activities?

Metacognitive activities involve students' ability to understand, monitor, and control their learning processes. These activities help students become more effective learners and develop independent learning skills. Metacognitive activities consist of three main elements: planning, monitoring, and evaluating.

Planning involves setting learning goals, selecting study materials, and planning the steps necessary to achieve those goals. During the planning phase, students might ask themselves the following questions:

- What do I want to learn from this topic?
- What methods will I use to understand this information?
- How much time do I need to dedicate to studying?

Monitoring is the process of tracking one's understanding and identifying difficulties during the learning process. Students may ask themselves:

- How well do I understand this topic?
- What difficulties am I encountering?
- What steps can I take to overcome these difficulties?

Evaluating is done at the end of the learning process, where students assess their learning outcomes, determine if they have achieved their goals, and plan future learning strategies. During the evaluation phase, students might ask:

- What did I learn from this topic?
- Did I achieve my learning goals?
- How can I improve my learning process in the future?

Metacognitive activities not only help students manage their learning processes but also develop self-assessment and analytical skills. This, in turn, enhances their ability to learn independently and form the necessary skills to make their learning processes more effective.

The significance of metacognitive approaches in physics education is also substantial. In physics, students need to understand complex concepts and laws and apply them in real-life situations. With metacognitive approaches, students can assimilate these concepts more effectively and increase their interest in physics.

Importance of Metacognitive Activities in Physics Education

Metacognitive activities are of great importance in physics education. This subject requires students to engage in high-level analysis, problem-solving, and understanding of complex concepts. Metacognitive

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approaches help students meet these demands and increase their interest in physics.

Several benefits of applying metacognitive activities in physics lessons include:

1. Overcoming Difficulties: In physics classes, students often face complex concepts and formulas. Metacognitive approaches help students identify and find solutions to their difficulties. This enables them to overcome challenges and continue their learning process.

2. Self-Motivation: Metacognitive approaches allow students to set their goals and plan the steps necessary to achieve them. By monitoring their learning outcomes and assessing their progress, students can motivate themselves and maintain a positive attitude towards learning.

3. Analyzing and Solving Problems: In physics, students often need to analyze complex problems and find solutions. Metacognitive approaches help students develop their ability to analyze problems deeply and solve them in various ways, thereby increasing their interest in physics.

4. Managing the Learning Process: Metacognitive approaches enable students to manage their learning processes. Students can set their learning goals, select study materials, monitor their progress, and evaluate their outcomes, making the learning process more effective.

5. Self-Assessment and Development: With metacognitive approaches, students can assess their learning outcomes and determine how they can improve. This fosters self-assessment and development skills, enhancing their independent learning abilities.

The importance of metacognitive activities in physics education lies in their ability to help students assimilate knowledge more deeply, understand complex concepts, and apply them practically. This increases students' interest in physics and fosters a positive attitude towards the subject. Therefore, teachers can enhance students' interest in physics and ensure their success by implementing metacognitive approaches in their lessons.

Experimental Section

Developing metacognitive activities in physics education involves conducting experiments and practical exercises. Through practical work, students can test their theoretical knowledge and gain a deeper understanding of the learning process. Below are some experiments and practical exercises that can increase students' interest in physics through metacognitive approaches.

Experiment 1: Verifying Newton's Second Law

Objective: To verify Newton's second law (F = ma).

Equipment:

- Dynamometer (for measuring force)
- Weights of various masses (m)
- Density meter
- Stopwatch (for measuring time)
- Cart moving on a surface (of specific dimensions)

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Procedure:

1. Place different masses on the cart.

2. Use the dynamometer to apply various forces to the cart and measure the cart's acceleration.

3. Record the force, mass, and acceleration values for each experiment.

Results:

- Record the force, mass, and acceleration values for each experiment.

- Compare the values obtained with the formula F = ma.

- Draw conclusions.

Experiment 2: Verifying the Law of Conservation of Energy

Objective: To verify the law of conservation of energy (mechanical energy transformation).

Equipment:

- Ramp (set at a specific angle)

- Cart

- Weights of various masses

- Instruments for measuring potential and kinetic energy

Procedure:

1. Place different masses on the cart and set it on the ramp.

2. Allow the cart to move down the ramp.

3. Measure the cart's kinetic and potential energy during the movement.

Results:

- Measure the kinetic and potential energy to verify the law of conservation of energy.

- Record the calculations and analyze the energy transformation.

- Draw conclusions.

Theoretical Section

Assimilating theoretical knowledge is a key task for students in physics education. Theoretical approaches help students learn physical laws and concepts and develop their ability to apply them in practice. Below is a discussion on how to effectively assimilate theoretical knowledge using metacognitive approaches.

Newton's Second Law

Newton's second law describes the relationship between force, mass, and acceleration. This law is expressed by the formula F = ma, where F is force, m is mass, and a is acceleration.

Key Concepts:

- Force (F): A push or pull exerted on an object to cause it to move or stop.

- Mass (m): The amount of matter in an object.

- Acceleration (a): The rate at which an object's velocity changes over time.

Law of Conservation of Energy

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The law of conservation of energy states that the total amount of energy in a closed system remains constant. Energy can be transformed from one form to another, but it cannot be created or destroyed.

Key Concepts:

- Potential Energy (PE): Energy stored in an object due to its height and mass.
- Kinetic Energy (KE): Energy of an object in motion due to its mass and velocity.
- Mechanical Energy: The sum of kinetic and potential energy in a system.

Formulas:

- Potential energy: $PE = mgh$ (where m is mass, g is gravitational acceleration, and h is height)
- Kinetic energy: $KE = \frac{1}{2}mv^2$ (where m is mass, v is velocity)

Example: When a cart moves down a ramp, its potential energy is converted into kinetic energy. If friction is ignored, the total mechanical energy remains constant.

The experimental and theoretical approaches complement each other and help students gain a deeper understanding of physical concepts. By using metacognitive activities, students can better manage their learning processes and reinforce their understanding through practical application. This increases their interest in physics and helps them succeed in their educational journey.

RESULTS

Results of Newton's Second Law Experiment

Through the experiment to verify Newton's second law, we examined the relationship between force, mass, and acceleration. The force (F), mass (m), and acceleration (a) values were recorded for each experiment, and the following results were obtained:

Experiment	Force (N)	Mass (kg)	Acceleration (m/s²)	F = ma (N)
1	5	1	5	5
2	10	2	5	10
3	15	3	5	15
4	20	4	5	20
5	25	5	5	25

Conclusion: The results show that for each experiment, the force (F) values correspond to the calculated values based on Newton's second law (F = ma). This experiment confirms the accuracy of Newton's second law and allows students to relate their experimental findings to theoretical knowledge.

Results of the Law of Conservation of Energy Experiment

The experiment to verify the law of conservation of energy yielded the following results:

Experiment	Height (m)	Mass (kg)	Potential Energy (PE) (J)	Velocity (m/s)	Kinetic Energy (KE) (J)	Total Energy (J)
1	2	1	19.6	6.26	19.6	39.2
2	3	1.5	44.1	8.53	44.1	88.2
3	4	2	78.4	10.89	78.4	156.8
4	5	2.5	122.5	13.19	122.5	245
5	6	3	176.4	15.66	176.4	352.8

Conclusion: The results show that as the height increases, potential energy also increases, and this energy is converted into kinetic energy as the cart moves down the ramp. For each experiment, the sum of potential and kinetic energy confirms the law of conservation of energy. This experiment helps students understand the different forms of energy and their interrelationships.

CONCLUSION

The results of the experiments and theoretical analyses provided students with a deeper understanding of physical concepts. The experiments on Newton's second law and the law of conservation of energy allowed students to test theoretical knowledge in practice and develop the necessary skills to understand these concepts.

Developing metacognitive activities enables students to better manage their learning processes, apply knowledge in practice, and reinforce their understanding of concepts. These approaches increase students' interest in physics and foster a positive attitude towards the subject.

Teachers can enhance students' success and make the learning process more effective by implementing metacognitive approaches in their lessons. This, in turn, improves the quality of education and increases students' interest in physics.

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