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Using digital media in the scientific process of building knowledge of mechanics

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Abstract: *The article presents some diagrams of the scientific process of building knowledge of mechanics through digital media such as interactive experiments on screen, video analysis, simulation, and compound experiments. computer connection. This medium contributes to overcoming the difficulties that traditional teaching encounters when teaching physics knowledge.*
Key Word*: Digital media, Coach software, teaching physics*

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I. Introduction

Along with the general trend of world education, Vietnam has been continuing its educational reform journey at all levels in order to maximize the capacity of learners. The teacher plays an important role in this noble mission. However, a part of teachers have not yet boldly changed teaching methods, have not explored, learned and updated to apply in lessons, but only loyal to the traditional way of teaching. Therefore, it is necessary to change both in the thinking and actions of teachers. Physics is a subject with a lot of practical knowledge associated with life. Therefore, teachers need to be equipped with effective support means in the teaching process to create attraction and promote positivity, self-reliance, creativity, and at the same time develop learners' capacity . Digital teaching is one of the means that has been researched and applied by many authors and educational institutions with positive results. According to research by Cheng and Weng, teachers' use of digital media has a positive impact on students' academic achievement [1]. Riehemann and Jucks also show that the use of digital media for teaching and learning in higher education is very beneficial for academics and university students [2]. Using digital media has been an essential part of teaching and learning [3], [4]. Therefore, the exploration, exploitation and application of digital media in physics teaching is an important task in the current educational innovation.

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1.1 Theoretical basis

Cognitive activities of learners in learning are essentially cognitive problem solving activities [5]. The process of solving a scientific and technical problem of a scientist usually takes place as follows: First, clearly define the content and requirements of the problem to be solved, the given conditions and the conditions to be achieved. next. Then find out if there is a way to solve that or similar problem in the treasure of human knowledge and experience. If available, list all available solutions and select an appropriate solution. If not, they must propose new solutions or build new knowledge and means to use as tools to solve problems. Finally, experiment with applying new knowledge and new solutions into practice to evaluate their effectiveness, thereby supplementing and perfecting the built knowledge and proposed solutions.

It is possible to imitate the process of solving a scientific and technical problem of a scientist to organize the teaching process in order to form in learners the ability to solve problems. However, in order to ensure success, it is necessary to pay attention to some characteristics that differ between the scientist and the student when solving problems, that is, motivation, interest, need, ability to solve problems. problems, about time spent solving problems, about working conditions, means of work. Therefore, learners cannot completely build scientific knowledge on their own, but need the help of teachers, enabling learners to go through the main stages of the problem-solving process. and self-reliant to deal with some of the difficulties in the process.

1.2 Process of teaching physics knowledge

In the process of teaching physical knowledge in general, the process of organizing cognitive activities usually takes place according to the following steps:

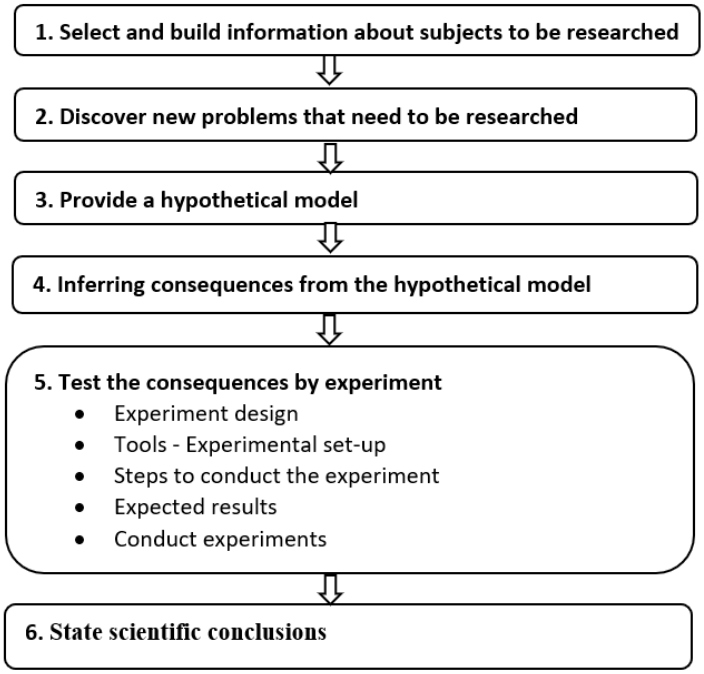

Figure 1. Map out the process of organizing physical cognitive activities in the process of teaching physics knowledge

According to this process, depending on the purpose of each learning content, digital media such as interactive screen experiments, video analysis, simulation experiments or computer-coupled experiments are used flexibly. Active at all stages through Coach software. It can be used in the speculating phase of problem solving or testing the consequences of a hypothesis.

II. Research Methods

The article uses theoretical research methods: studying some physical knowledge in the mechanics of free fall, Newton's 2nd law; raised the difficulties when using traditional teaching media in these knowledge from practical teaching experience; explain the reasons for using digital teaching media in the lesson, thereby establishing a diagram of the scientific process of building that knowledge as a basis for designing a specific and detailed teaching process.

III. Research results and Discussion

3.1 Research results

3.1.1 The scientific process of building knowledge: Free Fall

+) Difficulties when using traditional teaching means: The process of falling objects often happens quickly, it is difficult to collect many sets of data (x-t), (y-t) ; Difficult to analyze and process data; When doing verification tests with vibrating rods, there is often friction that distorts the data during the measurement process.

+) Video analysis experiments can automatically collect and store many data sets, present data sets in the form of tables and graphs (x-t), (y-t), and draw rules. the motion of an object in free fall is uniformly accelerated; Do not waste time conducting real experiments to verify.

+) Flowchart of knowledge building process: Free fall

1. Select and build information about subjects to be researched
Through observation:
When observing objects in free fall (with air resistance being small compared to gravity acting on the object): The object falls vertically, from top to bottom. Objects move faster.

⇩

2. Discover new problems that need to be researched
What are the laws of free fall (in direction, direction, and type of motion)?

3. Provide a hypothetical model
Objects are free-falling in a vertical, top-down direction, and the motion is uniformly accelerated.

4. Inferring consequences from hypothetical model
Corollary 1: The displacement of the object in the horizontal direction is zero
Corollary 2: The distance traveled by an object is proportional to the square of the time it takes the object to travel that distance.

5. Test the consequences by experiment
Design the experimental plan for video analysis:
Tools: Camera, falling object, ruler, plumb line, Coach software, computer.
Experimental setup: Place the standard ruler in the direction of the plumb line, position the camera so that the edges of the camera frame are parallel to the plumb line (the camera's lens axis is perpendicular to the plane formed by the object and ruler).
Steps to take: Drop the object and record a video recording the process of the object falling
Expected result: If the object falls vertically, the graph (x-t) is a horizontal line
If the object is moving with uniform acceleration, the graph (y-t) is a parabola
Conduct an experiment: Obtain a video of the falling object
Process the results on Coach software, obtain graphs (x-t), (y-t) according to Figures 2 and 3.

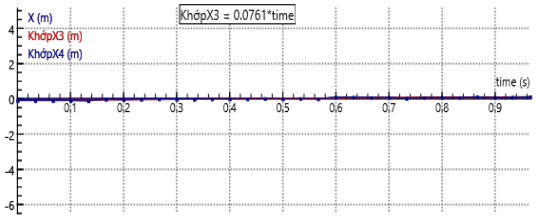

Figure 2 . Graph (x-t) is a horizontal line

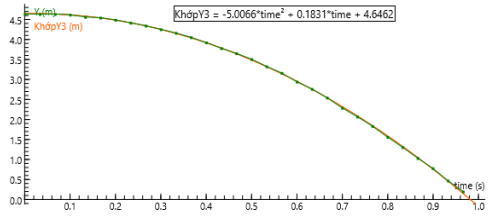

Figure 3 . Graph (y-t) is a parabola line

6. State scientific conclusions
Free-fall motion is vertical, top-down, and uniformly accelerated.

3.1.2 The scientific process of building knowledge: Newton's 2nd Law

+) Difficulties when using traditional teaching means: The process of moving objects often happens quickly, it is difficult to collect many sets of data (s-t); Difficult to analyze and process data; When doing verification tests with vibrating rods, there is often friction that distorts the data during the measurement process; Difficult to assemble, transport to class .

+) The computer connection experiment can be used in the testing phase of the consequences from the hypothesis because *Computer-connected* experiments can automatically collect and store many data sets, present data sets in the form of tables and graphs (s-t), and draw out motion laws of objects. Acceleration is proportional to the force acting on the object and inversely proportional to the mass of the object .

+) Flowchart of knowledge building process: Newton's 2nd law

1. Select and build information about subjects to be researched
Through observing things and phenomena happening in reality: An object is at rest, when subjected to a force, its velocity changes (acceleration is obtained).

2. Discover new problems that need to be researched
How is the acceleration obtained by an object related to the force applied and the mass of the object?

3. Provide a hypothetical model
Hypothesis: The acceleration obtained by an object is directly proportional to the force applied and inversely proportional to the mass of the object.

4. Inferring consequences from hypothetical model
Corollary 1: a ~ F when m is constant
Corollary 2: a ~ 1/m when F is constant

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5. Test the consequences by experiment

** Check consequences 1 from experiment 1 pairing computers: a ~ F when m is constant*

Experiment design 1:

Tools: Same mass m, pulley mount, photoelectric gate sensor, coupler, Coach software, computer.

Experimental arrangement 1: Hook the pulley to the support, and hang the objects of mass m on the pulley. Connect the optical port sensor to the connector, connect the connector to the computer. Use Coach software to declare the coupler, optical port sensor. Declare measuring method: start measuring when n=1, stop measuring when n=20.

Steps to take:

- On the left side of the pulley hanging 5 objects of mass m, on the right of the pulley hanging 3 objects of mass m, the force acting on the system is 2mg, when measuring, the jaw joint (s_1-t) will determine the acceleration a_1 (mass of system is 8m).
- On the left of the pulley hanging 6 objects of mass m, on the right of the pulley hanging 2 objects of mass m, the force acting on the system is 4mg, when measuring, the jaw joint (s_2-t) will determine the acceleration a_2 (mass of system is 8m).

Expected result: if the mass m of the object is constant, then the acceleration $a_2 = 2a_1$

Experiment 1: For the moving body system and processing the results on Coach software, the graph (s_1 -t, s_2 -t) is obtained (Figure 4).

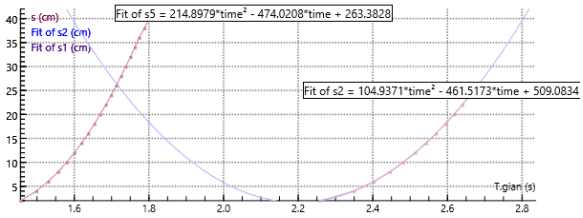

Figure 4 . The graph (s_1 -t, s_2 -t) shows a ~ F when m is constant

** Check consequences 2 from experiment 2 pairing computers: a ~ 1/m when F is constant*

Experiment design 2:

Tools: same mass m, pulley mount, photoelectric gate sensor, coupler, Coach software, computer.

Experimental layout 2: Hook the pulley to the support, and hang the objects of mass m on the pulley. Connect the optical port sensor to the connector, connect the connector to the computer. Use Coach software to declare the coupler, optical port sensor. Declare measuring method: start measuring when n=1, stop measuring when n=20.

Steps to take:

- On the left of the pulley hanging 3 objects of mass m, on the right of the pulley hanging an object of mass m, the force acting on the system is mg, when measuring, the jaw joint (s_1 - t) will determine the acceleration a_1 (mass of system is 4m).
- On the left of the pulley hanging 4 objects of mass m, on the right of the pulley hanging 2 objects of mass m, the force acting on the system is mg, when measuring, the jaw joint (s_2 - t) will determine the acceleration a_2 (mass of system is 6m).

Expected result: If a constant force mg is applied, the acceleration $a_2 = 1.5a_1$

Experiment 2: For the moving body system and processing the results on Coach software, the graph (s_1 -t, s_2 -t) is obtained.

⇩

6. State scientific conclusions

The acceleration obtained by an object is directly proportional to the force applied and inversely proportional to the mass of the object.

$$a = F/m$$

3.2 ***Discussion***

It can be seen that surveying the motion of objects is difficult when using traditional teaching means. With the help of computers through Coach software, when conducting video analysis experiments, experiments paired with computers, learners can test the predictions made (or scientific hypotheses that have been made). proposed) or the consequences derived from the hypothesis. Not only that, learners can use this medium to help review, consolidate knowledge at home after studying in class, prepare lessons before conducting real experiments, which can reduce practice time. at the laboratory [6]. Combining these types of experiments in the learning process also helps learners avoid some misconceptions about knowledge [7]. However, when using a combination of types of experiments in teaching physics in general, it is also necessary to ensure principles such as: only use virtual experiments when real experiments do not help learners fully perceive. , exactly the knowledge of physics to be studied; or need to ensure that the function of the experiments must be suitable for each specific teaching stage.

IV. Conclusion

The article has presented two diagrams of the scientific process of building knowledge of mechanics in the content of "Free fall" and "Newton's 2nd Law" based on the diagram of the scientific process in teaching knowledge. physics in general. The results of the article initially serve as a reference for teachers when using digital media in specific teaching stages. Subsequent published studies will refer to the content of the design of the teaching process with specific activities based on the process diagrams built in the article and the organization of pedagogical experiments according to the processes. In this study, collect, process and analyze experimental data to confirm the significance of the research results..

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