

DESIGN TOOLS TO EVALUATE THE TEACHING OF FRICTION FORCE IN THE DIRECTION OF DEVELOPING STUDENTS' QUALITY AND COMPETENCE

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The article presents the design of a tool for evaluating the teaching of friction force topic in the direction of developing the quality and competence of high school students. Based on the experimental results of pedagogy at Tuong Duong 1 High School, the effectiveness of the proposed tools has been evaluated, thereby proposing solutions to improve the efficiency of testing and assessment in the direction of developing the quality and competence of students.

Keywords: Evaluate; development orientation; friction force; high school students.

1. Introduction

Testing and evaluation are indispensable parts of the teaching process. Researching testing and assessment methods to match the needs of teaching method innovation is an essential requirement in the current period. The evaluation of educational outcomes shifted from focusing on testing knowledge retention to testing and evaluating the ability to apply knowledge to solve problems. The assessment of learning outcomes in the learning process should be taken seriously to be able to timely impact to improve the quality of teaching and educational activities.

Meeting the requirements of comprehensive and synchronous innovation of the 2018 General Education Program, the renovation of the assessment of educational results should be carried out together with the reform of teaching forms and methods, which contributes to the strengthening of linking teaching in school with practice, forming the problem-solving competence of high school students. At the same time, in order to improve the competence of teachers on testing and evaluation towards the development of students' learning outcomes, the issue "Designing tools to test and evaluate the teaching of friction in the direction of developing students' quality and competence" was selected.

The proposed toolkit includes checklists, rubrics, worksheets and assessment sheets, which are experimentally applied to teach “friction force” in the direction of developing the quality and competence of 10th grade students at Tuong Duong 1 High School.

2. Purpose, principles and procedures of testing and evaluation in teaching

The assessment of student learning outcomes has the following purposes:

- For teachers: Help predict students' strengths and weaknesses to help students overcome their weaknesses. Testing and evaluating learning outcomes also help teachers monitor students' progress and consider whether the progress is commensurate with the stated goal. In addition, it also helps teachers to grade and classify students.

- For students: Testing and evaluating learning results helps students understand the specific goals of learning, promote their strengths and overcome their own weaknesses, promote positivity in learning.

- For the administrators: Help determine the effectiveness of the learning program; Provide feedback to managers and program designers; Assert to the society about the quality and effectiveness of education; Support teacher assessment through teaching results.

In testing and evaluation, it is necessary to ensure 8 principles including: Reliability guarantee; Guaranteed value; Comprehensiveness guaranteed; Ensure development; Ensure flexibility; Ensure objectivity; Evaluation in a practical context; In accordance with the specifics of subjects. On those principles, the testing and evaluation process in education is built according to the following steps:

- (1) Analyze the purpose of the assessment, the learning objectives to be assessed.
- (2) Develop a plan for testing and evaluation.
- (3) Selection and design of testing and evaluation tools.
- (4) Perform testing and evaluation.
- (5) Processing and analyzing the obtained results.
- (6) Explanation of the results and feedback.
- (7) Applying assessment results in developing students' learning outcomes.

Previously, Vietnamese education is oriented towards content-approaching teaching (teaching and learning approach to equipping knowledge), recently turned to the orientation of competency-based teaching. The assessment of learning outcomes according to the competency approach should focus on the ability to creatively apply knowledge in different application situations. In other words, competency-based assessment is the assessment of knowledge, skills and attitudes in meaningful contexts (Do Huong Tra, 2019). In essence, there is no contradiction between the assessment of competence and the assessment of knowledge and skills, competence assessment is considered a higher development step than knowledge and skill assessment. To demonstrate the student's ability to a certain extent, students need to be given the opportunity to solve problems in real-life situations. Students have to apply the knowledge and skills learned at school, while using his own experiences to solve practical problems. Thus, through the completion of an assignment in a real context, one can simultaneously assess both cognitive ability, implementation skills and the values and emotions of the learners. On the other hand, competence assessment is not completely based on the educational program of each subject

like assessment of knowledge, skills, because competence is the generalization and crystallization of knowledge, skills, attitudes, emotions, values, ethical standards, etc. which is formed from many different disciplines, various fields of study, and from the natural social development of a person. It is possible to summarize the difference between assessing learners' ability and assessing learners' knowledge and skills as in Table 1.

Table 1: *The difference between content-based assessment and competence-based assessment*

	Content-based assessment	Competence-based assessment
Assessment purpose	<ul style="list-style-type: none"> - Identify the acquisition of knowledge and skills according to the objectives of the educational program - Evaluation and ranking among learners 	<ul style="list-style-type: none"> - Assess the ability of learners to apply learned knowledge and skills to solve real-life problems - For the progress of the learners themselves
Assessment form	Periodically assessment	Regularly and periodically assessment
Subject to be assessed	Students are assessed by teachers	Students are assessed by the teacher, by other students and self-assessed
Evaluation context	Associated with learning content (knowledge, skills, attitudes) learned in school	Associated with the learning context and real life of learners
Assessment content	Knowledge and skills in a subject	Integrate knowledge and skills of many subjects, many educational activities and learners' own experiences in social life
	<ul style="list-style-type: none"> - Content achieved in learning according to standards, evaluate whether or not the person has achieved a content learned 	<ul style="list-style-type: none"> - Assess the level of competency development of the learners
Assessment tool	Questions, exercises, tasks in an academic situation or in a real situation	Tasks and exercises associated with practical situations and contexts
Assessment timing	Usually deployed at certain times in the teaching process, especially before and after teaching	Evaluation at all times of the teaching process, focusing on assessment while learning
Evaluation results	<ul style="list-style-type: none"> - Learner competence depends on the number of completed questions, tasks or assignments - The more units of knowledge and skills gained, the more capable they are considered to be 	<ul style="list-style-type: none"> - Learner competence depends on the difficulty of the completed task or assignment - The more difficult and complex the task, the more competent it will be considered

3. Examining and evaluating the teaching of friction force in the direction of developing students' learning outcomes.

3.1. The goal of teaching of friction force

In terms of competence, the friction force teaching is designed in the general education curriculum of Physics with the goal of developing the following competencies for learners: define; describe, measure and calculate different types of friction; Understand the role and application of friction in life and technology; Give examples of the advantages and disadvantages of friction in practice and how to increase and decrease friction in specific cases; Ability to analyze situations, detect and state problems to be researched; Experimental practice competence: Know how to propose a reasonable hypothesis and come up with the optimal experimental plan to test the validity of the hypothesis; Know the application of physical phenomena related to environmental protection; Capability to report and present learning products; Ability to perceive science, nature and social discovery, apply knowledge and skills learned in life (Ministry of Education and Training, 2016).

Regarding personal qualities, after completing the “friction force” lesson, students are aware of the role of the individual with the community by developing recommendations for the rational use of vehicles and equipment using friction; Report truthfully and accurately the results achieved in practice and experiments; Be responsible in the assigned work, unite and cooperate with team members to complete the task; Ability to listen, analyze and evaluate people's opinions; Consciously follow the rules and maintain general hygiene in practice (Ministry of Education and Training, 2016).

3.2. Testing and assessment tools

Based on the requirements to be achieved by students after completing the friction lesson, methods and tools for evaluating specific content have been proposed. In this section, corresponding to each requirement to be achieved, questions and evaluation table of the content, the implementation results of the learners will be presented. The effectiveness of applying the proposed tools to the practical teaching of friction force will be evaluated through pedagogical experiments, which will be presented in the following section.

The requirements to be achieved include (1) Detecting the problem to be studied: Friction force; (2) Perform the experiments, thereby discussing and answering how the magnitude of sliding friction is; (3) Understand that the magnitude of the sliding frictional force depends on the material and condition of the two contact surfaces, proportional to the magnitude of the pressure; (4) Understand the characteristics of sliding friction force and coefficient of sliding friction; (5) Practicing and applying; (6) Exploration and expansion (Do Huong Tra, 2011).

a. Detecting the problem to be studied: Friction force

To help students discover problems, teachers need to ask open-ended questions for them to learn and discuss in groups. During the discussion, suggestions may be given by the teacher to make the results of the discussion highly effective. Regarding friction force, in order to visualize the meaning and benefits of friction force in real life, the following questions can be raised:

- A ball is moving on a flat surface and there is no external force acting on it. Does it come to a point where the ball will stop?
 - Suppose A is skating on an ice rink and B is skating on the street, whose movement do you think will be smoother?
 - When you hold a water bottle in your hand, why doesn't it pass through and fall down?
 - Do you remember seeing a warning sign to warn you about the wet floor?
- What explains all of these?

To evaluate students' discussion activities, 02 specific criteria were proposed, including “Students actively participate in discussions” and “Students articulate the research problem correctly”.

b. Perform the experiments, thereby discussing and answering how the magnitude of sliding friction is

Learning products include “Sliding friction test results table” and “Conclusion about the magnitude of the sliding friction force”. The student's experimental process must be evaluated against specific criteria. On the basis of the actual teaching, an evaluation rubric was proposed as shown in Table 2. Participation in group activities is also assessed through the following criteria: (1) Participation in task assignment; (2) Gladly accept the assigned task; (3) Paying attention to the task; (4) Encourage other members of the group.

Table 2: Rubric - used to evaluate the student's experimental process

Criteria	Level 1	Level 2	Level 3
Theoretical foundations	The theoretical basis has not been prepared	Insufficient theoretical background preparation	Prepare a full theoretical basis
Experimental tools	No suitable tools have been selected yet	Selecting the right tools	
Conduct experiments	The experiment was not performed correctly	Executing the experiment correctly but it is still slow	Perform the right experiment and on the specified time
Experimental results	Unable to handle the experimental data	Having processed the data but not giving the appropriate results	Process the data and give the appropriate results

c. Understand that the magnitude of the sliding frictional force depends on the material and condition of the two contact surfaces, proportional to the magnitude of the pressure

To understand that the magnitude of the sliding frictional force depends on the material and condition of the two contact surfaces, proportional to the magnitude of the pressure, specific examples, close to reality, can be given for students to visualize as well as be able to experiment before making conclusions. In this study, 02 scenarios were proposed for experiment, as below:

Scenario 1: There are 3 cases as follows: (1) A smooth ball moving on a smooth surface; (2) A smooth ball moving on a rough surface or vice versa; (3) The surface of the

ball and the surface of the movement are both rough. Which friction force do you think will be the highest, the lowest?

Scenario 2: Suppose there are 2 bricks of the same material placed on the table, one weighs 2 kg, the other weighs 5 kg. The same force is applied to both bricks. Which brick do you think will advance further? How do you know if the prediction is correct?

To make a statement as well as prove their statement is correct, students will be divided into groups and perform their group's experiments. The experimental process of the students, from the conception of the idea, experimental preparation, as well as collection and discussion of the results obtained, were assessed using rubrics as shown in Table 2. Effectiveness and teamwork attitude were also evaluated similarly.

d. Understand the characteristics of sliding friction force and coefficient of sliding friction

To assess the level of meeting this teaching goal, after studying the lesson “friction force”, the checklist will be applied, in which there are specific criteria including (1) Students state the set point and the direction of friction force; (2) Students state the formula for calculating sliding friction force; (3) Students state the formula for calculating the coefficient of sliding friction; (4) Students state the characteristics of the coefficient of sliding friction.

e. Practicing and applying

To fully appreciate the level of application of theoretical knowledge in practice, the assignments should be given both practical relevance and academic calculation. Therefore, in this study, 2 examples have been proposed, specifically as follows:

(1) Find 5 examples of friction in real life and its physics meaning. This is an open-ended question, requiring students to use their observation competence to visualize the results as real-life examples. With this example, students are assessed on the number of examples given, as well as the physical meaning of those examples.

(2) Calculation task: A hockey player uses a club to push the ball to impart it with an initial speed of 10 m/s. The coefficient of sliding friction between the ball and the ice surface is 0.10. Let's take $g = 9.8 \text{ m/s}^2$. How far does the ball go before it stops? Choose the correct answer out of the following four: A. 39 m; B. 45 m; C. 51 m; D. 57 m.

f. Exploration and expansion

To help students explore and expand their knowledge related to friction, open-ended questions need to be asked. In this study, the following questions have been proposed: Why does grease reduce friction? Is the force of friction beneficial or harmful? How to reduce the force of friction in case of harm? Apart from the learned frictional forces, are there other types of frictional forces? If yes, please provide an example. In fact, does friction cause environmental pollution?

3.3. Research tools of pedagogical experiments

The experiment was conducted in class 10A of Tuong Duong 1 High School (Figure 1 and Figure 2). Learning activities are observed, information collected and evaluated by the method of question - answer, observation, evaluation through learning products, writing test. Testing and evaluation tools are designed including study sheets,

rubrics, checklists, questions, and exercises. The worksheets are designed as described in Study sheets 1, 2, 3 below.



Figure 1: Experimental image of pedagogy of “friction force” lesson



Figure 2: Student group activities at Tuong Duong 1 High School

Study sheet 1: Determine the magnitude of the sliding friction force

Design a method to determine the factors affecting the magnitude of the sliding friction force. The discussion groups develop experimental plans to test the logical consequences inferred from the hypothesis.

Hints:

- How to measure the magnitude of the friction force? On what factors does the magnitude of the frictional force depend?
- How to choose experimental equipment to investigate the dependence of the friction force on these factors? Tools requirements? Arrangement of tools?

Experimental plan

- Propose a plan to investigate the dependence of the magnitude of the friction force on the following factors:

Contact surface area:

The speed of the object:.....

Pressure on the contact surface:.....

Nature and condition of the contact surface:.....

- How to choose test equipment? How to arrange tools:

.....

- Sequence of conducting test:

.....

- Discuss how to process the data and evaluate the results:

.....

- Discuss the requirements of the measuring tools, how to read the indicators of the tools, how to reduce the systematic error of the measurement:

.....

Study sheet 2: Determine the magnitude of the sliding friction force

Conduct experiments and collect data. Data processing, commenting, evaluation, and drawing conclusions.

I. Conclusion of factors affecting the magnitude of sliding friction force.

Sliding friction force	No dependency	Dependency
Contact area		
Sliding speed		
Pressure on contact		
Nature and conditions of contact		

II. Determine the relationship between friction force and pressure N

1. Data collection and data processing

- The mass of the object $m = \dots$
- Table of measurement results:

Execution number	Dynamometer magnitude F	$\mu = \frac{F}{mg}$	$\Delta\mu$	$\bar{\mu}$
1				
2				
3				
4				
5				
Average				

+ Calculate the average value of the measurements: $\bar{\mu} = \frac{\mu_1 + \mu_2 + \mu_3 + \mu_4 + \mu_5}{5} = \dots\dots\dots$

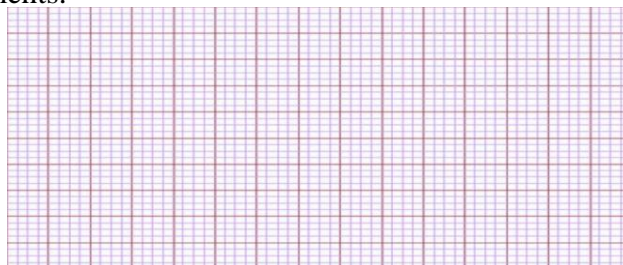
+ Calculate the absolute error for each measurement: $\Delta\mu_1 = \bar{\mu} - \mu_1 = \dots\dots\dots$ $\Delta\mu_2 = \bar{\mu} - \mu_2 = \dots\dots\dots$ $\Delta\mu_3 = \bar{\mu} - \mu_3 = \dots\dots\dots$ $\Delta\mu_4 = \bar{\mu} - \mu_4 = \dots\dots\dots$ $\Delta\mu_5 = \bar{\mu} - \mu_5 = \dots\dots\dots$	+ Calculate mean absolute error of measurements: $\Delta\bar{\mu} = \frac{\Delta\mu_1 + \Delta\mu_2 + \Delta\mu_3 + \Delta\mu_4 + \Delta\mu_5}{5} = \dots\dots\dots$ + Ratio error: $\delta\mu = \frac{\Delta\bar{\mu}}{\bar{\mu}} \cdot 100\% = \dots\dots\dots$
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

- **Comment:** The dependence of F on N?

.....

- **Draw graphs $F_{ms}(N)$. Draw comments.**

.....



2. Comments. Draw a conclusion (Confirm or reject the hypothesis)

.....

3. Newly acquired knowledge

Study sheet 3: Determine the magnitude of the sliding friction force (Each correct answer is worth 1 point)

Level 1: Knowledge

Question 1: Sliding friction force

- A. Appears only when the object is moving slowly
- B. Depends on the magnitude of the pressure
- C. Proportional to the object's speed
- D. Depends on contact surface area

Question 2. An object of mass N slides on a horizontal plane. The coefficient of sliding friction between the object and the plane is μ . What is the force of sliding friction?

- A. $F = \mu_t N$
- B. $F = \mu_t N$
- C. $\vec{F} = \mu_t \vec{N}$
- D. $\vec{F} = \mu_t N$

Question 3. When pulling a moving container, the force acting on the puller is?

- A. The force exerted by the puller on the earth
- B. The force of the container acting on the puller
- C. The force exerted by the puller on the container
- D. The force of the ground acting on the puller's feet

Question 4. An object slides on a plane, when the speed of the object increases, the coefficient of friction between the object and the plane is

- A. Unchanged
- B. Reduced
- C. Increases in proportion to the object's speed
- D. Increases in proportion to the square of the object's speed

Question 5. Coefficient of sliding friction

- A. proportional to the force of sliding friction and inversely proportional to the pressure
- B. depends on the area of contact and the speed of the object
- C. independent of the material and condition of the contact surface
- D. depends on pressure

Level 2: Comprehension

Question 6: A train carriage of mass 80 tons moves in a straight line under a horizontal pull $F = 6 \cdot 10^4$ N. Take $g = 10$ m/s². The coefficient of friction between the train and the track is?

- A. 0.075
- B. 0.06
- C. 0.02
- D. 0.08

Question 7: A car of mass 5 tons is moving on a horizontal road, the coefficient of friction of the car is 0.2. Take $g = 10$ m/s². The magnitude of the friction force is?

- A. 1000 N
- B. 10000 N
- C. 100 N
- D. 10 N

Question 8. An object slides on a horizontal contact surface. If the contact area of the object is reduced by 3 times, the magnitude of the sliding friction between the object and the contact surface will be

- A. reduced by 3 times
- B. 3 times increase
- C. reduced by 6 times
- D. unchanged

Level 3: Application

Question 9: A car of mass 1.2 tons starts from rest due to the pull of the engine 600 N. Assume the coefficient of friction of the car is 0.02. Take $g = 10$ m/s². Traction is parallel to the road surface. What is the speed of the car after 10 seconds from the start?

A. 24 m/s	B. 4 m/s	C. 3.4 m/s	D. 3 m/s
Level 4: High level of application			
Question 10: An object moving on a horizontal road with a speed of 15 m/s slides up a slope with a length of 100 m and a height of 10 m. The coefficient of friction between the object and the slope is $\mu = 0.05$. Take $g = 10 \text{ m/s}^2$. Slope distance that the object can go until it comes to a complete stop and the speed of the object when it returns to the bottom of the slope are?			
A. 100 m and 8.6 m/s	B. 75 m and 4.3 m/s		
C. 100 m and 4.3 m/s	D. 75 m and 8.6 m/s		

3.4. Results and discussions

The test results help teachers understand the students' level of knowledge about the causes of friction, classifying frictional forces (resting friction, sliding friction, rolling friction), determining the magnitude of the friction force. Students have been able to apply the beneficial effects of friction in practice, and at the same time limit and eliminate the harmful effects of friction. Students demonstrate competence in solving exercises, designing, assembling and conducting experiments to investigate the dependence of coefficient of friction, friction force on materials, etc. In addition, students understand how to collect and process data, thereby evaluating the results to find out the causes of errors.

The way the class is organized through group work attracts active students and timid students. The results show that students are comfortable when communicating in small groups, can express their own thoughts naturally. The language used when communicating in groups is often specific and intimate, and students have the opportunity to experiment with the language without being pressured from the outside. Students have many conditions to help each other, supplement each other's knowledge, freeing teachers from the roles of instructor, debugger, and classroom controller. The results obtained are actively reported by the students incorporating the use of information technology. That creates conditions for teachers to observe, analyze and process information to give accurate assessment results.

Innovating testing and assessment methods, using a variety of testing and evaluation tools helped teachers understand the level of achievement compared to the requirements of knowledge, skills, attitudes and competence to apply and solve problems of students. Since then, teaching and learning activities have been improved in a timely manner.

The combination of assessment tools shows the advantages of each assessment tool, thereby finding a method to combine appropriate assessment tools for a comprehensive, fair, honest, and highly categorical assessment.

In fact, there are still some common problems when designing testing tools, that is, a large number of students, usually more than 35 students. Then, it was difficult to control when students made many mistakes, leading to not timely stimulating and promoting students' positivity. In addition, teaching and experimental equipment is not synchronous and incomplete.

4. Conclusion

A tool to test and evaluate the teaching of friction in the direction of developing the quality of students' competence has been designed and implemented in class 10A of Tuong Duong 1 High School. The results show that reducing pressure on students' grades, improving learning efficiency, and developing students' competences. Teachers understand and know exactly about each individual's competence and qualities and propose solutions to overcome their weaknesses and promote their strengths.

The assessment has changed from knowledge assessment to evaluate the process and the method in which learners research, understand and apply knowledge in practice, aimed at developing learners' practical competence, focusing on evaluating higher-order thinking competence such as creative thinking. The assessment is comprehensive, fair, honest, and capable of classification.

The article presented the results of changing the approach to testing and assessment in the direction of developing the quality and competence of learners. The results have indicated the difficulties when implementing assessment tools, proposing solutions to overcome, helping students actively approach and apply effective learning methods, especially self-reading and self-study.

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TÓM TẮT

THIẾT KẾ CÔNG CỤ KIỂM TRA, ĐÁNH GIÁ CHỦ ĐỀ LỰC MA SÁT THEO ĐỊNH HƯỚNG PHÁT TRIỂN PHẨM CHẤT NĂNG LỰC HỌC SINH

Nguyễn Thành Công

Khoa Vật lý, Trường Sư phạm, Trường Đại học Vinh, Việt Nam

Ngày nhận bài 22/9/2022, ngày nhận đăng 29/12/2022

Bài viết trình bày nội dung thiết kế công cụ kiểm tra, đánh giá chủ đề dạy học “lực ma sát” theo định hướng phát triển phẩm chất, năng lực học sinh trung học phổ thông. Trên cơ sở kết quả thực nghiệm sư phạm tại Trường Trung học phổ thông Tương Dương 1, bài viết đã đánh giá được hiệu quả của bộ công cụ đề xuất, từ đó đưa ra được những giải pháp nâng cao hiệu quả công tác kiểm tra, đánh giá theo định hướng phát triển phẩm chất năng lực của học sinh.

Từ khóa: Kiểm tra đánh giá; định hướng phát triển; chủ đề lực ma sát; học sinh trung học phổ thông.