DEVELOPMENT AND SYSTEMATIC SOLVING OF TRAINING PROBLEM SETS FOR RESEARCH EDUCATION OF FUTURE TEACHERS

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Abstract

The subject research expertise of the future teachers is discussed on the basis of the methodology of scientific research. It is proposed to form research expertise when learning physics and mathematics through specially allocated and solved by the educational research problems.

Keywords: teacher training, research expertise, educational research activity, scientific method.

1. INTRODUCTION

The research expertise of future teachers can be developed in the process of educational research activity. Such activity systematically engages the students in empirical or theoretical research studies within the scope of the students' specializations. The educational research studies involve creative solution of training research problems wherein the process of solution is unknown to the students and has to be accomplished according to the scientific method.

The main criterion of a student's having acquired the research expertise sufficient for his or her future pedagogical activity is the student's ability and readiness for formulating a research problem and solving it using the scientific method, either individually or in a group. In that regard, the educational research activity

mimics the actual process of scientific research. The exact definition of what constitutes a research training problem varies throughout the modern pedagogical and psychological literature. However, a research training problem is generally agreed to constitute an inquiry that demands an independent formulation, justification, and proof of a hypothesis.

In general, research training problems constitute just one type of research problems, other types including: cognitive problems, cognitive research problems, scientific research problems, and specialized scientific research problems. The professional training of future science teachers must include learning to solve the research problems of all the above types. In that regard, the research training problems constitute an important stepping stone from traditional learning to independent research activity.

Step-by-step solution of research problems ensures a progressive development of research expertise, as well as the systematization and consolidation of the acquired knowledge. It should be noted, however, that the ability to solve research problems at different levels of the above hierarchy depends crucially on the maturity of the student, including the student's capacity for independent research activity.

Solving a research problem demands following a pre-defined algorithm:

(i) understand or independent formulation of the research problem; (ii) tabulate the existing knowledge and skills; (iii) identify the knowledge gap; (iv) fill the gap by means of observation, experiment, interviews, etc.; (v) formulate a hypothesis; (vi) validate the hypothesis; (vii) draw conclusions and make generalizations. This algorithm constitutes the basis of the scientific method.

2. MATERIALS AND METHODS

According to the famous interpretation of A. M. Novikov (2007), methodology is a guiding principle for organizing activity in a given area. Thus, we can consider the scientific method to be the guiding principle for organizing scientific activity. Such an approach directly relates the research expertise of the future science teachers to their readiness and ability to conduct an independent research study according to the principles of the scientific method.

In that interpretation, the scientific research process is divided into phases and stages, each described in meticulous detail. The phases and stages of scientific research become the basic elements of the research expertise to be acquired by a future science teacher in his or her subject area (Belyanin, 2011; 2013).

3. RESULTS

The article contains specific examples of training results based on developing and solving mathematical and physical problem sets. The example of the physical problem set is based on a body motion in the field of gravity. The problems explore how the fall time of the body depends on the initial conditions stipulated in the problem.

In a physical situation as major source items include:

1) object is the physical body mass *m*;

2) the phenomenon is the movement of the body in gravity field or gravitational interaction of the body with the Earth;

3) models are uniform motion and uniformly accelerated motion of body;

4) laws are equations describing the uniform motion and uniformly accelerated motion of the material point;

5) physical and geometrical values are the path, motion, speed, acceleration, angle, etc.

As *a problem* for the studied physical situation choose the question of how to determine, what is, from changing what initial conditions and how will depend body flight time on the gravity field. For clarity, this problem is only *educational* research problem.

As a *hypothesis, educational* research problem we formulate the statement that body flight time will depend on the initial speed, direction and altitude, shape of the Earth's surface or other effects on the body.

To ascertain the truth of the hypothesis, we organize training activities students on *developing* on basis of *selected physical situation* corresponding physical problems*,* their succession of solution and analysis for each problem.

Motion time of a body in gravity field

1. Smooth puck mass *m*, lying on a smooth horizontal surface, pushed with the velocityu_0. Evaluate the time during which the puck will pass way *l*.

2. The stone mass *m* thrown vertically upwards from the ground with an initial velocity u_0. Evaluate flight time of the stone.

3. The stone mass *m* thrown from the ground at an angle α to the horizon with an initial velocity u_0. Evaluate flight time of the stone.

4. The stone mass *m* released at height *h* from the Earth's surface. Evaluate flight time of the stone.

5. The stone mass *m* thrown at the height *h* from the ground straight up with an initial velocity u_0. Evaluate flight time of the stone.

6. The stone mass *m* thrown at the height *h* from the ground vertically downward with an initial velocity u_0. Evaluate flight time of the stone.

7. The stone mass *m* thrown at the height *h* from the ground horizontally with initial velocity u_0. Evaluate flight time of the stone.

8. The stone mass *m* thrown at the height *h* from the ground at an angle α to the horizon with an initial velocity u_0. Evaluate flight time of the stone.

9. The stone mass *m* thrown at the height *h* from the ground at an angle α to the horizon with an initial velocity u_0. Evaluate flight time of the stone, if horizontal blowing wind, creates a permanent resistance power for the stone movement.

10. The stone mass *m* thrown at a height *h* from the base of the inclined plane at an angle α to the horizon with an initial velocity u_0 up an inclined plane, located at angle β to the horizon. Evaluate flight time stone, if horizontal blowing wind, creates a permanent resistance power for the stone movement.

An example of mathematic problems set demonstrates how to examine the properties of angle bisector. Mathematical situation demonstrated through educational research is taken for angle bisector from the various geometric figures as flat as spatial:

1. The side of an equilateral triangle is *a*. Evaluate the length of the bisector angle of the triangle.

2. The sides of an isosceles triangle *a* and *b*. Evaluate the length of the bisector sat base angles of the triangle.

3. The square side is *a*. Evaluate the length of the bisector angle between aside of the square and its diagonal.

4. The side of the rhombus is *a,* smaller diagonal is *b*. Evaluate the length of the bisector of a smaller angle of a rhombus.

5. The bases of an isosceles trapezoid are equal *a* and *b*. Evaluate the length of the bisector for angle at the more base of trapezoid.

6. The rib of cube is *a*. Evaluate the length of the bisector of angle at the vertices of the cube.

7. The rib of cube is *a*. Evaluate the length of the bisector of angle between the diagonals of the cube.

8. The cuboid has dimensions *a, b* and *c*. Evaluate the length of the bisector of angle at the top of the box.

9. The right triangular pyramid has dimensions: *a*-side of the base, b -side of the rib. Evaluate the length of the bisector of angles at one of the tops of the base.

10. The right triangular prism has dimensions: *a* -side of the base, *b* -side rib. Evaluate the length of the bisector of angles at one of the top of the base.

4. DISCUSSIONS

Development, solving and research of the solution of a problem set in physics or mathematics can be regarded as solution of education research problem that is able to determine the research expertise of the future teachers. The problems set should include in this case, no less than ten separate problems, the condition that unites some physical or mathematical situation and the solution of some problems are interrelated with other problems.

The set of physical problems is a set of hierarchically linked evaluating physical problems, the situation each of which corresponds to some physical situations, have the same requirements for all problems (one and the same issue) and the changed conditions by any additional impact on the problem object. The system of mathematical problems is defined similarly.

We determine the following basic structural elements of a future teacher's research expertise that can be acquired during educational research training based on the sets of physical or mathematical problems:

1. The ability to use the educational material to identify an appropriate physical or mathematical setting to be explored in the context of the problem
2. The ability to formulate the problem
3. The ability to determine specific research goals
4. The ability to determine the success criteria for the theoretical study
5. The ability to formulate a hypothesis
6. The ability to develop the research strategy
7. The ability to prepare the technical basis for the research study
8. The ability to conduct the study
9. The ability to presents the results of the study use the results in practical applications
10. ability to critically analyze the results of the study
11. The ability to reflect on one's own research activity
12. The ability to reflect scientifically on the problem solved and advance the research to the next level, exploring the physical and/or mathematical settings evolving from the one addressed most recently

5. CONCLUSION

Educational research problem, capable of forming subject research expertize of the future teachers is not each of these problems, but the entire problems set. These problems set might be called educational research set only if they are developed via a dedicated student based on the physical or mathematical situation, which is given him. He have to solve and to analysis all the problem solutions too.

Control and estimation of subject research expertize level of future teachers, generated when performing theoretical studies using physical and mathematical sets training problems is carried out directly in the process of training activities when developing and solving problems, as well as the expertise of the experts-teachers.

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