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PEDAGOGICAL FOUNDATIONS HOLISTIC AND SYSTEMATIC KNOWLEDGE DELIVERY TO STUDENTS IN THE SYSTEM OF NATURAL AND EXACT SCIENCES USING STEAM EDUCATIONAL TECHNOLOGY

Khodjamberdiev M. S.
Associate Professor, Andijan State University

Abstract
This article presents the pedagogical foundations of imparting holistic, systematic knowledge to students using STEAM educational technology in the system of natural and exact sciences.

Keywords: Person-oriented education, STEAM educational technology, science, technology, engineering, art, and mathematics disciplines, career orientation.

Introduction

The scientific and technological process that leads to the civilization of the 21st century is one in which anyone who is able to analyze, synthesize, evaluate their intellectual capabilities, as well as develop adaptive mental and creative abilities better than others, will be rewarded with work and career opportunities – these prophetic reflections written nearly 30 years ago clearly outline the requirements being set for the training of modern specialists [1].
The essence of preparing such specialists is expressed in the "Development Strategy of New Uzbekistan for the 2030s," which emphasizes continuing the development of the national continuous education system, creating opportunities for quality educational services, training highly qualified personnel in line with the modern needs of the labor market, and enhancing the quality and efficiency of higher educational institutions' activities as a priority task [2].
To address these tasks, it is crucial to create an advanced education system based on the latest achievements in global science and innovation, utilizing the rich spiritual potential of our people and universal, national values, along with the latest advances in contemporary culture, economics, science, technology, and innovation. This system would aim to prepare qualified specialists who are active thinkers, creators of innovative ideas, and able to implement them in practice. This is of utmost importance in today's rapidly developing era, where society needs specialists who can think critically, generate innovative ideas, and effectively apply them in practice. This, in turn, requires the introduction of innovations into the educational process and the use of modern interactive and creative teaching.
As a result, university students will not only study theoretical knowledge, practical skills, competencies, and thinking, but will also be capable of identifying, analyzing, evaluating

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trends, seeking new ideas, and predicting the outcomes of these changes in the future, all while being able to solve a wide range of problems.

Based on the above reflections, this article presents the pedagogical foundations of providing integrated and systematic knowledge for future professions based on the STEAM technology, one of the modern educational technologies, considering the continuity of science, education, and production. It discusses the integration of physics with science, technology, engineering, art, and mathematics (STEAM) through an active approach—career orientation. The article aims to outline the pedagogical principles of providing systematic, integrated knowledge for the professions that will be pursued in the future [3].

The integration of disciplines, or the interconnection of sciences, is considered a didactic condition, and when properly implemented, it not only helps to systematize the educational process but also strengthens the knowledge acquired by students. It increases students' interest in studying, ensuring that they engage with theories and scientific concepts. As a result, knowledge becomes clearer, more generalized, and allows for practical application [4].

An analysis of literature on STEAM educational technology indicates that this teaching method, considering the integration of sciences, is based on technological and engineering thinking. It involves the development of theoretical knowledge, acquired skills, and competencies in a way that spirals from simple to complex, with life, practice, and production. This approach helps students understand the interconnectedness of the micro and macro worlds around them, as well as their constant movement, leading to a comprehensive, indivisible understanding.

The content of STEAM education technology consists of the following:

S – Science: Developing students' knowledge, skills, and competencies related to science through research skills.

T – Technology: Developing students' knowledge, skills, and competencies in technology.

E – Engineering: Developing students' knowledge, skills, and competencies in engineering.

A – Art: Expanding students' worldview by developing their knowledge, skills, and competencies in the field of art and culture.

M – Mathematics: Developing students' knowledge, skills, and competencies in mathematics.

The methodology for organizing practical activities based on STEAM education technology includes dividing students into 5 groups based on their educational and cognitive development levels and capabilities according to the conditions of the STEAM teaching technology.

1st Group – Science – Theoretical Group
2nd Group – Technology – Technologists Group
3rd Group – Engineering – Engineers Group
4th Group – Art – Artists Group
5th Group – Mathematics – Mathematicians Group

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Students divided into groups will be assigned tasks based on the theoretical aspects of Newton's laws, their application in life, practice, and production, including mathematical formulas and diagrams.

They will be given a set amount of time, and once the time is up, the decisions and reflections of each group on the topic will be discussed. They will be required to write their conclusions on a pre-prepared chart, and the teacher will make a general conclusion.

When conducting activities in small groups, the following outcomes are achieved:

Each student's active participation is ensured, and there is an increased ability to monitor and assess their activities.

A quick problem-solving method is ensured. Students will become creators of many new ideas in a short time.

At any time during the activity, it is possible to increase students' interest and allow for a group discussion involving the entire class.

Some students may hesitate to share their individual thoughts with the teacher on the subject, but in small groups, they can freely exchange ideas with their peers, meaning they participate actively in the lesson.

Steps for organizing small group activities:

1. A lesson plan is created, and the start time for small group work is specified within the lesson.
2. Each group selects its leader. There is no need to allocate separate time for this.
3. A problem or question related to the topic is selected for small group work. The objective and tasks of the question are clearly explained to the students.
4. Time is allocated to work on the problem. Typically, 15-20 minutes is sufficient to make a decision on the issue within any given topic.
5. Groups may be provided with relevant educational-methodological and visual learning materials.
6. The teacher ensures there is no noise in the classroom and that no students become passive participants. The teacher monitors the group activities and learns from their thoughts.
7. Group leaders present the collective opinion of their group on the topic in the form of a presentation. It is recommended that the presentation last no longer than 10 minutes.
8. After the presentation, time is allocated for a debate. The teacher conducts a general analysis of the problem and evaluates the groups' activities.

Teaching Technology of Newton’s Second Law within the "Dynamics" Module based on STEAM Education Technology:

The fundamental laws of dynamics are expressed in Isaac Newton's book "Mathematical Principles of Natural Philosophy" (1687). These laws were discovered based on Newton’s own experiments and theoretical studies, as well as previous research conducted before him.

Newton’s second law expresses the relationship between the force applied to an object, the acceleration of the object under that force, and its mass. Students will independently create this law based on experiments.

Here is the English translation of the provided Uzbek text with the different group's reflections on Newton's Second Law based on the STEAM education technology:
Variant of Reflections of Students on Newton's Second Law Based on STEAM Education Technology

1st Group S – Science – Theoretical Group	Newton's second law expresses the relationship between the force (F) applied to an object, the acceleration (a) it acquires under this force, and its mass (m). The acceleration of an object is directly proportional to the force acting on it and inversely proportional to its mass. The force acting on an object is equal to the product of the mass of the object and the acceleration it gains under that force.
2nd Group T – Technology – Technologists	Newton's second law expresses the relationship between the force (F) applied to an object, the acceleration (a) it acquires under this force, and its mass (m). The acceleration of an object is directly proportional to the force acting on it and inversely proportional to its mass. The force acting on an object is equal to the product of the mass of the object and the acceleration it gains under that force.
3rd Group E – Engineering – Engineers Group	a) The construction of vehicles, such as cars carrying a specific weight, buses carrying a certain number of passengers, trains, and airplanes, is developed by considering the force of gravity acting on them. b) The weight of the load in vehicles like trucks or train cars must be taken into account, particularly when the train is moving uphill or downhill, or traveling on a flat track.
4th Group A – Art – Visual Artists Group	
5th Group M – Mathematics – Mathematicians Group	F = ma (Force equals mass multiplied by acceleration)

Based on the above reflections, this article examines the scientific and theoretical foundations of Newton's Second Law for university students in the natural and exact sciences direction. The study considers the integration of science, education, and production using STEAM technology, one of the modern educational technologies. It explains the practical applications of Newton's Second Law, such as the movement of objects (automobiles, buses, train cars, airplanes, spacecraft, artificial satellites, elevators, and other moving objects) in various conditions—on flat or curved paths, or circular motion. The article emphasizes that the design and preparation of these objects, taking into account the required conditions, technological, engineering, and design aspects, as well as mathematical calculations, are essential in their creation.

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