

Interdisciplinary relations in physics education – an important factor in improving student motivation

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The paper deals with the problem of enhancing the motivation of high school students as an important condition for achieving the established education goals and underscores the use of interdisciplinary relations in education as a possible approach to the solution to this problem. A particular variant of a physics and astronomy lesson for the 10th grade is proposed basing on the interdisciplinary relations: physics – Russian language – information technology. The practical realization of the lesson is traced in both organizational and technological aspect elucidating the importance of such type of motivating education for the development of various skills (research, linguistic, digital, etc.).

Keywords: motivation, physics education, interdisciplinary relations, Russian language, information technology

INTRODUCTION

Motivation is a driving force of human behavior in terms of performing an activity or achieving specific goals. The motives for doing a particular activity can be different. On the one hand they are closely related to the individual attitudes of the personality – needs, aspirations, interests, aims, etc., and on the other hand – to the considerable influence of external factors determined by the social environment. In this respect, motivation is supposed to be studied as a complex system consisting of various motives that are united and interact. According to Edward Deci people have the “*inherent tendency* to seek out novelty and challenges, to extend and exercise one's capacities, to explore, and to learn” [1]. If this tendency is a main factor in the activity one performs, then the activity itself is taken as a pleasure, and the performing of it brings satisfaction and a feeling of self-determination. In psychology, this kind of motivation is called *intrinsic*. In contrast – if the main factor for the successful performance of a specific activity comprises of external stimuli and rewards, the motivation is called *extrinsic*. Extrinsic motivation is a construct which always refers to the performance of an activity in order to attain some separable outcome. Therefore, when a student studies in order to obtain some benefit (a good grade, praising, to be noticed) this means that extrinsic motivation is their priority, and when they derive pleasure from the very process of learning, intrinsic motivation is leading, and it is directed to the process of cognition [2].

From the viewpoint of the “self-determination

theory”, which was first developed by Edward Deci and Richard Ryan, *people have three innate psychological needs – competence, autonomy and relatedness*. According to the authors intrinsic motivation will be manifested at a high level, when a suitable environment is created, in which these psychological needs are satisfied. This accentuates the conditions that not only cause the manifestation, but also maintain and enhance this special type of motivation. Teaching experience shows that the intrinsic motivation for learning and achieving is enhanced when the outside pressure, stress, interpersonal tension and negative emotions in the learning process are reduced.

It is important to note that intrinsic motivation leads to high-quality education and creativity, but it can be manifested only in terms of activities that are in their essence *intrinsically interesting for the individual*: for instance, they present some challenge, are attractive because they contain an element of novelty or have esthetic value for the particular individual. However, one can claim without any doubt that in the process of education many of the tasks, which teachers pose to their students, are not interesting or pleasant in their essence. Apparently in that case the teacher must rely on extrinsic motivation paying specific attention to the following fact: while the intrinsically motivated behavior which is a consequence of interest and satisfies the innate psychological needs of competence and autonomy, *is a prototype of self-determining behavior*, the extrinsically motivated types of behavior may be different depending on the degree of autonomy and self-determination they reflect [3].

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Practically this means that in a particular situation the students can perform extrinsically motivated actions with disinterest, opposition, even resentment and in another situation – with desire, when they have accepted the fact that the given task has value or is useful to them. For example, students who do their homework because they are afraid of their parents' sanctions and those who do the same activity because they personally believe, they are convinced in its value for the future (for their chosen career). In both cases the motivation is extrinsic, but in the second case the activity suggests some personal approval and the feeling of individual choice, while in the first case – adhering to a form of extrinsic control, that is, both types of extrinsic motivation differ in their degree of relative autonomy. Consequently, in school practice it is important to take into consideration that the extrinsic motivation for the behavior can range from absolute unwillingness, to passive compliance, to active personal commitment of the students to the performance of the school activity. Then it is logical to pose the question: how could the teacher stimulate more active and willing forms of extrinsic motivation, instead of passive and controlling ones, that is, how could they assist their students in understanding and accepting the responsibility and the feeling of value of the extrinsically set aims as a personal viewpoint? And how could they collaborate systematically in stimulating intrinsic motivation at the same time?

The research of various psychologists shows that the level of the motivation for learning at school can be enhanced in several aspects [4]:

- it is essential to organize and maintain an effectively functioning school environment, which fulfills the students' needs for physical and psychological comfort and allows them to perform various school activities in accordance with their cognitive interests and the main syllabus;
- it is necessary to create conditions for collaboration and mutual aid among the participants in the process of learning;
- the learning objectives must be clear and comprehensible for the students and possible to be realized in short terms;
- the learning tasks must be of average difficulty, engaging and interesting, based on a direct link with reality;
- schoolwork must be reasonably challenging, in accordance with the students' abilities;
- it is necessary to obtain a timely and adequate feedback, *which focuses on the achieved learning progress*;

- the teacher may reward students *after achieving learning results*, on the condition that these results correspond precisely to the preliminary established (announced) standards;

- it is necessary to develop students' autonomy regarding school time organization, self-preparation and performing various activities as well as in terms of exercising effective self-control and self-regulation.

INTERDISCIPLINARY RELATIONS. RELATIONS OF PHYSICS AND ASTRONOMY TO RUSSIAN LANGUAGE AND INFORMATION TECHNOLOGY

The aim of the present paper is to emphasize the use of interdisciplinary relations in physics and astronomy education as a possible approach to enhancing the motivation for learning at school. The interest in this problem has been provoked by the fact that interdisciplinary relations can be viewed as a didactic condition for: a higher scientific level of education based on interdisciplinary synthesis; the stimulating of students' cognitive activity; improving the quality of learning [5].

In terms of organization, in order to establish successfully the interdisciplinary relations in education, the teacher must pay attention to the following:

1. There are different classifications of interdisciplinary relations in education based on one sign or another, but most generally, three levels of relating can be identified: *educational content (information); type of school activity and methods of organizing the learning process*.

2. These relations can be established in different forms [6]:

- a) Lessons featuring examples that demand knowledge from other subjects;
- b) Lessons focusing on tasks with interdisciplinary content;
- c) Integrated lessons (seminars, conferences, discussions, workshops, etc.);
- d) Interdisciplinary trips and extracurricular activities.

3. In order to decide what interdisciplinary relations to use in practice, the teacher must study carefully the students' attitudes and interests regarding the educational content taught in the different school subjects.

In the specific case the question is about an interesting and rarely applied in school practice variant of interdisciplinary relations: physics and astronomy – Russian language – information technology.

Physics and Russian language as school subjects can be related at different levels [7]:

1) *Level of conceptual and terminological content.* It refers to the acoustic aspect of the Russian speech (tone, timbre, level of intensity, etc.) and the peculiarities of the Russian stress.

2) *Operative (communicative-speech) level.* It is connected with the use of scientific information and its application in the form of Russian speech.

3) *Methodological level.* It is related to the selection of educational-didactic materials for working out the various linguistic norms in the Russian language (putting stress and other signs, word spelling, etc.).

Physics and astronomy and information technology establish an interdisciplinary relation by applying software and hardware in tackling educational tasks with physics content. It is an incontrovertible fact that the preparation of computer presentations with the help of information and communication technology (ICT) is the most popular educational task in contemporary teaching practice. It is important, however, that this activity should demand from the students such actions as the autonomous search and selection of scientific information from different sources, conclusion drawing and summarizing, adequate use of the collected information in accordance with the preliminary set goals. Thus by exercising their creative skills on the computer, they have the opportunity to demonstrate their competence in physics, the skill to deal with information technology and create products of high educational and esthetic value, to develop their communicational skills of presenting publically a specific content, that is, to enhance their learning motivation as a whole.

A VARIANT OF ESTABLISHING THE INTERDISCIPLINARY RELATIONS: PHYSICS AND ASTRONOMY – RUSSIAN LANGUAGE – INFORMATION TECHNOLOGY

An open physics and astronomy lesson in Russian entitled „ПРОГУЛКА В КОСМОС“ (in translation “A Walk in Space”) was given in “Peyo K. Yavorov” Profiled High School (Petrich) with the participation of tenth grade students. The main organizer of the event was the physics teacher and the guests were the school management, teachers and inquisitive students.

The lesson aims were to present the Russian astronautics’ global achievements by computer presentations in authentic language and to enhance student motivation for learning physics and astronomy on the basis of interdisciplinary relations

to Russian and IT. The preparation for the lesson took one month and it included the following activities:

- *Studying the students’ attitudes and interests in:* 1) astronomy, astrophysics and astronautics; 2) learning Russian; 3) using ICT. A number of informal conversations were made between the students and the physics and astronomy teacher;

- *Forming the teams of students and assigning tasks for homework* – preparing presentations in Bulgarian on specific topics connected with the Russian astronautics achievements;

- *Searching for texts and graphic information on the Internet and preparation of the presentations by the students* using MS PowerPoint;

- *Discussion and correction of the presentations’ content* in collaboration between the students and the physics and astronomy teacher;

- *Checking the ready presentations* by an information technology teacher-consultant and discussing with the students the possible variants of improvement;

- *Translation of the presentations in Russian;*

- *Discussion and correction of the Russian text* in collaboration between the students and the Russian language teacher-consultant;

- *Final arrangement of the presentations* under the guidance of the physics and astronomy teacher;

- *Active work on behalf of the students (in collaboration with the physics and Russian language teachers) aiming at practicing and mastering their skills in presenting orally their work in front of audience.*

At the beginning of the lesson, as an introduction to the topic, the physics and astronomy teacher presented in Russian the structure of the Solar system and underscored the important role of space research in revealing its secrets (Fig. 1).



Fig. 1. The physics teacher at the beginning of the lesson „Walk in Space”.

After that the first team of students gave their presentation “A Short History of Russian Astronautics” (Fig. 2). They represented the apparatuses, flights and programs of the former Soviet Union (USSR) in the 20th century, as well as Russia’s intentions of new missions after 2020.

Plenty of emotions were inspired among the guests by an impressive video representing all the phases of realizing the space flight of a rocket – from its launch from the Russian Baikonur Cosmodrome to the landing of its capsule.



Fig. 2. Ori Yuzirov and Goran Angelov while giving their presentation “A Short History of Russian Astronautics”

The presentation “The Russian Animals in Space” started with an exciting story about the dog Laika – the first animal to orbit in outer space (Fig. 3). Curious information was also presented (accompanied by plenty of photos) about other animals – dogs, rabbits, turtles, worms, as well as some types of bacteria, which spent time in space as part of the Russian space research.



Fig. 3. Tedi Velkova while giving the presentation “The Russian Animals in Space”.

The next presentation was devoted to the first cosmonaut Yuri Gagarin and the first female cosmonaut Valentina Tereshkova (Fig. 4). The students showed pictures and presented interesting data about the flights of both Russians hailed as heroes of USSR. In addition, verses dedicated to Yuri Gagarin were recited.



Fig. 4. A presentation entitled “The First Cosmonaut Yuri Gagarin and the First Female Cosmonaut Valentina Tereshkova”.

The last team traced three big space projects in their historical and technical aspect: the Buran shuttle, the space station Mir and the International Space Station (ISS) (Fig. 5). The students emphasized that for the time being ISS is the only operating world laboratory for scientific-technical experiments under the conditions of zero gravity.



Fig. 5. Vanina Dodekova and Mariya Krusteva while giving the presentation “The Buran Shuttle, the Space Stations Mir and ISS”.

Finally an amusing game with the audience took place – filling in a crossword containing Russian words connected with astronautics. As an emotional ending of the “space walk” and as a greeting to those who were present the song “Gravity” performed by Intras Busulis and Elena Vaenga was played.

After the end of the lesson, all authors of presentations were awarded with certificates and presents for the work done. They were congratulated by the school principal and the Russian language teachers.

CONCLUSIONS

From a psychological and teaching perspective the suggested variant of an extracurricular event

incorporates a number of advantages that have stimulating influence on learning motivation:

- The students are facing a kind of challenge as the fulfilling of the learning tasks demands the combination of acquired knowledge and skills regarding three school subjects that do not belong to the same cultural-education sphere.

- The learning material is valuable, interesting, and useful – connected with the practical application of the acquired knowledge and skills, and the learning tasks demand from the students' autonomy and active search, organizing and using information to achieve the specifically formulated goals.

- The students have the freedom of choice regarding the fulfilling of the posed tasks. They could work individually or in a team under the conditions of friendliness, respect, mutual assistance, lack of competition and unnecessary strain.

- The teacher plays the role of a social partner who understands, helps, and supports the students initiating step-by-step discussions connected with the process of fulfilling the posed tasks and providing a valuable feedback regarding the degree of achieving the learning objectives.

- The student activity is not associated with specific grades or preliminary promises about rewards, which, as research shows, undermines intrinsic motivation in long-term plan, especially regarding creative tasks.

- The lesson takes place in informal atmosphere. The students can demonstrate their knowledge and skills in front of their classmates and many other guests of the event, which motivates them additionally for a successful performance.

- The praises and congratulations that the students get concern mainly their efforts and work, and not just the achievement of a specific result. This fosters their motivational value.

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