

The Role and Place of Achievement Motive in Modular Technology of Teaching Physics to Future Engineers

Gnitetskaya Tatyana N^{1, a}, Almaev Nikolay A.^{2, b}, Ivanova Elena B.^{3, c}

¹The School of Natural Sciences, Far Eastern Federal University, 8 Sukhanova St., Vladivostok, 690950, Russia

³The School of Natural Sciences, Far Eastern Federal University, 8 Sukhanova St., Vladivostok, 690950, Russia

^ae-mail: gnitetskaya.tn@dvfu.ru, ^ce-mail: lena---iv@mail.ru

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Abstract. This article justifies the necessity of organization of goal-oriented activity in teaching physics to first-year students of engineering majors. It was shown that creation of conditions for the formation of motives helps students proceed to the scientific level of mental reflection adequate to the requirements of university training. The article provides examples of the organization of groups' competitions when establishing personal and collective responsibility.

Introduction

In relation with the emergence and rapid development of new technologies in all industries, there is an urgent need for engineers with a high level of training in physics. Today, there is a high demand for engineers who can independently: 1) define the purpose, 2) set the optimal strategy to achieve it adjusting all the possible ways to this goal, and 3) define the tasks that will lead to the goal in terms of this strategy. Unfortunately, as a result of tasks overload in the first year, students often lose interest to the study of cause-and-effect relationship and the content of abstractions in the material of a course of physics, the establishment of which helps to produce self-activity skills and the ability to think analytically, which is very necessary for the implementation of goal-directed activity. The main cause of freshmen's overloads is both a lack of self-activity skills and non-compliance of their physical and mathematical training received prior entering the university to the requirements of that university.

These two interrelated problems 1) increasing interest to activities or motivation 2) and elimination of overloads have been the subject of psychologists' studies in Russia and other countries for a long time. This paper analyzes the possibility of organizing achievement motive at physics lessons, and provides examples of a special module organization and conducting of seminars on physics, during which this motive can form.

Adaptive regression in the level of representation

Distinction of sensual and ideal representation of reality might be traced to Plato and Aristotle. Recently following types of representations of reality were proposed by I.L. Prokopchik-Gailo [1]. Table 1 shows a model of the system of mental reflection, which contains hierarchical levels [1]. Each level of the system has its own emergent properties. Types of thinking in terms of the model are differentiated depending on the mental elements of the corresponding level. First sensory-perceptual level goes after the level called system- forming environment where unconscious response occurs in the form of a reflex, and where there is no thinking. Let's assume that this level is formed at first-year of education in all cases. The first level is implemented through a feeling using conscious subjective response that provides such sensory-perceptual thinking as handling feelings. The second visualizing level is in charge of forming of visual thinking as handling specific, generalized and other images, and emergent properties are multipolarity, dichotomous self and world-perception. The next third level is scientific one where the dichotomous perception disappears - emergent properties have only a verbal

nature. It is the level of scientific thinking as handling scientific concepts, laws and principles. The highest level is the fourth – this level of systemic vision completes the range of mental reflection of the world by a modern man.

Table 1
The system of human mental reflection [1]

		Levels of mental reflection	Mental element
System-forming environment	Reflex	Unconscious response	No thinking; Congenital conditionality development
1. Sensory-perceptual level	Feeling (percept)	Awareness; Subjectivity; Expendability.	Sensory-perceptual thinking as handling feelings (percepts)
2. Visualizing level	Image	Multipolarity; Dichotomous self and world-perception.	Visual thinking as manipulation of images (specific, generic, etc.)
3. Scientific level	Scientific definition	Only verbal nature; Disappearance of Dichotomous perception	Scientific thinking as handling scientific definitions (concepts, laws, principles, etc.)
4. Level of systemic vision	System of vision	Prediction within cognized systems	Systematic thinking (handling systems of vision)

The model provides the possibility of extending the range caused by human development. Given that each level is broken down into sublevels, it becomes obvious that the way from the first level to the fourth is extremely long and associated with human intellectual development.

Therefore, the attempt to create conditions that would allow freshmen to jump from the first level of mental reflection to the third and even to the fourth at first glance seems unreal. However, this model assumes that each subsequent level does not destroy the previous one, but completes the development stairs. A person can consciously switch attention from one level of mental reflection to another keeping in mind the entire range.

This situation led to the hypothesis that jumps from lower level to higher are possible. Goal-directed activity that in its turn gives opportunity to make this jump may correspond to the activity that realizes achievement motive. Achievement motive was studied in detail in the mid-twentieth century by a group of psychologists including McClelland, Atkinson Heckhausen et al and subsequently was frequently used in other studies (see, for example, N.A. Almaev [2]). Achievement motive was first time defined as the «competition with standard of excellence» [7] (McClelland et al, 1953, P.110). Need for competition with a peer is natural for student but at the same time it may lead to bitter frustration in the case of failure and subsequent development of the fear of failure (Heckhausen, 1967)[6]. How risk of frustration and failure may be moderated? How need for competition with a peer might be transformed into the competition with standard of excellence? One of the ways to respond on a raised question is explained in this paper.

Team as a moderator of peer competition

Of course students' goal-oriented activity in condition of achievement motive emergence is strongly connected with the intellectual tension, the upper limit of which is individual, that's why tasks must be adjusted for everyone. Two situations are possible in the case of tasks monitoring – individual and collective responsibility for executed work. Therefore, in the first case, a competition

between students is set, and in the second – goal-oriented activity is organized as a team competition where everyone is able to find his place. In the first case, the task must be easy, in the second – complicated. Here are two relevant examples of the organization of this competition.

The first example. The study of a module is suggested to be step-by-step [4], and the first step is to make up an accessible for all but complex task for independent work. Students using textbooks and scientific articles independently write notes on theoretical questions of the module that precedes their study at a lecture. A teacher prepares in advance questions on all topics and gives them to students at the beginning of the semester. Each question has references up to ten names indicating paragraphs and pages. Writing a summary lets students familiarize independently with questions of the topic, during this time students independently overcome personal barriers of uncertainty and form the range of questions, answers to which can be obtained during a lecture. The standard of perfection here is a content of textbooks.

Mandatory control of summaries is conducted in the first few minutes of the lecture: A teachers records the presence or absence of a summary. During the semester exam, students are asked additional questions on those topics, on which for some reason they didn't write a summary. The form of a lecture is changing too. Teachers clarify the complexity of questions during the checkout of lecture's summaries and build a lecture with an emphasis on complex issues. Clear and previously well summarized questions by students are stated figuratively on a lecture without taking much time.

Second example – organization of seminars in the form of scientific conferences. This example is good when issuing complex tasks, the fulfillment of which indicates the degree of students' creativity, and created conditions make students carry out activities on scientific and systemic levels of mental reflection. Competition here is organized between teams in the group, the composition of which is selected on the basis of psychological compatibility, and each stage of the competition is judged in contrast to the summary control, where the presence or lack of it is recorded. Low grades create the risk of denial by a student the need of achievement, because, according to the Hekhausen theory, achievement motive appears simultaneously with avoidance. [5] At a seminar in the end of study of a module's topic, students discuss the most difficult issues of the topic and make reports [3]. The standard of perfection is the best report. The seminar allows to assess a speaker, the assessment can be negative. To reduce the negative influence of poor grades on student's motive, the grades are made by two opponents - "black" one from the group of enemies and "white" one from home group. "White" speaks first; his task is to allocate the positive side of the report, on the base of which to put the highest possible grade. The task of the "black" opponent is to emphasize all defects of the report and to offer an assessment taking into account these shortcomings. A teacher listens to opponents and chooses one of these assessments in his closing remarks. But whatever a teacher's choice would be, the goal is achieved, and positive evaluation, even if it was not received, was heard from other students, some of whom are not interested in it (by the terms of the competition, the winner team is that one that scored most points). So achievement motive has been realized.

Summary

Organization of the process of teaching physics to first-year students providing the creation of conditions of the formation of achievement motive lets increase the level of requirements and complexity of tasks in physics. Moreover, the unwillingness of students to be absorbed in complex tasks is minimizing. Increasing complexity of tasks, in its turn, promotes the higher level of mental reflection and allows to build as quickly as possible skills of independent activity. An important result of the implementation of this approach in training of engineers was reducing discomfort of students with insufficient background in physics and mathematics, caused by psychological and emotional stress, which lead to realization of helplessness and loss of interest in learning. This approach was implemented in learning process of physics by first-year students of the Far Eastern Federal University (Vladivostok, Russia). The authors developed a method of solving physical problems with first-year students of engineering majors with favorable conditions to form students' achievement motive that will be described in the following article.

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