The Formation of Motivational Sphere for Learning Activity under Conditions of Change of One of Its Leading Components

M. Rodionov, Z. Dedovets

***Abstract*—**This article discusses ways to implement a differentiated approach to developing academic motivation for mathematical studies which relies on defining the primary structural characteristics of motivation. The following characteristics are considered: features of realization of cognitive activity, meaning-making characteristics, level of generalization and consistency of knowledge acquired by personal experience. The assessment of the present level of individual student understanding of each component of academic motivation is the basis for defining the relevant educational strategy for its further development.

***Keywords*—**Learning activity, mathematics, motivation, student.

I. INTRODUCTION

MOST research papers on academic motivation [1], [6], [7], [9], [10] consider it as multi-component and multi-level personal education. Motivation depends on improving existing relations between its components, the creation of new relationships and also changes in attitude towards studies. Because this structure is deeply personal in nature, it is necessary to use a differentiated approach to create and enhance learning motivation, based on defining the dominant pertaining structural characteristics of each individual. The characteristic levels of the formed motivational sphere in learning activity are used as a basis for such definitions [7], [9], [11] considered as stages of its ontogenic genesis.

These stages are traditionally separated as follows: general cognitive motivation, learning-cognitive motivation and self-learning motivation. It is known that these stages differ from each other because of, amongst other things, students' attitude towards the studied subjects, the nature of research activity, and the behavioral characteristics of cognitive processes.

In particular, the characteristic of attitude towards the studied subject changes, during stage transition, from being amorphous and non-differentiated to being positive and responsible. The characteristics of research activity become less reflexive and more reflective.

The features of cognitive activity also change - from an empirical cognitive approach, which is subject-dependent and largely random in nature, to a conscious theoretical cognitive approach. Such an approach allows each person to select consciously and independently the studied subject to correspond to their preferences. It also allows planning the most optimal direction for future research work.

M. Rodionov is with the Department of Mathematics and Computer Science Teaching, Penza State University, Penza, Russia (e-mail: do7tor@gmail.com).

Z. Dedovets is with the Department of School of Education, The University of West Indies, Trinidad and Tobago (e-mail: Zhanna.Dedovets@sta.uwi.edu or opolonzh@rambler.ru).

II. MOTIVATION

A. General Cognitive Motivation

The student's attitude towards the subject is amorphous and unfocussed. The student displays unstable feelings towards subject novelty as well as curiosity and casual interest. There is partial recognition and acceptance of the goals set by the teacher:

1) The research activity is reflexive in nature. The task is received from the outside and not internalized. The student accepts it in a non-critical manner as a set exercise. The solution can be a replication of standard actions and methods, quite often unrelated to the task conditions, or be a random search for a solution by trial and error. The student is only interested in solution results and does not carry out a systematic search for common approaches.
2) Features of cognitive processes. Usually the student will superficially recognize distinctive terms and attributes regardless of how essential they are. The student's adoption of educational material is random in nature and depends on the way the information is displayed as well as emotional influences and other various non essential details. The result of this interaction between components of a motivational sphere at this stage is a selection of a concrete strategy for solving the given task based on its categorization.

B. Learning-Cognitive Motivation

1) The student's attitude towards the subject is positive. Tasks given by the teacher are well accepted. Teacher and student define goals together. The student takes independent initiatives and actions.
2) Research activity is partially from "within". The student analyses the task more comprehensively. Actions may vary based on changes in task conditions. The student directs activity to finding a common approach for solving the given task displays attempts to evaluate the effectiveness of learning activities and also demonstrates self-control and self-evaluation.
3) The empirical cognitive approach is largely replaced by a theoretical approach linked to the subject's generalized

context. General patterns are beginning to take a significant place in individual's experience. Such patterns appear as "carriers of meaning" for learning material. A formal result of learning activity during the second stage is a viable research strategy selection based on a variety of known approaches and heuristic schemes.

C.Motivation in Self Education

1) The student's attitude towards the studied subject is positive and responsible. The student displays a set of skills to establish goals and overcome challenges while achieving such goals.
2) The research activity is productive. The student displays a purposeful development of common approaches, seeks non-standard solutions, flexible actions and learning skills, and an independent ability to adopt such approaches in new areas of the studied subject.
3) Features of cognitive processes. A theoretical cognitive approach is predominant. The student demonstrates an ability to independently perform consistent patterns of modeling and analyze functional roles, and to conceptualize characteristics of personal cognitive activities. The student actively adopts skills to objectively generate new information. At this stage, the student can independently and consciously select "the subject" in ways which reflect effective personal learning preferences and plans regarding the research activities.

Table I reflects the content of all stages (A, B, C) in categorized form.

TABLE I
THREE LEVELS OF MOTIVATION

Motivational levels	Activity characteristics related to motive realization	Cognitive processes features	Learning activity type	Individual experience content	Emotional condition	External result
General cognitive motivation	Situational activity directed towards realization of external motive	Visual-image and verbal-logical thinking components are differentiated.	Reproductive execution of individual learning actions is based on known templates or teacher's instructions. Research is based on trial and error approach.	Segregated terms attributes are recognized. Set of predefined strategies to solve the given tasks is present.	Positive, unstable, short-term, subject dependent	The strategy to solve learning cognitive tasks is defined.
Learning-cognitive motivation	Active actions are directed towards motive realization in terms of specifically organized activity.	Simple interactions forms between different components of thinking	Productive conversion of non-standard task and independent strategy selection to solve the given task are present. Student is concentrated on searching for common approaches bases on personal intuition	Terms and common approaches in activity are present.	Positive, stable, long term, subject dependent	Strategy to achieve the set goal is defined. Range of tasks assignment to achieve the defined goal is produced.
Motivation in self-education	Active actions directed towards motive realization in terms of specifically organized activity as well as outside of such activity.	The use of patterns corresponding to high level of abstractions	Productive independent activity for setting goals is present. The search for non-standard approaches for solving the given tasks, acquisition of basic learning actions and skills and their conversion into know-hows is present. Task oriented development of common approaches is present	Self-education methods are present.	Positive, stable, long-term, subject independent.	Motive plan realization is established. Selection of intermediary goals is present.

III.TYPOLOGY OF CONDITIONS FOR STUDENT LEARNING MOTIVATION

Given the need for a differentiated approach to the formation of learning motivation, it is suitable to adopt as an analytical unit of this phenomenon the following three elements [9]:

C –features of cognitive activity (cognitive component);
T –characteristics of "meaning-making" (intentional component);
S –level of generalization and systemic knowledge, which are present in individual experience (competency component).

Based on a simple analysis of possible ways to combine all three levels of these elements, there are select 15 possible variations of *CTS*.

A graphical interpretation of possible conditions demonstrates two main stages in the advancement of motivational space (which correlate to mid and high-school students) (see Fig. 1). The picture depicts possible transitions from one condition to another, based on specifically organized learning activity.

It is evident that we must take into consideration the present position regarding each student's motivational readiness to select the appropriate way to improve the student's level of motivation.

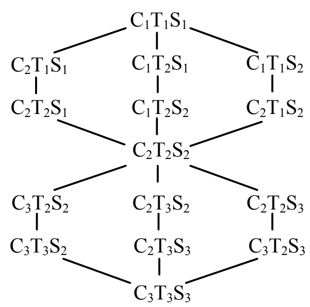

Fig. 1 Motivation space

A.Students with Insufficient Level of Intentional Component Development

A student who has not developed a sufficient level of intentional component in comparison with other two components (schemes: $C_2T_1S_2$ is a first transition and $C_3T_2S_3$ is a second transition) can be characterized as having a substantial intellectual potential which is enhanced by an ability to absorb and understand an educational factual material "on the hoof". However, an absence of a deeper interest towards mathematical studies does not permit advancement of abilities during classroom activities on this subject. The process of goal formation is mainly defined by external factors such as teacher's requests, craving for recognition among classmates, avoidance of punishment and so on. Any given task generates only occasional interest, for example where there is novelty or entertainment value and it is easy to solve.

Such a student seeks the most conventional solution which does not involve overcoming additional intellectual challenges. In cases where such students meet non-trivial situations, they feel uncomfortable and try to apply already acquired skills and knowledge. The intellectual approach is basic, lightweight, intuitive and largely predictable-and does not display the ability to perform cognitive variation of actions based on a predefined plan.

B.Students with Insufficient Competency Component Level Development

If a student's motivational system correlates to combination: $C_2T_2S_1$ at the first stage and $C_3T_3S_2$ at the second stage, then there is a high original cognitive activity in conjunction with a low level of knowledge of classroom material, with individual experiences being unrelated to school mathematical course material.

There is a relatively high level of learning motivation among students in this group together with sufficient intellectual potential-showing the presence of such qualities as a desire to acquire new knowledge and facts, and a determination to overcome challenges. At the same time, significant gaps in knowledge, lack of general and special methods and skills in learning activities quite often lead to inconsistent performance when solving given tasks.

Such a student tends to display impulse guesses based on random "fishing" of individual pieces of knowledge from a general pool of knowledge when solving complex tasks. As a rule, the heuristic search is sporadic and often undisciplined.

Such students do not want to carry out standard mathematical activity (because it does not have novelty value) and yet do not possess the ability to organize their own research activity.

C.Students with Insufficient Cognitive Component Level Development

Where a student's motivational sphere is described by systems $C_1T_2S_2$ or $C_2T_3S_3$, there will be poorly integrated cognitive substructures but also, generally, a positive attitude towards study and a sufficiently high competence in theoretical and practical training. Such students do not need additional stimulation from the teacher. They are internally programmed to acquire certain knowledge and methods of action. At the same time, their cognitive process of adopting and absorbing education material is by a "hardwired" link to predominant thinking substructures (topological, metrical, algebraic or projective). This has a negative influence on the realization of research processes.

Such students try to compensate for their weaknesses through a laborious enumeration of all already acquired knowledge to identify and draw parallels between the problem being studied and past related activity and convert the given tasks to the level of a standard exercise.

Whereas students in other categories largely concentrate on success, this type of student is very sensitive to failure. Therefore, while trying to solve non-trivial tasks they quite often feel intimidated, their initial steps are scattered and inefficient, they control each step on the way to a solution, and they sometimes return to prior stages without justification. The student can be stuck at the beginning stages of thinking for a long time, unable to abstract themselves from one or another component of a task system. Special attention is paid to the tasks which have immediate practical value which allows the actualization of previous learning and life experience.

IV.Ways to Build Students Motivation to Learn

Each of the different student types requires different strategies to organize and to regulate students learning activity. There are three main strategies.

A.Development of an Intentional Component for Motivation Learn

Here, the main direction of the formation of a student's system of motivation is the provision of an optimal combination of both situational and also robustly conceptual motivational factors which depict a fully-fledged development of addressing subject content [4], [6], [7], [9].

This means that the study of any given learning material must reflect a specific meaning for the student, connected to past experiences, future expectations and personal subject preferences. During the learning process, the original meaning intertwines with the systems of additional motivational factors in a way which directly connects with content of the studied material.

At the same time, the possibility emerges of directing general mechanisms for goal formation to a specific, mathematical subject oriented content. This is achieved by a staged introduction to a situation where a student must make a choice. At the beginning, this choice is about the methods of subject activity which lead to achieving solutions for given learning tasks and then (at the second stage) the choice between these tasks, which are, essentially, subjective projections of the basic meaning of mathematical activity [9], [6], [13].

Let us consider the following example.

A student can be placed in a situation where a choice must be made through the independent construction of a task. Such work rationally should begin from an analysis of a ready made geometrical drawing which performs a function of a basic visual model of the situation. As such, while for example reviewing triangle configuration and a median of a triangle (see Fig. 2) during classroom activity, it is practical to offer the students the possibility to highlight all possible common patterns related to the triangle median.

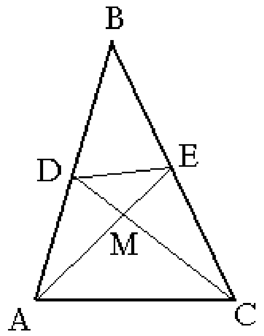

Fig. 2 The triangle ABC

As a result there might be a possibility of the whole range of the following statements:

1) The median of a triangle divides the triangle into triangle and trapezoid,
2) The diagonals of the resulting trapezoid are medians of the original triangle,
3) Each median divides the triangle into two equal triangles.
4) The triangles DMA and EMC are equal,
5) The triangle AMC and quadrangle DBEM are equal and so on.

The process of reviewing problems defined by the students themselves has much better motivational value than an exercise taken from a schoolbook. In addition, the more challenging the given task (within an acceptable level of difficulty) and the selected approach to its resolution, the greater will be the personal significance of this task and approaches to its resolution for the student.

B.Competency Component Development for Motivation to Learn

The main approach for the advancement of an individual student's structure of experience under any given circumstance is to focus the learning process on the creation of common methods of educational activities [3], [4], [6], [9]. The higher the generalization level of adopted methods, the greater the possibility of applying them in new situations. This is also true regarding the process of goal formation during the search process of a student activity. At this stage, student's learning motivation becomes internalized.

The following different learning activity methods are used by a student in acquiring mathematical competence: general educational methods, which are applicable to other disciplines (an example of analogy); general mathematical methods (for example, approaches to work with a task, theorem or a term); special methods (for example, vector method, method of geometrical placements, various methods for solving mathematical equations, inequalities and its systems, computational algorithms and methods) and also particular methods which are used at more intermediate intervals when studying content. The formation of the correct blend of various educational approaches at the highest level of abstraction, and generalization is possible through the realization of unified schema [3], [9], namely:

1) Acquiring basic principles which comprise a coherent methodology when solving exercises within a particular system,
2) The introduction of particular methods with attendant motives for its application,
3) Setting general learning goals and their acceptance by the students,
4) Teacher and students together compiling a basic approach while analyzing one or more suitable mathematical constructions,
5) Practicing methods in set situations and the correction of possible mistakes and shortcomings in application,
6) Transferring the adopted approach to new content,
7) Constructing new approaches and methods based on transformation and abstraction from the original approach (for example, application of interval method for solving trigonometric inequalities and its system suggests the significant transformation the original base of this method, such as transition from intervals to circular-arcs).

The designated sequence is combined into loops, where each one of such loops reflects the next level of abstraction and highlights the growing level of student self-motivation.

C.Cognitive Component Development in Motivation to Learn

The advancement of a motivational sphere in the students of this type is performed through the consistent creation of opportunities to form all cognitive thinking substructures and their further integration and referencing in the research activity [2], [5], [7], [8]. Such referencing helps the merging of separate methods to solve exercises into general activity approaches. This allows expansion of the range of selected directions for research thinking and at the same time increases the level of success during its realization.

The initial working stage in the identified direction is the diagnosis of a student's thinking structure based on execution of special exercises [2], [7], [9].

The predominant substructure of thinking thus revealed determines the teacher's choice for methods and presentation forms of learning subject content. At the same time, the same exercise can be solved differently by different students, each of whom might apply a different approach familiar to them, and as a result such a method requires minimal efforts in its application.

At the next stage, the teacher must constantly pay attention to the possibility of translation of one or another term or thesis into alternative "language" (for example, transforming natural human language into algebraic terms while formalizing the conditions of the given task). This "translation" is subjectively evaluated as a method of creative thinking. The regular application of such methods provides an intellectual basis for the creation of general mathematical approaches and methods (for example, the graphing methods for solving equations and inequalities, method of geometric transformations, vectors and coordinates). It is known that such methods include direct two way transformations from the language of algebra to the language of geometry. At the same time, the application of these methods creates a virtuous spiral of success [12], [13], [14].

V.CONCLUSION

Therefore the comprehensive tracking of development levels for one or more motivational components to learning allows the teacher to adequately assess and apply the main educational strategy. Crucially, such an approach permits and requires the flexible adaptation of educational programmes to each student's abilities and the dynamics of individual progress through cooperative construction between teacher and student which focuses on the main components of learning activities outside of the predefined subject and programme areas. At the same time, the teacher must take into account the preferences of each student towards educational content, forms of educational material, characteristics of cognitive activity and level of student's creative initiatives.

One of most important constant factors in all three highlighted phases is the students' interactions and cooperative efforts while applying heuristic methods in research activities. This is because such interactions and efforts integrate and embed the original undifferentiated attitude towards studied material into a value conscious and emotional sense in the student's personal space [1], [4], [6], [7], [9] if needed, appear before the acknowledgment.

REFERENCES

[1] V. K. Vilyunas, *Psychological mechanisms of human motivation*. Moscow, MSU: University Press, 1990.
[2] I. S. Yakimanskaya, *Age and individual characteristics of creative thinking of students, monograph*. Moscow, M: Pedagogy, 1989.
[3] O. B. Episheva, V.I. Krupich, *Teach students to learn mathematics*. Teacher's Book. Moscow, M: Education, 1990.
[4] I.A. Simnya, Educational psychology. Moscow, M: Logos, 2004.
[5] I. J. Kaplunovich, T. A. Petukhov *Five substructures of mathematical thinking: how to identify and use in teaching*. Moscow, M: Math in school. 1998.
[6] V. G. Leontiev, *Psychological mechanisms of motivation of educational activity*. Novosibirsk, NSPI, 1987.
[7] A. K. Markova, T. Mathis, A. B. Orlov, *Formation of learning motivation*. Moscow, M: Education, 1990.
[8] J. Piaget, *The structure and mathematical operator structures of thinking.* Teaching Mathematics. Moscow, M: Uchpedgiz, 1960.
[9] M. A. Rodionov, *Motivation in mathematical studies. From theoretical thinking to practical realization,* Germany, Saarbrücken: Palmarium Academic Publishing.
[10] H. Hekhauzen, *Motivation and action*. M: Pedagogy, 1986
[11] D. Ziegler, *Theories of Personality.* St. Petersburg, Peter Press, 1997.
[12] C. Plumpton, *Generalization and Structure* Process of learning mathematics Ed. By L. R. Chapman. Oxford. Pergamon Press, 1972, pp.87–121.
[13] M. Rodionov, S. Velmisova, *Development of the theme in the process of geometrical problems solution* Romai Educational Journal. Vol. 4 (2009), pp.13-18.
[14] R. R. Skemp, *Schematic Learning*, Process of learning mathematics Ed. by L. R. Chapman. Oxford. Pergamon Press, 1972, pp.183–194.