Visual Modeling of Integrated Constructs in Mathematics As the Base of Future Teacher Creativity

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Abstract

Visual modeling concept of integrated constructs (essence) of mathematical objects in teacher training of humanistic area is presented as technology of education in problem solving. The main goal of innovative approach is student's activity in mathematics on generating of concrete essence manifestations on concepts, methods, theorems, algorithms, procedures and so on. Such student's activity should be:

- Success in an area of actual interests and person's experience and reached by perception;
- Have high level of variability in visual modeling;
- Success in domain of reflection process stimulation.

Similar creative behavior of persons is typical for actors, dancing, and figure skating and so on.
Now we show that such technology will be fruitful for teacher training in mathematics for humanistic specialties.

Introduction

Actualization of productive links between mathematics and social sciences as subjects taught at high school, being the basis for vocational education of students are responsible for powerful humanitarian potential, determining processes of socialization and adaptation to the changing phenomena of world around as well as stimulating development of intellectual forces and personal qualities of students. Social sciences (foreign languages, for example) always aims at solving its problems with the help of wide base of verbal information, social interactions and practical , experimental realization of theoretical constructions by using personal experience; mathematics wants to achieve logic completeness, create mathematical knowledge based on models and integrity, which serve social processes and phenomena. Contents of mathematical education of students on humanitarian faculties () consists on set theory, discrete mathematics, mathematical logics and probability theory, calculus and statistics. Students have some difficulties in learning of mathematics, do not see the real links between mathematics and special subjects, feel himself weak ability to understanding of mathematical ideas. Indeed we remark the whole cohort of problems of teaching mathematics for students on humanitarian faculties: -Weak motivation to learning of mathematics; - Some break between person's lines of experience to self-realization and aims of mathematical education; - Thinking, concerning with verbal and visual components, and weak level of mathematical generalizations; - Tendency to concrete activity with mathematical objects but weak perception of theoretical constructs.

Influence of social sciences (humanities) and mathematics on formation of substructures of a person will be especially powerful, if the process of their teaching and learning (as well as selection of the appropriate contents) is as much interconnected as possible. But it's worth mentioning that impact of social sciences on mathematics and mathematics on social science is not proportional and has certain particularities in essence and forms of presentation. Mathematics, being objectively a highly formalized science demanding a high level of abstraction and derivation from realities of the actual world, requires activization of concretizational, motivational and activity-modeling processes during its learning. It defines the following basic components of influence on the humanitarian contents on learning of mathematics with developing effect: - *Motivational* (determining personal meaning of activity in the direction of the "purpose – result" vector). For example, occurrence of motivations, stimulated by the humanitarian contents, can be manifested in the following criteria: integrity (presence of anticipation for manifestation of cognitive experience; anticipation can take shape both in reproductive as well as in productive learning activity; thus, in the first case, they can take shape of humanitarian problems, phenomena, processes resulting in motivated introduction of mathematical concepts, procedures and theorems; in the second case it can take shape, for example, of quasi-research activity of students in small groups aimed at solving of humanitarian problems by means of mathematical instruments and modeling. Another criteria are: achievements (creation of the social situations problem, which stimulate coming to life of new mathematical information); background (creation of conditions for directed perception by activization of mental activity; - *Self-determination* (creation of the situational dominant of a social position choice of the pupils while solving social- humanitarian problems with maximal use of mathematical resources and modeling).

In this situation we should define innovative methods, forms, resources and technologies of teaching mathematics then research activity of students are fixed on the background of humanities and mathematics integration. Students must show in research activity with mathematical knowledge such attributes of scientific thinking as insight and nonlinear thinking, visual modeling and anticipation, founding, reflection and mental efforts in context of social interactions.

Background

The basic conception of our paper is an understanding of mathematics for students on humanitarian faculties by

using the idea of creation and decision of mathematical tasks by students themselves on the base of teacher's pattern (visual modeling) and student's creativity and personal experience. Exactly, research activity of students is personal activity including in process of new creation (also, personally modern) and having in-system and out-system shift of knowledge and skills in new situation, changing of conditions and methods of actions (as internal or external) during the problem solving. Such approach will be promote the person's motivation and creativity grow, activity and thinking of visual modeling, founding of person's experience as sequence of crossing from concrete forms of experience to model ideal of process or phenomenon.

Motivation. So we base on detailed structure of student's interests components, which consists from three area of characteristics: A – motivation of results achievement, R – motivation of self-realization, E – motivation of thinking efforts. Based on this position we define the *interests of students (I)* as vector (oriented) psychological category:

$$\vec{I} = \vec{A} + \vec{R} + \vec{E}$$

All of these characteristics should be actualized by special pedagogical instruments, actions, resources according to educational aims using student's creativity and experience developing.

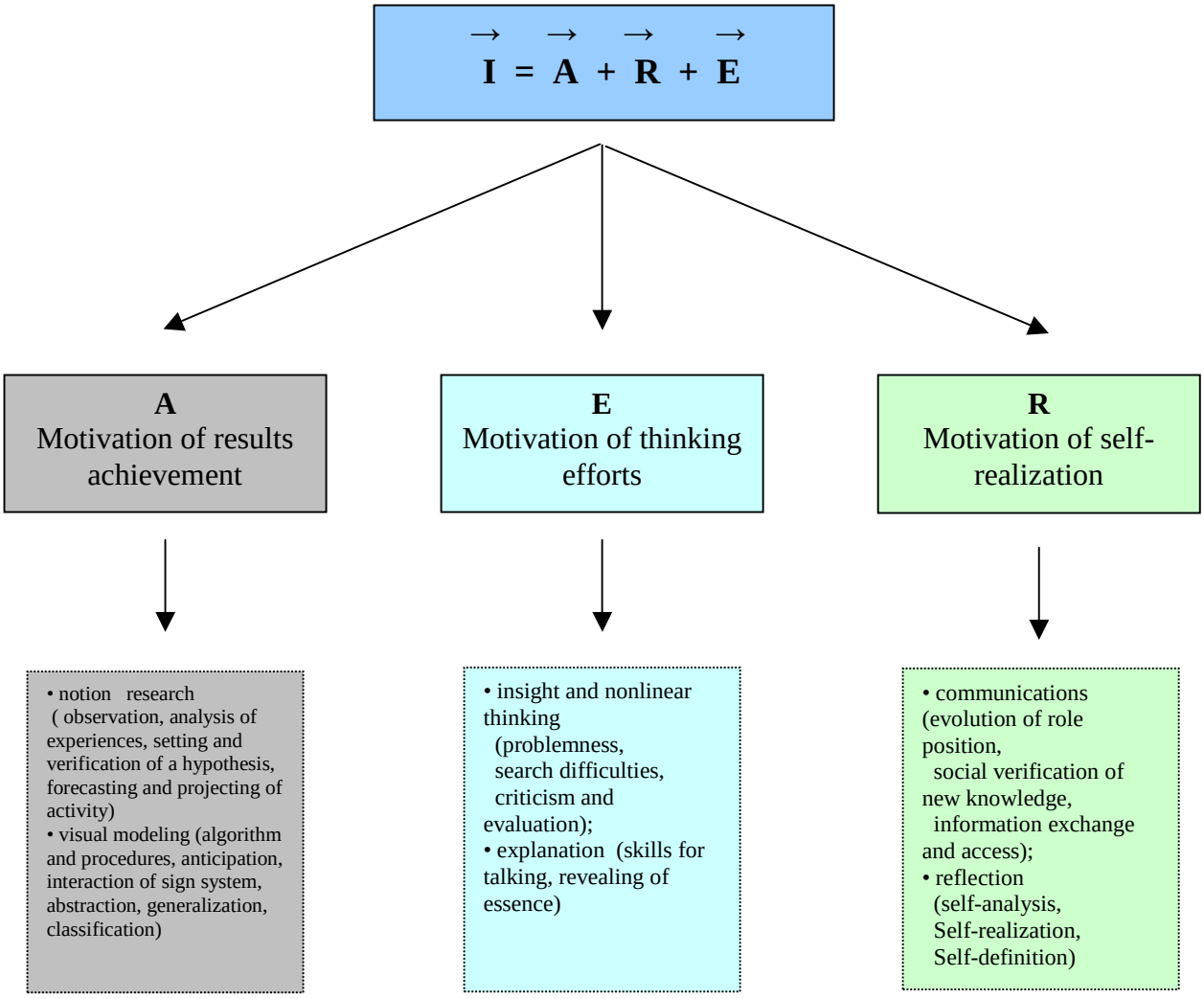
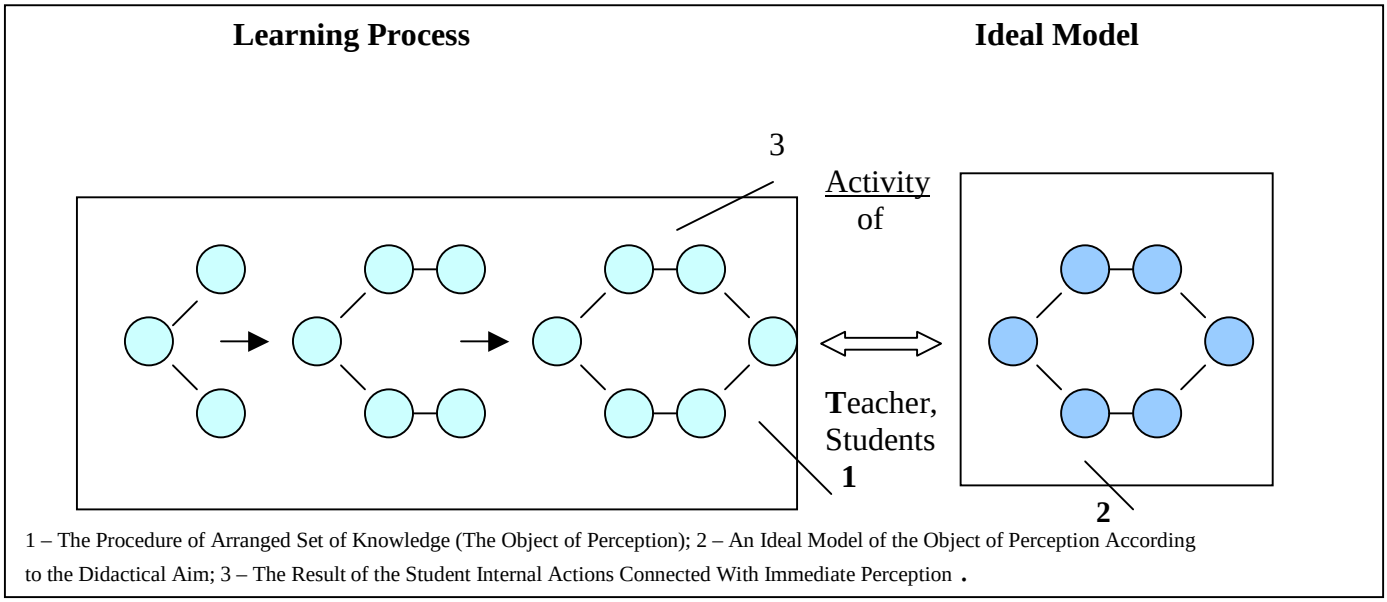


Fig.1. Characteristics of Components of Student's Interests

Visual Modeling. The pedagogical *technology of visual-modeling learning* of humanities and mathematics plays a fundamental role in the proposed didactic system of humanities and mathematics

integration of knowledge and actions. This technology makes it possible to achieve stochastically guaranteed result of teaching of various qualitative levels of learned material as well as integrity of representation of the basic humanities, information and mathematical structures.

Visual modeling methods of learning present: -"a priori" modeling the essential links of the object of perception; - a process of forming an adequate category of ultimate purpose of the learners' internal actions during the process of immediate perception; - all teachers' managing actions, modeling of separate pieces of knowledge or an arranged set of knowledge for stabilizing the learners' immediate perception.



1 – The Procedure of Arranged Set of Knowledge (The Object of Perception); 2 – An Ideal Model of the Object of Perception According to the Didactical Aim; 3 – The Result of the Student Internal Actions Connected With Immediate Perception .

Fig.2. Visual Modeling of Mathematical Object (Procedure)

The process of perception of the given visual model presupposes all key qualities of the science, information or mathematical object. It is especially important when information is of great volume (or contains a mix of mathematical (physical) and informatics knowledge or actions). It is necessary to keep in mind such actions when separate pieces of knowledge or an arranged set of knowledge are given. We can deal with proving theorems, solving problems, constructing the algorithm, modeling the real phenomena, learning some parts of scientific and mathematics analysis in its various logical correlations, with a single lesson presentation, a lecture etc.

As has already been mentioned, according to A.N. Leontiev (Russian psychologist), when visual methods of learning and teaching are used, it is necessary to proceed from the psychological role, which they (methods of learning or teaching) play in the perception of new material. He chooses two functions of visual methods of learning or teaching:

- the first is aimed at extending the sensible experience;
- the second is aimed at developing the essence of the processes or phenomena under study.

Founding. We based our assumptions on the fact that concordance or optimisation of interaction of fundamental and professional components in the general structure of pedagogical education is a key moment in training of a student at a teachers' training college. It is obvious, that fundamentalisation of mathematical knowledge without considering it as a pedagogical aim will hinder professional training of a teacher. At the same time it is beyond doubt that a teacher is not in able to fulfil his professional functions successfully without a certain volume, structure and quality of fundamental knowledge. Thus, in a nutshell, the problem is to find means, forms and ways to bring to concordance fundamental and professional lines in the process of pedagogical education.

In order to realise the principle of founding it is necessary to define the basis for helical diagram of the basic knowledge, skills and experience of mathematical training of students at teachers' training colleges modelling. If founding of various school subjects is to be carried out layer by layer, then volume, content and structure of mathematical training must undergo considerable changes in respect of practical realisation of theoretical generalisation of school knowledge based on the principle of a "boomerang". If the knowledge is being founded in such a way, the teacher, who possesses knowledge of the subject, together with the student will master methodological side of teaching. The school knowledge will act as a

structure-formation factor, making it possible to select theoretical knowledge from mathematics of a higher level, via which school knowledge has been founded. The layer of founding provides perfection and extension of practical skills, projected by approximate basis of learning activity. In the activity aspect of pedagogical process realisation of foundation principle acquires a helical character, which corresponds to dialectical understanding of a system of knowledge development.

Development of spirals of personal experience via integral constructs of ancestral generalisation and technological comprehension of its specific manifestation render integrity and orientation to the projected didactic system. At the same time construction of such a model absorb in its unique and particular manifestation all main features of theoretical knowledge about foundation process of basic educational elements of mathematics. Creation of system-genetic block of spiral's founding makes it possible to define a stable nucleus of educational information content, which projects elements of approximate basis for educational activity of students. On the other hand, projecting of theoretical generalisation (ancestral concept) onto specific diversity of special case in forms of updated practical applications creates a stable motivational effect in acquiring mathematical knowledge. But even comprehensive, well-timed and modelled spiral of founding will not carry a cognitive and professional component of prospective activity, if methods and elements of educational activity are not shaped in the process of education, which develop its component composition, if structure, particularities of perception and comprehension, stimulation of motivational and emotional sphere of students and definition of mechanisms for checking and correction of spirals of founding are not taken into consideration.

Approaches and methods of educational activity

We try to use methodological ideas of problem solving, visual modeling, founding, activity in small groups, humanizing mathematics education:

- *setting of the productive humanitarian problems with mathematical decision* (actualization of humanities and mathematics knowledge on the basis of integration; participation in discussion and statement of educational tasks; construction of humanities and mathematical model of process or the phenomenon; ability to consolidation (in thinking of the pupil and activity) the initial data for the decision of the problem);
- *educational activity of students by using of model pattern* (quasi-research activity of students aimed on creation and search of new patterns ; search experiment using numerical methods and computing procedures, diagnostics of information dynamics of parameters; monitoring and correctional interaction of obtained results, search of integrative knowledge and prospect of development; skills of visual modeling and estimation of real processes);
- *efficiency of using resources (material, materialized, ideal) for activization of cognitive processes and social interaction* (presence of adequate results in practical activities; joint analysis, information interchange, presentation of results; visual modeling in educational activity; reflection and internal plan of students action).

Conclusions and suggestions

The analysis of these results made us feel confident that the hypothesis concerning the opportunity to increase motivation in learning of mathematics by incorporating into research activity with personal experience and mathematical knowledge is consistent and logical. It can be achieved by means of development of resource lessons and activization of cognitive and creative activity of students.

The conducted research has shown the importance of the chosen topic and has partially confirmed the put forward hypothesis about the significance of the integrated approach to interaction of humanities and mathematics. Research of the innovative approach in visual modeling of humanitarian and mathematical processes, activation of motivational and cognitive processes have promoted positive changes in personal development and successful mastering (learning) of teaching material. Founding of personal experience of students, as basic form of realization of interaction of humanities and mathematics has shown its efficiency and opportunity for further research. It is recommended to develop the *cycles of pattern of developing mathematical models* (integrated constructs) in teaching of mathematics for students on humanitarian faculties of universities and to carry out a detailed analysis and feasibility of the technological innovations.

Bibliography

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