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The Development of Students' Intellectual Tolerance in the Process of Teaching Mathematics at Secondary Level

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I. ABSTRACT

Mathematics is an exact science, it is the embodiment of order and logic. Without it, the development of technology and the knowledge of nature would be impossible. It helps us to understand the world around us, to learn more about its laws. An understanding of mathematics is crucial both for humanity in general and for individual intellectual development. This understanding needs to be seen with reference to the idea of intellectual tolerance within the education process. In learning mathematics, this means finding ways to overcome stereotypical thinking when searching for solutions to mathematical problems. Students with low level intellectual tolerance avoid applying new methods and only use known methods. So the teaching of mathematics should be directed to enabling students to break free from stereotypical conservatism. This can be achieved by using carefully selected strategies and methods-helping students become aware of different perspectives with regard to a studied fact or phenomenon. These strategies, such as the development of the skills to modify activity in changing situations, or to find concise and mathematically beautiful solutions, all enhance of students' development. In this paper, the author discusses the components of thinking within the mathematical activity, and outlines a model of the formation of intellectual tolerance. The author also outlines methodological approaches in secondary school mathematics teaching which are designed to develop this intellectual tolerance.

Keywords: education, the intellectual tolerance, thinking, teaching of mathematics, non-euclidean geometry, teacher, student, secondary school.

II. INTRODUCTION

We know that the creative process in any field of intellectual activity is multifaceted and extremely complex. It requires an almost spiritual combination of intense mental activity and imagination, concentration, considerable volitional determination and the mobilization of existing knowledge and experience. But not all intellectual activity can be called creative. Mental labour can also be mechanical, with repetitive operations, based on algorithms. Creativity is the combined personal and purposeful theoretical and practical activity , which leads to the creation of new previously unknown hypotheses, theories, and methods. Of course, with regard to school based education, with the by definition rare exceptions of prodigies , such novelty is subjective in nature, being evaluated as such only by the particular student.

Thinking, understood as a process, as an activity, is realized in the course of interaction between external factors and the specific, internal conditions of mental activity. Successful outcomes from this thought process are closely connected with the cognitive features such as analysis, synthesis and generalization, contradiction, classification and classification. For students, the development of internalised creative thinking as a general approach is directly related to the formation of methods of thinking.

Mathematics can be considered to be the main source and stimulus for human intellectual development. This has been true both historically for societies in general but also for each individual. Mathematical, especially geometric, activity is the primary type of intellectual activity that a person has to practise almost from birth, locating and manipulating the objects of their surrounding reality. This importance continues. The purposeful process of teaching mathematics creates the greatest opportunity for pupils to generalize, analogize, compare, systematize, classify, contrast. Such methods of thought activity have significant transferability to related scientific fields and to real life activity in general.

2.1 The thinking components of mathematical activity

Let us consider which components of thinking are most inherent in the mathematical activity, representing its deep and essential characteristics. V. Krutetsky intensively studied the development of mathematical abilities of students and identified the structure of that ability [3]. This formation is based not on rote memorizing the information provided by the teacher, but on active participation by the student in the process of its acquisition and an independent searching, which gradually leads to the formation of the ability for self-learning and self-development. In other words, the development of mental activity occurs as a result of the student's transition from actions performed on the instruction of the teacher to independent actions, including the setting of subjectively creative problems and their resolution. This results in the formation of creative intellectual abilities. The presence of these abilities presupposes the individual's ability to solve problems by using methods and finding solutions whose results were not available from past experience, but chosen for the first time with a substantial restructuring of this experience.

Leading components of thinking underlying the mathematical activity include the ability to quickly and broadly generalize mathematical objects, relationships and actions, to convert the thinking process with expanded reasoning (the breadth of thinking) and to speedily and freely vary the methods (flexibility of thinking) [3, 6, 7]. The flexibility of the mind is expressed in the freedom of thinking from the shackles of old ways of solving problems and the ability to quickly change one's actions when the situation changes. The opposite of flexibility is mental inertia, expressed in the tendency default to the habitual course of thought and the difficulty of switching from one system of actions to another, in the persistent repetition of the method used, despite the fact that it leads to an erroneous decision. The breadth of thinking is understood as the ability to form generalized modes of action that have a wide range of transfer and application to particular, atypical cases; the ability to cover the problem as a whole, while not missing any relevant details, to generalize the problem and to expand the scope of application of the results obtained as a result of its resolution. Therefore, the breadth of thinking is often called generalization of thinking.

M. Kholodnaya remodelled these ideas, producing a study of cognitive styles, which can determine unique individual ways of processing information that characterize the specificity of the mindset and features of the intellectual behaviour of any particular person. [4].

One of these styles is tolerance of incongruous and ostensibly unrealistic experience. This cognitive style reveals itself in situations where ambiguity is prevalent. Tolerance of unrealistic experience implies the possibility of perceiving impressions that do not correspond to or even appear initially contradictory to the students' ideas. The meaning of this cognitive style is often interpreted in a broader psychological context and characterises individual ways of organizing intellectual behaviour in conditions when the "normal" reflection of reality is challenged. Intolerance of such experience signify an initially low level of intellectual development, where students close off from cognitive contact with any contradictions in the world around them, to the extent that the individual's picture of the world becomes unresponsive to the changing conditions of reality. On the contrary, intellectually tolerant persons (as defined above) perceive the world as it really is. Their cognitive impressions are constructed in accordance with the objective characteristics of what is happening and their cognitive images are open to any, and unusual information (open cognitive position).

Tolerant thinking is closely related to the ability to overcome stereotypes. Stereotypes are a convenient way of classifying material, a way to make the world around us more accessible to understanding. The number and quality of stereotypes depend on personal experience; they are manifested in the interaction of students with differences in gender, age, nationality, religion, cultural level. We can say that stereotypes make it easier for people to perceive the stable structures of the surrounding world. But in the dynamic processes of creativity (and arguably elsewhere), and in particular in solving mathematical problems of search character, stereotypes become an obstacle: they enslave thinking, create tendentiousness, conservatism in solving new problems, forcing the mind it to follow the well-trodden paths that do not lead to the correct solutions . The routine of habitual thinking can mean that phenomena that run counter to established personal beliefs about reality are simply ignored. The pupil "closes": ceases to be receptive to the unexpected and loses the ability to be creative. Clearly, it is important to find practical approaches to overcome this, and develop reative qualities of thinking and tolerance. The basis for this work in the teaching of mathematics is to use scientific methods such as analogies, comparisons, generalizations, contrasts, systematization and classifications –all involving students in research activities, promoting the emergence of new associations, and thereby developing their creative potential.

In any sphere of thought and activity, there are the norms of setting problems and their solutions and in addition the grounds and possibilities of the object as a whole. The integrity and completeness of thinking depends on both-on simultaneously combining the formulation and solution of problems with the possibility of a different vision and object, and a different attitude to that object. Flexible consciousness allows us to understand that the world is changing, and that everyone must change with it - there are no invariably correct ideas, either in science and in life.

Such thinking, as indicated in the numerous psycho-pedagogical and methodical literature, is not reflected in both mass school education and the most popular pedagogical innovations. The actual forms and norms of cultural work in their entirety, including the alignment and movements in the development of any school disciplines, remain closed to students. This requires teachers who themselves have the necessary fullness of thinking, or understand their limitations and seek to overcome it. In addition, an adequate pedagogical connection is necessary, in which both pupils and teachers can interact in exploratory dialogue, since otherwise both will become boring and no thinking will occur [9].

In particular, in order for the students and teachers to have a common sense of tolerance, it is necessary to design assignments so that they naturally attract the student and teacher as something strange, but interesting-for example tasks for building potentially "possible worlds." A possible world can be a physical world, a world of language, an inner world, a world in which one of the properties of space is changed and so on. Immersion in this world allows you to "look from the outside" into the real space that corresponds to one or another paradigm.

An illustrative example in this respect is the discovery of the non-Euclidean geometry by N Lobachevsky, when a conscious change in the perception of axiomatics led to a new perception of the surrounding space. The actualization of such perceptions in school courses on mathematics could serve as a means of developing tolerant thinking among high school students. It is of course necessary that the problems in question are interesting for high school students, whilst ostensibly conflicting with a student's way of thinking in order to encourage the student to really think, and not to work in the usual way.

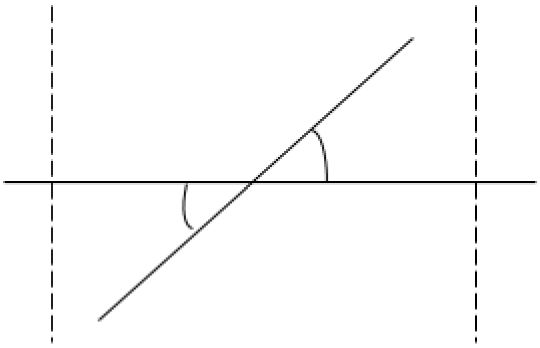

Fig. 1: Intersecting straight lines *m* and *l*

With respect to non-Euclidean geometry, we can give the following example: two straight lines *m* and *l* intersecting at some acute angle α (Fig. 1). Prove that the line m can be projected orthogonally onto the line *l* in the form of some finite line segment.

Indeed, for a given angle α there is a segment $x = SA = SB$ such that through the points *A* and *B* we can draw two straight lines, *n* and *p*, which are parallel to the line *m* in the directions *Bn* and *Ap* respectively, and which are perpendicular to the line *l*. Consequently, the line m is projected onto the line *l* in the form of a segment *AB*.

The unexpectedness of this fact from the point of view of the familiar Euclidean geometry, both causes genuine interest among students and also accustoms them to the potential possibility of the existence of alternative cognitive positions.

2.2 The model of the formation of students' intellectual tolerance

The thinking qualities which ensure the efficiency of the search processes and which comprise the core of the developmental potential of the school mathematics curriculum are presented in the form of the following model. (Fig.2). In its upper part are the basic prerequisites for the development of thinking: the active activity of students, the beginnings of abilities and innate qualities.

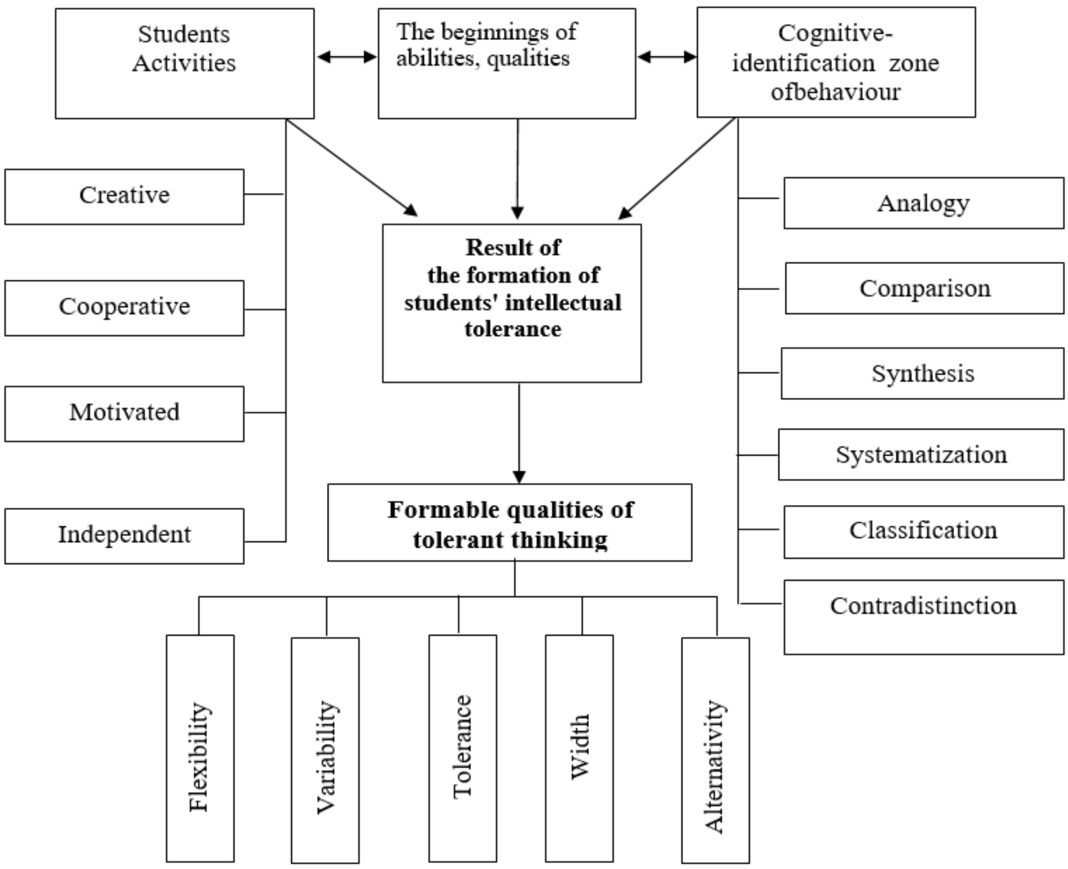

Fig. 2: The model of the formation of students' intellectual tolerance

The development of students' intellectual abilities is ensured both by the character of the joint educational and cognitive activity of all participants in the learning process, which has an independent, internally conditioned, creative character, and also by the experience in the cognitive-identification zone of behaviour of the student when using such thought techniques as analogy, comparison, generalization, systematization, classification and contradiction.

As a result of purposeful learning, thinking acquires the qualities of generality, variability, flexibility, breadth, alternativeness and tolerance. These qualities, as follows from the previous discussion, are manifested, in particular, by the following indicators:

1) The fast and smooth appearance of unusual associative connections; "susceptibility to the problem"; "a sense of novelty," the ability to see an object from a new angle, to discover it in practice (tolerance and alternative thinking).
2) The ability to switch from one habitual action to another; ease of restructuring of knowledge in accordance with the requirements of the task (flexibility and variability of thinking).
3) The ability to see the general in the particular; expand the scope of application of the results obtained as a result of the resolution of problems (width and generalization of thinking).

It should be noted that in contemporary school classroom situations the focus on the formation of flexible and alternative thinking, has unfortunately not yet become sustained. The majority of students have a poorly formed orientation toward alternative thinking-rarely switching to new and unusual ways of doing things. The various methods and methods of mathematical activity they have studied are often represented in their minds in an isolated form without sufficient correlation with each other. This is evidenced by literary data, conversations with teachers, the results of written works and oral polls conducted by us during the ascertaining experiment, as well as personal observations of the progress of teaching in secondary schools.

In our opinion, the reasons for this situation include the wide variation in students' mathematical development of students and a reduction in the volume of teaching hours, which does not allow sufficient time for the needed purposeful work. We believe the answer lies in the introduction of elective courses focussed on developing orientation, the content of which should include: the destruction of established stereotypes of thinking; the development of the ability to vary actions when the situation changes; acquaintance with various ways of solving mathematical problems and identification of various solutions depending on the nature of the activity.

2.3 Principles of formation of students' intellectual tolerance

Mathematics teachers have always had to decide which components should be included in the content of mathematical education, and to what extent they can ensure the formation of a highly developed personality in the greatest degree in accordance with the requirements set out by the school . The solution requires the potentialities of mathematics as a science, including those related to creative mathematical activity, to be identified and implemented in the learning process. Manyeminent methodologists are engaged in the selection of mathematical content and the development of the optimal form of its organization [1, 2,]. The organization of content should enable students to master the methods of scientific knowledge and various forms of activity. In the content of mathematical education, in addition to subject knowledge, sufficient attention must be paid to concepts, theorems, methods of cognition, heuristic techniques and special heuristics.

The source of the formation of content is mathematics, but not as a fixed, abstractly deductive science, but as a developing dynamic system, viewed from philosophical, methodological, historical positions, taking into account the specifics of creative mathematical activity [1]. Thus, the main criterion for selecting mathematical content is that it contains an adequate reflection of the necessary specifics of mathematical activity. It is possible to describe as parameters determining the expediency of selecting the mathematical content for both base and elective courses a number of indicators that together constitute the target component of mathematical education.

2.4 Realization of the purposes of mathematical education

1) Intellectual development of students and the formation of intellectual tolerance. Non-Euclidean geometries are a strikinglyy illustrative example of the fact that only a qualitative intellectual leap in understanding the known scientific facts can lead scientists to the discovery of fundamentally new scientific concepts. Constant practice of this process in elective occupations makes it possible to naturally update a number of qualities of scientific thinking, to reject stereotypes and to develop the ability to look at a well-known fact or pattern from a new, in many ways, unexpected point of view.
2) Use in practice and study related sciences and continuing education. For example, spherical geometry finds significant application in cartography, geodesy, navigation, as well as in physics and astronomy. It is advisable to show such an application in the course of solving applied problems related to various spheres of life activity and production.
3) Formation of the mathematical language as a means of describing and exploring the world around us. In this connection, careful note should be taken of N.I. Lobachevsky's revolutionary ideas about the geometric structure of the surrounding space and the possibility of using the "languages" of various geometries to explain the phenomena of macro- and microworld.
4) Formation of ideas about mathematics as part of the universal culture, understanding of the importance of mathematics for social progress. In this context it is possible, for example, to mention the dramatic history of the discovery of non-Euclidean geometry by N. Lobachevsky and Farkas Bolyai, which was the result of a thousand-year struggle of ideas, far beyond the boundaries of geometrical science itself.

2.5 Accounting for and satisfying students' needs in mathematical education

1) Availability of the study content for all students; compliance with the age and individual characteristics of students. This indicator is ensured by an optimal combination of formal and visual-intuitive means of explaining the material.
2) Internal motivation of the content for all participants of the educational process; activity character of the content presentation. In this context, it should be noted that the logic of disclosing the content of any section under consideration should be understandable to the student, and this content itself should be presented as a chain of educational and cognitive tasks, in the course of solving which there is a constant external motivational support.
3) Continuity of the sections studied and methodological support for their study. From example, it is expedient to introduce the elements of non-Euclidean geometries on the basis of a comparison of their content components with the corresponding elements of the basic geometric course that have already been studied by now.

The targeted selection of the content of elective classes should be supported by the observance of conditions in which this content could fully function. These conditions include the interactive form of education, the maintenance of a favourable psychological climate, the inclusion of students in a systematic and consistent process of performing research tasks, and the optimal combination of various forms and methods of organizing the learning process. These conditions, in turn, are ensured by the observance of a number of principles of instruction, the content of which is both a logical consequence of the general principles of the principles according to mathematical content and also determined by the specificity of the elective course in question: the principles of alternativeness; correlation; motivational conditioning; developing the context of learning; unclosed and adequate control.

The implementation of these principles presupposes special attention to the selection of forms and methods of instruction. Among these particular attention should be given to such types of interaction between the teacher and students, in which schoolchildren are gradually introduced into a situation of free choice of the direction of search work whilst at the same time ensuring purposeful involvement in the analysis of the solution of problems of schemes of logical reasoning and heuristic procedures already partially mastered by high school students in solving problems of the basic course of geometry. Great emphasis should be placed, among other things, on the allocation of basic knowledge from the base course, heuristic conversation, brainstorming, independent work of a prolonged nature and student research.

All the affected constructs are presented in the form of a structural-logical model of the formation of intellectual tolerance in the framework of the elective course "Non-Euclidean geometry", which is depicted in the form Table 1.

Table 1: Structural-logical model for the formation of students' intellectual tolerance

Criteria for intellectual tolerance of students	Mathematical education purposes				Accounting for students' needs and satisfaction of them		
	Development of intellectual thinking	Continuation of education	Mathematical modeling	Development of the world outlook	Availability	Internal motivation	Continuity

Teaching Activities			
Conditions	Perception of the student as a subject of active cognitive activity	Creating favorable psychological climate	Inclusion of students in a systematic and consistent process of performing creative tasks

Principles of schooling	Alternatives	Correlations	Adequate control	Unclosed	Motivational conditionality	Developing context

Methods of forming tolerance in the educational process	Methods of knowledge formation	Heuristic conversation	Independent work of the prolonged nature	Lecture	Seminars	Discussions	Brainstorm	Research projects	Mathematical compositions
Learning Activities									

Result of the formation of students' intellectual tolerance	Expansion of the cognitive-identification zona of behaviour	Development of search skills	Development of interest to learn mathematics

We will reveal in more detail the methodological principles underlying the constructed model.

2.6 Principle of alternativeness

This principle consists in the need to create in the learning process the possibility of alternative consideration and subsequent comparison of different, often contradictory, approaches to resolving emerging problems. This actualises the desire and ability of a student to look at the situation "from the outside", to move into another "system of mental coordinates". The presence of this ability, in turn, allows the student who does not have a ready solution to a particular problem situation to evaluate from presented options, to comprehend the possible consequences of adopting one of them and to choose one that quickly, with the least cost, will lead to a resolution of the apparent cognitive conflict. For example, in the content of the elective course "Non-Euclidean Geometry," the possibility of alternative consideration of geometric facts and regularities is inherent, since most geometric definitions and theorems are formulated differently within different geometries, which accordingly leads to a whole spectrum of possible directions in the development of geometry. The task of the teacher in this context is to explicitly highlight these alternatives and to outline, with the students, possible prospects for their implementation.

2.7 The principle of correlation of mathematical content

This principle is closely connected with the previous one and with reference to the developed elective course it means ensuring an inseparable connection between the knowledge received by the students at the previous stages of the mathematical material study (Euclidean geometry) and the inclusion of previously unknown new elements (Non-Euclidean geometry).

This point can be clearly seen in the selection of the topics: "Geometry of a triangle on the plane of Euclid and Lobachevsky" and "Geometry of a quadrangle on the plane of Euclid and Lobachevsky“ within an elective course on Non-Euclidean Geometry. The teacher should work with the students to update the relevant information of Euclidean geometry and try by analogy to outline the reasoning process, taking into account the fundamental differences in the initial assumptions.

2.8 The principle of unclosed

This principle consists in a constant orientation toward the approach to the object of study as essentially unclosed, allowing expansion and replenishment by involving certain external relations in the analysis, both within the existing educational continuum and outside this framework. Observance of this principle presupposes the provision in the learning process of the possibility for the students to implement certain generalizations that "emerge" beyond the "limits" of the topic, section or course, and allow "distant" prospects for the development of the relevant material to be shown.

For example, Bernhard Riemann produced a profound generalization of the concept of space, developing the geometry of Riemannian spaces, which is an analogue of the internal geometry of the surface. At the same time, Lobachevsky's geometry began to be represented only as a concrete "representative" of the geometry of Riemannian spaces. Obviously, the study of the theory of Riemannian spaces and its generalizations is hardly advisable within the framework of school elective courses. Nevertheless, the mention of the very possibility of such generalizations is of great importance in the motivational and philosophical plan, and also plays an important role in the formation of intellectual tolerance.

2.9 The principle of the developing context

This principle presupposes the priority of forms of teaching in which the methods of solving problems are discovered by the students themselves in the course of joint and individual search activity. The successful application of these methods enables students to perceive them as their own "intellectual wealth", and the very search for and acquisition of such intellectual values becomes an internalised individual need. The basis for this work is the use in teaching of such methods of scientific knowledge as analogy, comparison, generalization, contradistinction, classification and classification, which brings students to practise heuristic activity, thus promoting the emergence of new associations, forming a thinking that is characterized by the qualities of flexibility, breadth and tolerance.

The material of the elective course "Non-Euclidean geometry", as already mentioned above, provides ample opportunities for the formation of intellectual tolerance. In particular, the solution of problems of non-Euclidean geometries introduces an additional element of creativity into search strategies, where the student constantly has to update understanding and perception of all possible associative connections. For example, if we consider in the framework of Euclidean geometry a configuration in which a parabola appears, then in the analogous situation within the framework of Lobachevskyian geometry the category of "parabola" itself has ambiguous meaning (there may be five types) and, accordingly, the composition and structure of the student's intellectual activity is substantially enriched, including new heuristic techniques and procedures.

2.10 Principle of motivational conditionality

The implementation of this principle presupposes the correlation and further integration of situational and content-semantic motivational factors "embedded" in the mathematical content in question. The mastering of a particular fragment of this content should initially reflect a semantic background which has a personal significance for the student whilst also implying the need to comprehend as much as possible the "semantic palette "of the assimilated system of geometric concepts, images and modes of action. In this case, the cognitive activity itself acquires for its subject a "full palette motivational colouring", realizing itself as a self-stimulating chain of activity acts, in which the result of each previous action is the immediate motive and stimulus of the subsequent.

The realization of this principle in the organization of the elective course "Non-Euclidean geometry" is manifested, in particular, in the fact that in most cases the presentation of sections of this course begins with a historical digression, which constitutes a kind of motivational "phenomenon". Theoretical material is presented in the form of a sequence of problems arising from each other with a wide use of different models and a constant appeal to the obvious prerequisites for considering each given situation. This orientation toward a constant transition from external to internal stimuli is a natural way of generating interest in activities related to mathematics.

2.11 The principle of adequate control

The prevailing consensus on the norms of evaluation in the teaching of mathematics requires teachers to mainly focus on the fact that students perform a task of a certain level without special consideration of the qualitative characteristics of the solution process. In our opinion, this orientation distorts the developmental possibilities of learning, since it is known that in the process of heuristic activity it is not so much the fact of accomplishing a task that is important as it is an opportunity to show one's own creative initiative, which also contributes to the formation of intellectual tolerance. From this perspective, it is advisable to consider the possibility of assessing the effectiveness, originality, simplicity and visibility of the solution produced when organizing the current and final diagnostics within the developed elective course. In this case, prerequisites are created for developing high-school students' self-evaluation landmarks, not only in terms of correcting existing gaps in knowledge, but also in terms of identifying immediate prospects for personal growth.

As indicators that determine the criterion, one can specify:

1) Choice of a rational way of solving problems;
2) Assessment of the possibility of comparing different approaches to the solution of a particular problem and the effectiveness of its application;
3) The nature and number of mistakes made by the student in the performance of assignments;
4) The ability to grasp the basic contradiction of the task in a more general context;
5) Possession of self-control techniques.

On the basis of these indicators, the following levels of formation of search skills among students can be identified:

a) Zero level - students do not feel the need to compare the proposed tasks with the previously studied facts and in finding their own solution, do not know the basic methods of solving problems and do not find the connections of different interpretations of the same regularity;
b) Low level - students have some basic methods of solving problems, and if the task requires the application of the method already studied, they perform a sequence of necessary actions, but the ability to exercise self control during the decision making process is clearly inadequate;
c) Average level - students have the majority of the necessary techniques, they can compare the solution of this task with the previously studied facts with a little help from the teacher and can take the initiative in applying the method that is indicated in the task and thus to a certain extent they own methods of self-control;
d) High level - students have all the techniques, can independently compare the proposed tasks with the previously studied facts and can find an alternative way to solve this task without any instructions from the teacher , but are inclined not to ponder on the solution or to try to further unravel the task.

The described ladder of levels was reflected in the organization of experimental work. Specific methodological solutions that contribute to the implementation of the selected principles in the study of the elective course "Non-Euclidean geometry,", which contributes to the formation of intellectual tolerance of schoolchildren will be considered in future publications.

III. CONCLUSION

When organizing work on the development of tolerance of a student's thinking within the framework of basic or elective mathematical courses, it is necessary to take into account not only the content context of such work, but also the individual and age characteristics of school children, their ability to work in a group, and the level of substantive training attained to date. In all cases, inculcating a productive and transformative approach to what could be done requires the problem in question to be interesting and meaningful to the student whilst also be in contradiction with existing patterns of thinking –inducing the student into a research-based approach rather than staying within the boundaries of familiar schemes and concepts.

A significant role in the formation of this quality can be played by elective courses, the content of which should include: the dismantling of established stereotypical thinking; the development of the ability to vary actions when the situation changes; acquaintance with various ways of solving mathematical problems and the identification of various solutions depending on the nature of the activity.

Within the framework of such courses, predominance should be given to those types of interaction between teacher and students which gradually introduce students to a situation of free choice of the direction of the search operation whilst at the same time ensuring that students continue to use knowledge of logical reasoning and heuristic procedures already partially acquired when solving problems within standard mathematical courses. Particular emphasis should be given to interactive conversation, brainstorming, independent work of the prolonged nature and student research projects. These recommended pedagogical formulations have been developed in several of the authors' elective mathematics courses and have been successfully tested in real school practice [8, 10, 11].

REFERENCES

1. V.S. Efimov *Possible worlds or create practice creative thinking,* Moscow, Interpracs, 1994. p. 124.
2. G. Dorofeev. Principles and standards for school mathematics. *Mathematics in school.* 1990, 6. pp. 2 - 5.
3. V. Krygovskaya. The development of student mathematical activity and the role of tasks in this development. *Mathematics in school.*– 1966, 6. pp. 19-30. 74
4. M.A. Kholodnaja, *Cognitive styles: About the nature of the individual mind,*- 2nd ed., St. Petersburg, 2004.
5. V.A. Krutetskiy, *Psychology mathematical aptitudes*. Moscow, Education, 1968, p. 431.
6. F. Perls, R. Hefferime, P. Goodman, *Gestalt Therapy. Excitement and Growth in the Human Personality,* New York, 1951.
7. M. Rodionov *Les critères de sélection du contenu des cours électifs de mathématiques.* Des jeux a la creativite. Méthodes d'éducation active: Actes du Colloque organize par la FIDJIP (Fédération Internationale du Systéme JIP), l'EUROTALENT (ONG dote du statut consultative auprés du Conseil de l'Europe). Sables d'Olonnes, France, Juillet 2007, Boulogne: Editions du JIPTO, 2007, pp. 161–163.
8. M. Rodionov, E. Marina, *Developing version thinking through drawing problems*, Pensa, 2006.
9. M. Rodionov M, N. Titova, Creation of "imaginary worlds" in facultative classes in geometry. Proceedings of higher educational institutions. Volga region. Social Sciences. 2007, (2). pp. 51-54.
10. M. Rodionov, S. Velmisova *Construction of Mathematical Problems by Students Themselves*. American Institute of Physics (Melville, NY 11747 USA). AIP Conf. Proc. -- Issue Date: October 30, 2008, Volume 1067. pp. 221–228.
11. M. Rodionov, Z. Dedovets. *The Forming of Students' Intellectual Tolerance: Theoretical Study and Implementation*. International Journal for Cross-Disciplinary Subjects in Education. 2014, (IJCDSE) Special Issue Volume 4, Issue 1, London., pp .775- 781.

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