OPEN ACCESS
EURASIA Journal of Mathematics Science and Technology Education
ISSN: 1305-8223 (online) 1305-8215 (print)
2017 13(6):1865-1879
DOI 10.12973/eurasia.2017.01205a

Development of Classification Thinking in Future Teachers: Technologies of Reflective Discussion

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Received 17 November 2016 ▪ Revised 27 January 2017 ▪ Accepted 19 March 2017

ABSTRACT
The main objective of the research is to create and approbate a new way of reflection formation in future teachers, which would increase the level of classifying thinking to the theoretical one. The "Formation of equivalence groups" technique was modified to conduct the experiment. It was carried out both individually and in collaborative discussions in pairs which involved justification. This made it possible to reveal the degree of the reflection conformity to the norms of scientific thinking in solving classification problems, the main obstacles to the application of these norms and ways to overcome them. Results. As a result the ways of reflection were identified. The experiment resulted in the identification of two ways of substantiating solutions to classification tasks and processes of reflection: reflexive and pseudo-reflexive. The typology of pseudo-reflexive assessments is presented. Evaluation of an intuitively correct solution to a task anticipates a cogent justification of the reflexive process. Underdeveloped reflexive processes can limit the capacity of adults for scientific classification thinking. Existing methods of logic classes study at a higher school context do not provide well-developed scientific theoretical knowledge. Existing methods do not provide its scientific-theoretical level. Reflexive processes corresponding to this type of thinking are to be developed in a classification logic norms study. A wider use of specific sign means will provide an effective differentiation of reflexive and pseudo-reflexive forms. The development and enhancement of reflexive processes in relation to the assessment of educational outcomes can be undertaken with the help of formalized tools. Presented in the article technology of pseudo reflexive forms diagnostics and technology of reflection initiation based on the logic of classes promotes the rise of classification thinking to the theoretical level. The proposed type of tasks is not connected with the content of a certain scientific discipline and can be applied at different levels of education.

Keywords: thinking; classification task; metacognitive process; reflection; reflexive and pseudo-reflexive forms; education; future teachers

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State of the literature

- The transfer from the predominance of the scientific and subject organization of academic disciplines to the creation of integrative courses is an important trend in the practice of education. At the same time, the substantive grounds for such integration remain insufficiently developed.
- Advanced classification thinking one of the meta-subject competencies that can be the basis for developing such integrative technologies. There are various methods of teaching individual operations of classification thinking, however, the methods for the formation of its higher levels are almost not represented in the scientific literature.
- In the methodological literature for higher and secondary schools there is no description of technologies where the study of formal and mathematical logic is associated with the practice of diagnosing the state of classification thinking and its increase to the theoretical level.

Contribution of this paper to the literature

- The authors propose the technology aimed at the formation of a higher (scientific and theoretical) level of classification thinking. The mechanism is the systematic use of reflection based on the logic of classes, and the identification of inadequate forms of pseudoreflection.
- The authors developed the structure of tasks that require evaluation and improvement of logical operations in classification thinking. The procedure includes individual and joint stages of work, criteria for diagnostic evaluation of the forms of reflection.
- The developed tasks and procedure are applicable to students of any age familiar with the baseline information on the logic of classes and can be used in higher, secondary, and primary school. The content of tasks is not connected with a specific subject and can be implemented on a variety of materials: the terminology of mathematics and other natural and human sciences, technology, as well as the materials of everyday life.

INTRODUCTION

The study of reflection can be regarded as being important in the scientific analysis of education. Reflection and reflexivity are usually considered in relation to metacognitive processes in psychology (Flavell, 1976). As with other meta-cognitions, reflection is not directed to subjects in the external world, but rather to the processes and ways of cognition (Veenman, 2012); reflection can be regarded as being actualized when difficulties emerge in the course of identifying solutions. The structures of meta-cognitive experience provide involuntary regulation of thinking through control of information and resources processing, and applied strategies assessment (Kholodnaya, 2001).

The roles and functions of reflection have been studied with regard to the development of the intellect and abilities (Zampieri & Schelini, 2013)and research thinking (Künsting, Kempf & Wirth, 2013); and neuropsychological mechanisms (Ahmetzyanova, 2015; Han, Bi & Ybarra, 2016). The key role of reflection in mental states regulation

(Prokhorov, Chernov & Yusupov, 2015; Prokhorov & Chernov, 2015), in understanding metaphors and proverbs by children at primary school (Artemyeva, 2013), links with epistemological beliefs (Bedel, 2012; Belet & Guven, 2011) and conceptual comprehension (Hennessey, 2003). It can be recognised that reflection is manifest in a situation in which the person either has to justify and prove an already discovered solution or has to choose an alternative solution (Flavell, 1979). Discussion and collaboration in vocational education (Vivian, Falknerand&Falkner, 2013) enhance the role of meta-cognition in the process of developing solutions to tasks (Kramarski & Mevarech, 2003). A metacognitive approach has revealed subtle aspects of the processes and procedures of psychological experiments that direct a person to select limited or inadequate ways of finding solutions (Roberts, 2002).

INITIAL THEORETICAL GROUNDS

L.S. Vygotsky (1962) was one of the first to illustrate the role of reflection in the development of the child's thinking (Yasnitsky&van der Veer,2015; Van Oers, Wardekker, Elbers &Van der Veer, 2008). According to the cultural-historical approach, the logical form of reflection has to correspond to the specificity of thinking types. Therefore, complexes can be regarded as akind of early undeveloped manifestation and form of classification thinking (van der Veer, 1994; Gelman& Markman, 1986). The learner forms and develops conceptual thinking through studying scientific classification systems of which the key concepts are *awareness* and *reflexivity*. The basis of the development of reflection is the assimilation of logical knowledge as knowledge of thinking norms (Tulviste, 1987; Yamauchi&Markman, 1998; Deng & Sloutsky, 2015). In its turn, *content reflection* is a typological property of a *theoretical level* of thinking (Davydov, 1996).The learner can master logical knowledge unconsciously (Gelman & Markman, 1986; Gelman, 1988). Therefore, norms of comparison and classification can be a by-product of studying scientific classifications (Ahn & Medin, 1992; Johansen & Kruschke, 2005; Milne, 2007). Taxonomy development: Assessing the merits of contextual classification**.** *Records Management Journal*, 17(1), 7-16). The logical form of operation remains on the periphery of educational attention, and does not become the subject of reflection. In other cases, such as at a higher school, the logic of classes is a special subject of study and is included in such academic courses as logic, both formal and mathematical. It has been demonstrated that special training methods encourage and empower students to master elements of the logic of classes and to develop adequate forms of reflection even at a preschool age.

The context and catalyst for the positive development of school students' successful classification thinking is the teachers' well-developed theoretical level of understanding of classification thinking. However, research relating to the education and training of future teachers reveals a significant number of errors in respect of the logical form of comparison and in relation to the level of reflection that is required to eliminate mistakes (Kurbanova, 2014). The ability to perform other operations of the logic of classes does not provide a theoretical level of classification thinking either, as it is not supported by corresponding forms of reflection, and is replaced by its substitutes which are not connected with the logic

of classes (Kurbanova & Salikhova, 2016). In this regard, it is necessary to identify the real content of reflexive processes that future teachers can experience whilst undertaking tasks and solving problems which require highly developed levels of theoretical thinking. In relation to classification thinking these are issues which require the improvement of comparison quality with the help of various operations of the logic of classes, together with an assessment, evaluation and justification of these results. Therefore, the goal of the experimental study was to reveal the types and content of reflexive and pseudo-reflexive processes of future teachers which relate to the solving of classification tasks which demand a well-developed level of theoretical thinking.

OBJECTIVES

The purpose of this study was to create and test a new way of reflection formation in future teachers, which could increase the level of classifying thinking and make it theoretical. The following objectives were identified as the main: to identify the degree of conformity of the reflection process when students solve classification problems with the norms of theoretical thinking, the main obstacles to the application of these norms and ways to overcome them; To develop a type of tasks requiring the use of classification thinking of a theoretical level and at the same time free from the subject content of a certain scientific discipline; Develop a technology that connects diagnostic and training functions based on the method of reflexive discussion.

METHODS

Data collection methods

The material was collected by means of the technique "Forming groups of equivalence on verbal material" (Olver, 1966, 1995) as modified by A. T. Kurbanova (2014). Each of 2 subtests of an initial technique is 14 tasks of comparison (7 to find similarities, and 7 to identify differences). The stimulus material of the 1st subtest is presented by the words 'banana', 'peach', 'potato', 'meat', 'milk', 'water', 'air', 'bacteria', and 'stone'. The first question is "How are a banana and a peach alike?", the second is "How do a banana and a peach differ from a potato?", the third is "How are a banana, a peach and a potato alike?" and so on. The word range in the 2nd subtest is 'handbell', 'horn', 'radio', 'telephone', 'newspaper', 'book', 'picture', 'learning', and 'embarrassment'. Some correct decisions are possible in the majority of tasks. The lengthening of a range of words increases the difficulty of comparison.

The modified procedure included three stages. At the *preliminary* stage the initial technique was carried out; it was proposed to give several answers to each task whenever possible. At the *main* stage students arranged in random couples repeatedly performed the same tasks. The instructions given required discussion of the results of the first stage, to develop the best joint decision and to justify why it was the best for each task. Three types of tasks which aimed to improve comparison were singled out due to various combinations of

solutions taken in the first stage: comparison according to the degree of similarity, synthesis of independent features and specification**.** Only those tasks were taken into consideration at the stage of processing results which made two logically correct results of comparison during the preliminary stage. At the *additional* stage students individually solved three types of tasks of the *main* stage using the material of the first and second subtests of the technique; six tasks in total.

Type 1. Comparison according to the degree of similarity.

a) There were two correct answers to the question "How are a banana, a peach and a potato alike?": "everything is food" and "everything is plant food".

b) There were two correct answers to the question "How are a handbell, a horn and a radio alike?": "they both make sounds" and "these are tools of transmitting sound information".

The students were encouraged to explain their response to the question "Which of the two answers is better?"

Type 2. Synthesis of independent features.

a) There were two correct answers to the question "How are a banana, a peach, a potato, meat, milk and water alike?": "they are eatable" and "they are all products of nature". Give a new – a third – answer which would weave to gether and synthesise the two previous ones.

b) There were two correct answers to the question "How are a handbell, a horn, a radio, a telephone, a newspaper and a book alike?": "all of this transmits information" and "they are all created by a human". Give a new – a third – answer which would weave to gether and integrate the two previous ones.

The students were then invited to provide a rationale for their answer to the question "Which of the three answers is better?"

Type 3. Specification.

a) The question "How are a banana and a peach alike?" The answer: "They are eatable".

b) The question "How are a handbell and a horn alike?" The answer: "They both make sounds".

The students were required to build upon and improve this answer and explain why the new answer is better.

Description of the survey sample

The participants in the experiment were students of Kazan University from the4th and 5th years (78 men and 126 women), all of whom had undertaken classes in formal or mathematical logic.

Methods of data processing

At the *main* and *additional* stages, the share of answers in which the final decision was better than the initial results of comparison was calculated for each type of tasks. The share of "best" answers justifications given on the basis of logic-formal reflection, and different types of pseudo-reflexive justifications was evaluated. The *s*uccess of comparison improvement and the ratio*s* of various options of logic-formal reflection were compared at the *main* and *additional* stages with the help of $\chi 2$ Pearson's criterion.

RESULTS

Results of improvement tasks solution

The analysis of a general picture of the responses to the solutions to these tasks (Kurbanova&Salikhova, 2016) illustrate that students gave 6352 individual comparison results (3463 for 1st subtest, and 2889 for 2nd subtest) at the *preliminary* stage. 4088 solutions were nominated as the best (2044 for each subtest). Among the answers specified as the best ones, many (457 (22.4 %) in subtest 1,and 305 (14.9 %) in subtest 2) represented "poor abstractions" (overly generalized and abstract answers). Solutions to the comparison tasks (*preliminary* stage) which do not have violations of a logical norm ("complexes") made 88.4 % in subtest 1and 88.8 % for 2nd subtest. At the *main* stage only such logically correct solutions were considered.

Following further discussion, improvement at the *main* stage was achieved in the comparison tasks in proportion to generality in 48 % of cases in subtest 1 and 50% of cases in subtest 2; in tasks of independent signs synthesis it was in 36 % (1st subtest) and 32 % (2nd subtest) of cases, and in tasks of specification it was in 14 % and 22 % of cases appropriately. In other cases joint results were not better or even worse than the initial individual solutions of comparison tasks. During the *additional* stage all three types of tasks were solved significantly better ($p<0.001$) on the materials of both subtests (Kurbanova & Salikhova, 2016).

Comparison improvement justification: the results of qualitative and quantitative analysis

Examples of students' assessment justifications of the chosen answer as "best" are presented in **Table 1**.

Table 1. Examples of students' assessment justifications of the chosen answer as "best" (*main* and *additional* stages)

	The type and kind of justification	Examples of justifications
R 1	***Logic-formal bases of reflection: quantity assessment of similarity/differences***	
R 1.1	Comparison by the volume of classes	The answer "all this is food" is too general; the option "it is food of plant origin" covers a narrower area of food. The answer "a hand bell and a horn produce a sound" is unsuccessful: in the world there are a lot of things that produce a sound. The answer "these are tools specially created to produce a sound by a human" divides everything that produces sounds into things made by a human and those that are not made by a human.
R 1.2	Comparison of name meanings by the quantity of characteristics	The answer "a banana and a peach are fruit" is more specific than "all this is food". The answer "a hand bell and a horn are means to transmit sound information" is fuller than the answer "produce sounds".
R 1.3	The simultaneous registration of the volume of class and name meanings	The answer "natural food" is better, than just "food", it contains more signs and specifies fewer sets.
R 2	***Quality reflection inadequate to the task***	
	An essential sign as a main function of the class	The main characteristic of all these subjects is that they are all food, they are all edible; this is their basic purpose. The answer "a hand bell, a horn, and radio produce sounds" is the most essential similarity as this is their basic purpose; they are produced by a human especially for this purpose.
R 3	***Pseudo-reflexive justifications***	
R3.1	Declarative justifications	This answer is the best; it is obvious. It is the most essential sign. This is their main similarity. The main distinction is firm-liquid; the rest is unimportant.
R 3.2	Tautology	So, they are fruit, fruit. Because it is actually food. Well, it is really possible to eat all this. Everything transfers information, therefore this answer is the best.
R 3.3	Lack of alternative options	We have no other answers. And what another sign is it possible to give? Nothing else comes to mind.
R 3.4	Subjective preference	I like my answer, I do not like yours. Your sign "genuine, natural" is also correct, but I like my sign "all this is edible" more.
R 3.5	Disclosure of the sign content	The answer "natural food" is better, as a banana, a peach... contain mineral substances, vitamins; all this is necessary for a human.
R 3.6	Other categories (precedence in time, reasons, conditions) in the evaluation of quality comparison	At first a bell, a horn, a radio, a telephone, a newspaper are "created by people" and then they "transmit information". Precisely because "all these products are natural", they are "used by people". The sign "they all contain water" is the most important as there would not be anything without water: a banana, a peach, meat, and milk.
R 3.7	Lack of justification	I do not know how to explain.
R 3.8	Appeal of the answer formulation	This answer is shorter, more laconic. It is a simple answer. The other answer is also correct, but it is poorly formulated. It is expressed more originally. This answer is more beautiful, more scientific.
R 3.9	Similarity of tasks used by the technique	The answer "food" is the best as all members of this range are edible; all tasks are about the same; further there will be meat, milk…As in other tasks: they have similarity – to transfer information.
R 3.10	Sensual similarity/differences	The water differs in transparency and it has no taste; it can be defined at once – it is visible or it is possible to try.
R 3.11	Interpersonal context of justification	Both of us separately considered this answer the best, so it is the best. This is my workmate who insists that this answer is better. We watch that there should be equal answers: one is his, another is mine. It is a conventional answer; everybody agrees with it at once.

Table 2 shows the frequency of different variants of the reflective and pseudo-reflexive justifications of the chosen answer as "best" in joint tasks solutions (*main* stage) and after the performance of isolated operations of logic of classes (*additional* stage).

Table 2. The frequency of different variants of the reflective and pseudo-reflexive justifications of the chosen answers "best" in joint tasks solutions (*main* stage) and after the performance of isolated operations of logic of classes (*additional* stage)

	The type and kind of justification	Subtest 1				Subtest2			
		main stage		additional stage		main stage		additional stage	
		number	%	number	%	number	%	number	%
R 1	***Logic-formal bases of reflection: quantity assessment of similarity/differences***	25	18.2	185	56.5	22	17.3	121	40.5
R 1.1	Comparison by the volume of classes	1	0.7	30	9.1	1	0.8	21	7.0
R 1.2	Comparison of name meanings by the quantity of characteristics	24	17.5	141	43.1	19	14.9	91	30.5
R 1.3	The simultaneous registration of the volume of class and name meanings	0	0.0	14	4.3	2	1.6	9	3.0
R 2	***Quality reflection inadequate to the task***: an essential sign as a main function of the class	7	5.1	5	1.6	3	2.4	12	4.0
R 3	***Pseudo-reflexive justifications***	105	76.7	137	41.9	102	80.3	166	55.5
R3.1	Declarative justifications	21	15.3	26	8.0	15	11.5	29	9.7
R 3.2	Tautology	4	2.9	27	8.3	1	0.8	15	5.0
R 3.3	Lack of alternative options	4	2.9	6	1.8	7	5.6	3	1.0
R 3.4	Subjective preference	6	4.4	10	3.0	2	1.6	11	3.7
R 3.5	Disclosure of the sign content	9	6.6	20	6.0	5	3.9	22	7.4
R 3.6	Other categories of the evaluation	5	3.6	8	2.5	1	0.8	12	4.0
R 3.7	Lack of justification	29	21.1	26	8.0	40	31.5	45	15.0
R 3.8	Appeal of the answer formulation	2	1.5	12	3.7	2	1.6	18	6.0
R 3.9	Similarity of tasks used by the technique	0	0.0	1	0.3	1	0.8	1	0.3
R3.10	Sensual similarity/differences	5	3.6	1	0.3	12	9.4	10	3.4
R3.11	Interpersonal context of justification	20	14.6	-	-	16	12.8	-	-

The comparison of logic-formal justifications of correctly solved tasks at the *main* and *additional* stages according to χ2 Pearson's criterion are presented in **Table 3**.

Table 3. The comparison of logic-formal justifications of correctly solved tasks at the *main* and *additional* stages according to χ2 Pearson's criterion geometric mean of 15 experts' weigh-questionnaires data

	The type and kind of logic-formal justifications	ubtest	Main number	tage %	Additional number	tage %	evel of distinctions adequacy
R 1.1	Comparison by the volume of classes	I	1	0.7	30	9.2	p< 0.1
		II	1	0.8	21	7.0	p< 0.1
R 1.2	Comparison of name meanings by the quantity of characteristics	I	24	17.5	141	43.1	p< 0.001
		II	19	14.9	91	30.4	p< 0.01
R 1.3	The simultaneous registration of the volume of class and name meanings	I	0	0	14	4.3	p< 0.001
		II	2	1.6	9	3	-
R 1	The total number of explanations by the logic of classes	I	25	18.2	185	56.5	p< 0.001
		II	22	17.3	121	40.4	p< 0.001

DISCUSSIONS

The forms of reflection in justification of task solution

Each of the three types of comparison improvement tasks (*main* and *additional* stages) demanded one of the logic of classes operations: logical comparison (comparison according to the degree of similarity); logical multiplication (synthesis of independent features); the limitation of the name volume (specification). Even after the correct practical application of the logic of classes' necessary operation most students had difficulty in reflexively pointing out this operation as a method of solving tasks.

In joint tasks solutions (*main* stage) logic-formal justifications make up only 18.2 % and 17.3 % of the total number of the justified responses given by a couple of students (Table 2). All instances of quantity justifications relate to a smaller class size (R 1.1), to a larger number of class-forming signs (R 1.2), and at the same time both characteristics (R 1.3) are seldom used by students to assess a comparison result.

Various forms of pseudo-reflexive justification of the answers given were present in both subtests (76.7 % and 80.3 % appropriately). Quite often students consider the answer the best because both members of a couple have the same answer (R 3.11 – 14.6 % and 12.8 %), or

they cannot prove its advantages at all (R 3.7) which is particularly noticeable in the second subtest (31.5 %). Instead of the performed operation reflection students appeal to subjective preferences and make declarative statements that are not supported with arguments. They reveal additionally the content of the nominated similarity/differences and, for example, they explain the choice by an attractive answer formulation (Table 1). The next types of pseudo-reflexive justifications are identified: declarative justifications; tautology; lack of alternative options; subjective preference; disclosure of the sign content; other categories (precedence in time, reasons, conditions) in the evaluation of quality comparison; lack of justification; appeal of the answer formulation; similarity of tasks, used by the technique; sensual similarity/differences; interpersonal context of justification.

Analysis of a variety of pseudo-reflexive justifications together with consideration of the quality of forms assessment demonstrates that students do not single out the logic of classes in reflection on the operations which they used for formulating solutions. They do not apply the concepts of the logic of classes when they assess the quality of their solutions.

Therefore, at the joint improvement of comparisons only an insignificant element of the correctly solved tasks is followed by logic-formal reflection appropriate to the process of classification thinking.

At an *additional* stage accustomed training tasks were offered in order to facilitate individual solutions. Conditions and goals were formulated by the experimenter and singled out from the discussion context. It was easier for students to identify them as tasks requiring the application of classification operations. As a result, all three types of tasks on both subtests material were solved significantly better during the *additional* stage ($p<0,001$) (Kurbanova&Salikhova, 2016). Analysis of the data shows that the share of logic-formal justifications of comparison quality assessment is authentically increasing (Table 3). Thus the general share of different pseudo-reflexive justifications is significantly less in comparison with the *main* stage (Table 2). The share of students who did not prove their choice or proved it by the absence of an alternative is less than at the *main* stage. However, the total number of pseudo-reflexive justifications remains large and some of their types are en countered more frequently.

The development of reflexive processes as a dimension of pedagogical education improvement

It is in forms of reflection, including those presented in relation to correct answers, but not in practical solution tasks, that an insufficient level of classification thinking is distinctly revealed. All students studied the logic of classes in the*ir* courses of formal or mathematical logic. However, they seldom utilise this knowledge as an approach to classification thinking. Students training to be the teachers of the future, therefore, do not appear to be aware of situations when it is necessary to apply principles of the logic of classes to improve the quality of comparison and to compare and evaluate different

solutions. The presentation of a task in a formalized way (conditions are singled out and the objective is set) increases the success in the tasks set, and is more often followed by an adequate logic-formal reflection. Falling outside the scope of a conventional training task, including stimulus material of a technique in the form of ordinary language words, complicates the identification of tasks as demanding their solution on the basis of the logic of classes.

It is possible to suggest that technologies available at higher school do not guarantee the development of theoretical levels of classification thinking, and thus, do not provide future teachers with competences which they can aim to inculcate and nurture in their students. At the same time scientific researchers in education increasingly identify and highlight the necessity for the development of the capacity for reflection in teachers of the future (Akbari, 2007; Kirbuluta&Gokalp, 2014; Biktagirova&Valeeva, 2014; Hébert, 2015) and they confirm the dependence of its formation on appropriate conditions and technologies of education (Veenman, Van Hout-Wolters&Afflerbach, 2006; Schraw, Crippen&Hartley, 2006; Smit&Tremethick, 2017; Bass, Fenwick, Sidebotham,2016; Veen&de la Croix,_2017). Our results show that pedagogical education reform (Kalimullin, 2014) should be accompanied by the development of appropriate technologies which facilitate the study of the logic of classes that actively and meaningfully affirm and enhance reflexive processes. Reflexive processes diagnostics should be integrated into the process of educational assessment through the medium of formalized testing tools.

CONCLUSIONS

The research conducted led us to the following conclusions:

- Logic-formal reflection is adequate to a scientific-theoretical level of thinking. It is based on an understanding of the classification arrangement principle, where the measure of similarity/differences generality is a criterion of comparison quality assessment. It allows the comparison of various operations of classification thinking and the solving of comparison quality improvement tasks.
- The proposed experimental technique allows the study of reflexive and pseudo-reflexive forms used to solve classification tasks demanding a capacity for *a* theoretical level of thinking.
- Students' practical performance of classification thinking operations advances the correct evaluation of comparison quality. Reflexive justification of comparison quality together with forms of evaluation appropriate to solving tasks can be regarded as a significant feature of the experience in the development of student teachers and can be viewed as being a factor in eliminating barriers to learning.
- Logic-formal reflection is observed in less than 20 % of cases with correct tasks solution aimed at improving the quality of comparison in a joint decision. The majority of cases

(near 80%) make various forms of pseudo-reflexive justifications that do not correspond to the content of solving tasks as cogitative. Quality reflection which is also inadequate to classification thinking is used in some cases.

- ✧ The existing practice of studying mathematical or formal logic in high school does not ensure the formation of scientific and theoretical level of classification thinking in future teachers.
- ✧ Comparison improvement tasks formalization increases a share of logic-formal reflection and reduces a share of pseudo-reflection. However, the frequency of some types of pseudo-reflexive justifications occurrence thus increases. It illustrates the random approach adopted by some students in the ways in which they select their justifications for their responses in the absence of an orientation to the logic of classes as a basis for reflection.
- ✧ Some forms of future teachers' reflection reveal an insufficient level of thinking that limits their opportunities to form it in their school students.
- ✧ Joint reflexive discussion is a model of work on classification thinking, which can raise its level to the theoretical one.

PRACTICAL APPLICATIONS

The proposed tasks, the way of individual and joint work with them, the criteria for evaluating solutions simultaneously present a tool for diagnostics of classification thinking and its formation. These tasks can be used for the students who are familiar with the basic information connected with the logic of classes at all levels of education. The structure of the tasks gives the possibility to vary them according to the content of the disciplines and to include the materials of everyday life.

ACKNOWLEDGEMENTS

This work is financially supported by science and technology innovation talent support program of Henan province higher education (HUMANITIES AND SOCIAL SCIENCES), 2017- cxrc-04; Ministry of education humanities and Social Science Fund(15YJC630006); Henan social science program of Henan Province in 2016(2016BJJ017); Key research projects of Humanities and social sciences of Henan Provincial Department of education in 2016(2016-zd-046); 2014 Henan provincial government decision-making research tender topic(2014154); Key research projects of Humanities and social sciences of Henan Provincial Department of education in 2014(2014-zd-011); General research project of Humanities and social sciences of Henan Provincial Department of education in 2016(2016-gh-122); General research project of Humanities and social sciences of Henan Provincial Department of education in 2017(2017-ZZJH-163). Also, the work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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