

# ETHNOMATHEMATICS AS A FIELD OF KNOWLEDGE: THEORY AND METHODOLOGY

## ETNOMATEMÁTICA COMO CAMPO DE CONHECIMENTO: TEORIA E METODOLOGIA

## LA ETNOMATEMÁTICA COMO CAMPO DE CONOCIMIENTO: TEORÍA Y METODOLOGÍA

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**Abstract:** In Russian science, ethnomathematics is a new area of study. Its problems are compound and multifaceted. Notwithstanding the fact that the last decades have seen active advancement of disciplines concerned with the problems of ethnically-specific education and upbringing, many of its concepts and delineations remain undefined.

In this paper we present the results of a fundamental theoretical and methodological study carried out in 2013 - 2016. Here we reveal and describe theoretical foundations of ethnomathematics. Using the method of extrapolation, we mould its methodology and put together its terminology.

**Keywords:** ethnomathematics, folk mathematics, maths culture of an ethnic group, ethnomethodology of mathematics education, ethnically-specific methodology, ethnic education, ethnic didactics, ethnic psychology, ethnic physiology, ethnic culture.

### Introduction

**Urgency of the problem** of studying the theoretical fundamentals of ethnomathematics is necessitated by the need for a theory and methodology of education with respect to regional, national and ethnocultural aspects of teaching and learning, and by the lack of conceptual and methodological clarity in the contents, forms and methods of ethnically-specific teaching of mathematics in ethnic schools.

Thus, when substantiating theoretical foundations of ethnomathematics, we emphasize its methodological relation to other ethnically-specific sciences of man and society. These are a variety of domains: ethnology, ethnography, ethnopedagogy, ethnodidactics, ethnopsychology, ethnosociology, ethnic cultural studies, ethnophilosophy, ethnolinguistics, ethnomethodology, and others.

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Theoretically, ethnomathematics as a branch of science was shaped and framed in the writings of U. D'Ambrosio, P.Gerdes, G.Gilmer, L.Shirley, and others [1, 2, 3, 4, 5, 6, 7, 8].

A theoretical framework for study of folk mathematics as the contents of education found place in the books and papers of Russian researchers V.V.Bobynin, G.N.Volkov and V.M.Berkutov [9, 10, 11, 13, 15]. Pedagogical potential of ethnomathematics of various Russia's peoples are dealt with in the writings of T.S.Ammosova, V.M.Berkutova, N.I.Merlina, A.S.Mongush, Ch.M.Ondar, A.I.Petrova, and others [14, 15, 16, 18, 20, 21].

Our review of literature, however, shows that these theoretical tenets of folk mathematics research have not become a distinct subject of study in Russia. It was our strive to bridge this gap that inspired us to try and conceptualise the basics of ethnomathematics, relying on the writings of Russian researchers.

**Purpose of the study:** to reveal and characterise several theoretical propositions of ethnomathematics, and substantiate its methodology.

**Methods of Study:** theoretical analysis, generalisation, synthesis, extrapolation.

**Study Results and Discussion.** Now let us look at the fundamental methodological propositions. Today's encyclopaedias give only general definitions of methodology.

"Methodology (from 'method' and 'logia') is a doctrine describing the structure, logical organisation, methods and means/instruments of human activity"[22; 23].

"Methodology is a system of principles and ways of organising and shaping theoretical and practical activity, along with study of this system"[24].

A.M.Novikov and D.A.Novikov suggest a "pattern of methodology's structure" consisting of three components:

1. Characterisation of activity: features, principles, conditions, norms and standards of activity;
2. Logical structure of activity: subject, object, subject-matter, forms, means, methods, results of activity;
3. Temporal structure of activity: phases, stages, milestones [25].

For our working definition, we shall take these and shall, conditionally, use the structure proposed by A.M.Novikon and D.A.Novikov.

Methodological aspects of ethnomathematics studies arise from consideration of its nature and features, when we address the issue of the structure of methodological science. Thus, in modern science studies, it is common practice to identify four levels in the structure of methodology:

philosophical, general-scientific, specific-scientific and procedural. In this connection, it seems reasonable to consider how each of them is characterised in relation to ethnomathematics.

On the philosophical level, we shall consider ethnomathematics from the dialectical-materialistic, synergetic, evolutionary and genetic perspectives.

Philosophical interpretation of ethnomathematics, with regard to the basic tenets of the dialectical-materialistic approach, lies in studying the mathematical culture of an ethnic group through how the most general laws of motion, of the evolution of nature, society and thinking are reflected in it. (K.Marks and F.Engels).

From the synergetic perspective, the nature of ethnomathematics is the study of mathematical culture of an ethnic group as a self-organising and self-developing system. It is a common knowledge that synergetics rely on non-linear principles of the evolution of the world. In the most general terms, this idea can be rendered as 'multiple path/multiple choice'. In ethnomathematics, multiple choice means that "human thinking can offer more than one way of quantitative perception of the world, each of which arises from everyday practice"[27, p. 4].

The evolutionary approach to ethnomathematics is related to the concept of evolution/development as progressive occurrence of irreversible qualitative changes. In this perspective, folk mathematics is viewed as "cultural evolution" that is characterised by accumulation and transmission, from generation to generation, of the mathematical knowledge of an ethnic group.

When seen in the genetic perspective, ethnomathematics involves study of mathematical culture of an ethnic group that allows us to understand each and any phenomenon in terms of its arisal and development. This approach helps us track the evolution of an object or process from its origins up till now.

On the general scientific level, the problem of ethnomathematical studies can be considered in terms of different theoretical and methodological approaches: systems approach, structural functional approach, activity approach, axiological and cultural approach.

In ethnomathematics, the object-specific, functional and historical aspects of the systems approach require that a range of research principles, such as historicism, specificity, consideration for all-round ties and relations and development, come into play together, in a holistic combination (V.A.Slastenin, I.F.Isaev).

The structural functional approach in ethnomathematics prompts us to study the inner structure of

mathematical culture, understand the particular characteristics of its inner relations, and to reveal their role in the whole system or how they are related to the attainment of the key goal: ensuring the customary way of life of a people and catering to the everyday needs of man.

In terms of activity approach, mathematical culture of a nation is viewed as a form of human creativity. Within this framework, ethnomathematics studies the thinking of a people and their outlook, self-creation of the ethnic group as the subject of historical cultural process, the mechanisms of preservation and reproduction of mathematical culture in the ever-changing world.

Within axiological approach, the study of folk mathematics is to be based on the axiological attitude as a system of philosophy. In ethnomathematical axiology, artefacts of folk mathematics are to be viewed as universal human values.

The cultural approach to ethnomathematics implies a methodological stance that reveals the unity of axiological, activity-related and individually-creative aspects of mathematical culture and that views man as its subject, its 'principal character'.

V.S.Bezrukova claims that the cultural approach to education is what conduces to better taking into account ethnical, religious and historical qualities of pupils [28]. Thence it follows that methodological basis for ethnomathematical studies, on the general scientific plane, are to be made the systems and structural functional approaches that contribute to the efficient organisation of research. At this level, ethnomathematics is viewed as a systematic and consistent activity aimed at cognition, preservation and transmission of ethnic mathematical culture, with regard to the experience accumulated and the modern state of science and education.

At the specific scientific level, and keeping in mind ethnomathematics' cross-subject nature, we consider the ethnologic, ethnosocial, ethnocultural, ethnopsychological, ethnophysiological, ethnopedagogical and ethnodidactical approaches.

In terms of ethnological approach, ethnomathematics studies mathematical notions, ideas and methods of an ethnic group that are related to people's practice and day-to-day needs.

E.F.Vertyakova also identifies the ethnological approach to pedagogy, within whose framework the concept of a developing multicultural educational system is substantiated, the one that tries to direct a person towards universal human values through ethnic culture [29, p. 18]. The ethnosocial approach considers mathematical culture and its phenomena in terms of their specific usefulness to any given ethnic group; in other words, any phenomenon of mathematical culture is

appreciated as the one ascribed to the specific group and that which represents its interests. The ethnocultural framework views mathematical culture as part of a specific ethnic culture.

Ethnocultural approach implies such principles as nationalism, cultural and natural conformity. In this connection, it would seem practicable to single out the ethnopsychological and ethnophysiological conceptions that involve organisation of mathematics education process with regard to specific ethnic psychology, national ethos (perception, thinking, memory, etc.) and the structure/functionality of central nervous system and brain.

According to S.V.Struchkova, ethnopedagogical approach to the content of mathematics learning process is "a naturally organised process of integrating traditional cultures with today's educational systems, ideas, technologies that combinedly make up the educational environment"; it is viewed as the qualitative aspect of how the educational potential of maths grows in importance [30].

F.G.Yalalov claims that the tenet of the ethnodidactic approach to planning ethnic education is the three-component structure of its content. Namely, "the content of education is to combine the ethnic, cross-ethnic and multi-ethnic components" [31, p. 52].

Hence, at the specific-science level of cognitive methodology, ethnomathematics is part of the pedagogy that underlies the principles of nationalism, cultural and natural conformity. Ethnomathematics draws on folk mathematics as the source of shaping the nationally-focused content of mathematics education, and is aimed at learning the mathematical culture of ethnic groups through cultural dialog, which contributes to embedding tolerance in the learners' minds.

At the level of methodology and procedure, the nature and content of ethnomathematics are revealed when taken as an ethnically-focused educational technology in maths - the one that takes into account ethnopsychological, ethnophysiological and ethnocultural background of pupils.

Let us now define the subject matter of ethnomathematics. The problem of the terminology suitable to the issue was tackled in "Ethnomathematics as a field of scientific knowledge: its subject-matter and key concepts"[32]. However, upon revision of these early conclusions and claims, herein we stick to a slightly different approach. For instance, we have expanded the definition of the very idea of 'ethnomathematics' and drew a line between the object and subject matter of study.

In order to consider ethnomathematics as a field of knowledge, we shall identify a range of issues it is to tackle, and define its object and subject-matter. The mechanism of shaping ethnomaths

methodology is extrapolation, i.e. "the procedure by which knowledge is translated from one domain to another that is not observable or known, on the basis of a certain relation between the two - that of similarity, analogy, or tendency" [33, p. 106]. In our case this means translation of fundamental ethnopedagogical ideas (G.N.Volkov) [10; 13] and those of ethnodidactics (F.G.Yalalov) [31] to the methodology of mathematics. Thus, for instance, if the object of ethnopedagogy is the pedagogical culture of an ethnic group, then the object of ethnomathematics is its mathematical culture.

Analysis of international and national literature helps us single out the two aspects in which ethnomathematics can be viewed:

- 1) as a field of scientific knowledge whose subject-matter is folk mathematics. In other words, as a theoretical interpretation of folk mathematics of various ethnic groups, peoples and nations.
- 2) ethnomathematics can also function as part of pedagogy that studies and elaborates the goals, contents, approaches, principles, forms, means, methods and factors pertaining to teaching maths that conform to a child's ethnic background and contribute to shaping ethnopedagogical procedures.

In pedagogical literature, the object of the study is defined as "the domain of reality, a combination of real phenomena and processes to the study and substantiation of which this field of knowledge is directed"[34].

Consequently, in what concerns the first aspect, the object of study of ethnomathematics in our view is mathematical culture of an ethnic group produced by centuries and centuries of its history; it is an object of real life. Notwithstanding that fact that the notion "mathematical culture of an ethnic group" is common, it is rather intuitive and does not yield to a clear definition.

On the basis of a review of methodological and pedagogical literature, we can define mathematical culture of an ethnic group as a sphere of general culture that includes mathematical notions, knowledge, competence and practical skills relating to everyday life needs and to most necessary crafts, trades and arts, along with the way of thought and outlook specific to this group. According to V.M.Vishnyakova, the subject matter of a science is that aspect of its object to the study of which specific research in this domain is directed [34]. By the subject-matter of a science some colleagues understand the range of basic, most crucial issues and problems it studies.

By taking into account these statements, we can define the subject-matter of ethnomathematics as

folk mathematics. Analysis of writings by V.V.Bobylin, G.N.Volkov and V.M.Berkutov gives us grounds to define folk mathematics as a body of inductive and empirical mathematical knowledge and notions that have been accumulated by an ethnic group as the result of observation and social experience and handed down from generation to generation in oral form.

The object of ethnomathematics, as part of general pedagogy, is the process of teaching maths that is in conformity with the ethnic background of a pupil. In it we can identify the following key components: the goal, contents, work of a teacher and activity of pupils. Each of these components may be the subject-matter of study, along with their relations and interplay.

Here we suggest a concept of "ethnomethodology (ethnically focused methodology) of teaching maths", on the basis of writings of T.M.Balykhina, Ch.Yuxian, T.A.Krotova and others [35, 36]. At the heart of this methodology lies consideration for ethnopsychological and ethnophysiological background of pupils, ethnophilosophical outlooks, ethnopedagogical traditions, ethnocultural values, and the ethnosocial aspect of the life and activity of this ethnic group.

### **Conclusion**

Summing up, in a loose sense, ethnomathematics studies folk mathematics of various ethnic groups and suggests rational ways of putting it to use in ethnomethodology (ethnically-focused methodology) of teaching maths in the present context.

Finally, this paper deals with fundamental theoretical and methodological tenets of ethnomathematics as a new field of knowledge and research.

## **ETNOMATEMÁTICA COMO CAMPO DE CONHECIMENTO: TEORIA E METODOLOGIA**

**Resumo:** Na ciência russa, a etnomatemática é uma nova área de estudo. Seus problemas são compostos e multifacetados. Não obstante o fato de as últimas décadas terem visto um avanço ativo de disciplinas preocupadas com os problemas da educação e educação etnicamente específicas, muitos de seus conceitos e delimitações permanecem indefinidos.

Neste artigo, apresentamos os resultados de um estudo teórico-metodológico fundamental realizado entre 2013 e 2016. Aqui, revelamos e descrevemos os fundamentos teóricos da etnomatemática. Usando o método de extrapolação, moldamos sua metodologia e reunimos sua terminologia.

**Palavras-chave:** etnomatemática, matemática popular, cultura matemática de um grupo étnico, etnometodologia do ensino de matemática, metodologia etnicamente específica, educação étnica, didática étnica, psicologia étnica, fisiologia étnica, cultura étnica.

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## LA ETNOMATEMÁTICA COMO CAMPO DE CONOCIMIENTO: TEORÍA Y METODOLOGÍA

**Resumen:** En la ciencia rusa, la etnomatemática es una nueva área de estudio. Sus problemas son compuestos y multifacéticos. A pesar del hecho de que las últimas décadas han visto un avance activo de las disciplinas relacionadas con los problemas de la educación y la educación étnicamente específica, muchos de sus conceptos y delineamientos permanecen indefinidos.

En este artículo presentamos los resultados de un estudio teórico y metodológico fundamental llevado a cabo en 2013 - 2016. Aquí revelamos y describimos los fundamentos teóricos de la etnomatemática. Usando el método de extrapolación, moldeamos su metodología y reunimos su terminología.

**Palabras clave:** etnomatemáticas, matemática popular, cultura matemática de un grupo étnico, etnometodología de la educación matemática, metodología étnicamente específica, educación étnica, didáctica étnica, psicología étnica, fisiología étnica, cultura étnica.

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