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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

TEACHING METHODS OF GEOMETRIC QUANTITIES

Speciality: 5801.01-Theory and methodology of training and education (a method for training of mathematics)

Field of science: Pedagogics

Applicant: **Ruhiyya Orujali Jafarova**

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The work was performed at the department of "Methods of teaching subjects and technology teaching" of Nakhchivan State University.

Scientific supervisor: Prof.Dr.of Pedagogy
Azadkhan Safarkhan Adigozalov

Official opponents: Prof.Dr.of Pedagogy
Shahin Tagi Tagiyev

Prof.Dr.of Pedagogy
Abulfat Gulam Palangov

Doctor of Philosophy in Pedagogy
Khumar Tofig Novruzova

Dissertation Council ED 2.40 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Nakhchivan Teachers' Institute

Chairman of the Dissertation council: Prof.Dr.of Pedagogy
Ismayil Israfil Aliyev

Scientific secretary of the Dissertation council: Doctor of Philosophy in Pedagogy, Associate Professor
Giziltaj Tarverdi Shahbazova

Chairman of the scientific seminar: Prof.Dr.of Pedagogy
Mudafia Jamil Mahmudov

GENERAL CHARACTERISTICS OF THE WORK

Relevance and development of the topic. The Independent Republic of Azerbaijan has made significant progress in science, technology and education and this progress continues on an ascending line.

New Education Reform continues and achievements in this field are also evidence of the development of secondary mathematical education.

Mathematics, as a science, emerges as a need arising from the practical activity of human beings and develops with its own internal laws. It becomes a close assistant to people in solving problems that arise in everyday life, in the development of the exact and human sciences, in the process of improving techniques and technologies, allows students to extend their scientific and technical knowledge.

It is defined in the General Education Concept in the Republic of Azerbaijan (National Curriculum) framework document that through the teaching of mathematics in secondary schools:

- *at the level of primary education*, students are provided to perform arithmetic operations, master written and oral calculation algorithms, calculate numerical expressions, solve textual problems, have basic measurement skills, spatial and geometric concepts, classify the given information. They develop the habit of applying mathematical knowledge in everyday life;

-*at the level of general secondary education***,** solving everyday problems, the study of other relevant subjects, acquisition of mathematical knowledge necessary for secondary education in other forms, formation of the way of thinking that creates the basis for the intellectual development of students and successful practical activities, creating a full picture of the exceptional importance of mathematics in the development of civilization and society as an integral part of universal culture, acquisition of appropriate skills in the field of mathematics in accordance with their age, logical understanding and analysis of information in various forms and

contents, an essential understanding of the probabilistic nature of random events in life are provided.

-*At the complete secondary education* by expanding and developing the activities identified at the general secondary level inculcation of new concepts and essences, more systematic and application-oriented practical skills, enrichment of speech by developing mathematical language, mastering mathematical knowledge that forms the basis for continuing future education and professional activity, formation of algorithm culture are provided.

Spatial thinking in people's lives is necessary not only for those who are engaged in mathematics, but also in the study of physics, chemistry, geography and other school subjects. It is very important for people to imagine the structure of the objects in their activities without seeing them visually. To do this, they need to have a spatial thinking. The teaching of school subjects, especially geometry, is of special importance for the formation and development of students' spatial imagination. In order to form children's spatial perceptions in kindergarten education, visual-practical exercises on the shape of the object, its place in space, and its position are intended to prepare students for the formation of geometric perceptions in primary school.

One of the essential concepts learned in mathematics is the concept of quantity. Acquaintance with quantities also begins with kindergarten training, and one of them is the first acquaintance with the measurement of length.

Introduction to geometric quantities in primary school is continued by measuring the length of the segment, and in the upper grades by measuring the areas and volumes of geometric figures. Students' acquaintance with geometric quantities in primary school is part of the development of spatial imagination and is generally related to their geometric preparation.

Visual-practical acquaintance of young schoolchildren with geometric elements, by studying the simple properties of figures, the ability to apply knowledge to the solution of practical problems contributes to the formation and development of spatial imagination.

Research by psychologists, educators and methodologists has indicated that physiological, psychological and mathematical factors play an important role in shaping students' spatial perceptions.
The following stages in the development of students' spatial imagination can be noted:
-Demonstration of a geometric figure and the corresponding object in life,
-Acquaintance with the elements and properties of the geometric figure,
-Description of a geometric figures drawings by students.
It is necessary to strictly follow the laws of the learning process in the geometric concepts teaching, including quantities, at school:

1. Problem statement,
2. Training - as a type of social activity,
3. Teaching and learning - as elements of the learning process,
4. Unity of content and procedural aspects in training.

The mathematics course of I-IV, V-VI and VII-XI grades is taught on the basis of textbooks called “Mathematics” according to the Education Program. Primary mathematics education and secondary mathematics education are interrelated. Schoolchildren of I-IV grades are gradually prepared for mathematical education in V-VI grades and this goal is mainly intensified in IV grade. Scientific, psychological and pedagogical features should be taken into account in the teaching of geometric material and, in special cases, geometric quantities in those grades. Unlike primary grades, mathematics is taught by subject teachers in V-VI grades.
At present, the necessary knowledge in the teaching of mathematics is formed and developed on the basis of existing "content lines" and their close connections. “Content lines” reflecting the content of teaching in the educational program (curriculum) should be implemented on the basis of interdisciplinary relationships.
The content line is the part of the content that is considered necessary to ensure the implementation of the general learning outcomes of the subject. Content lines are defined to more clearly describe the content

that students will learn and are intended to systematize it. Based on the study and analysis of current world experience, the teaching of mathematics is defined by 5 content lines.
Of these, "Geometry" and "Dimensions" content lines are implemented:

1) In I-IV grades,
2) In V-VI grades,
3) in VII-XI grades.

Since the second stage (V-VI grades) is in the intermediate position, during the interpretation of geometric's teaching material it is necessary to take into account the specifics of teaching primary grades on the one hand, and planimetry and stereometry sections of geometry on the other hand in VII-XI grades.
The following requirements are set for the mathematical knowledge of primary school students to successfully master geometric material in the V grade:
Schoolchildren:
-distinguish geometric concepts (point, straight line, straight line segment, curved line, circle, polygon (types), name them correctly and mark them with letters;
- perform simple geometric constructions using a ruler and a compass;
- distinguish simple spatial figures and their elements;
be able to calculate the length of the segment on the plane (flat surface), the area of the figure, as well as the volume of a rectangular parallelepiped, cube in space.
Deficiencies in the geometric knowledge of primary school students will lead to a number of difficulties in later grades. So that:
- an error is made when measuring the length of the segment,
- do not classify rectangles correctly,
-cannot make a connection between the perimeter and area of a rectangle,
- are unable to break down the units of measurement of quantities or make mistakes,

- they are not able to cut the segment in half with the help of a compass.

Defects in students' knowledge and skills in measuring geometric quantities can also be attributed to high school students:

1. They cannot distinguish between "geometric figure" and "geometric quantity".
2. They make a mistake in the mathematical relations between the units of quantity.
3. They do not know the technology of measuring quantities
4. They are not able to apply the rules of arithmetic operations in performing mathematical operations on quantities.

Certainly, there are reasons for these mistakes.

We see these reasons in the reduction of program requirements for students' geometric knowledge:

1. There is little emphasis on practical work that develops geometric skills and habits in mathematics lessons.
2. The main methodological requirement in the teaching of geometric material is the use of concrete-deductive reasoning.

Otherwise, the application of the abstract-deductive approach reduces the quality of mastery.

In imparting geometric knowledge, the teacher should pay attention to the correct selection and classification of questions accordingly. It should be clear which questions are asked at the level of understanding and which at the level of imagination. Here, a point, a straight line, a straight line segment must be distinguished from each other as geometric concepts:

-straight line - the first concept, is infinite length,

-point- is the first concept, there is no size,

- straight line segment is a geometric figure and is considered to be the finite part of a straight line

The concept of segment length is a geometric quantity.

Distinctive features of geometric concepts should be visually noted. Although the fact that geometry is a deductive science creates certain difficulties in school teaching, the images of geometric figures accelerate the process of comprehension. Although, geometry is a

deductive science creates certain difficulties in school teaching, images of geometric figures accelerate the process of perception. The main task of the teacher is to match the word expression of the concept (geometric figure) with its description in the drawing.

The research topic has not been considered as a separate research object with the application of new teaching methods in terms of modern education reform. Until now, some issues of the subject have been studied on the basis of textbooks. In our research, a creative approach to the works of authors on this topic was shown and they were widely used. The scientific works of I. Rustamov[1], A. Palangov[2], S. Hamidov[3], A. Adigozalov, M. Shardakov[4], H. Istomina[5] and others are examples.

Research goals and objectives; The purpose of the research is to develop a methodology for teaching the measurement of geometric quantities in I-XI grades on the basis of modern pedagogical technologies. In order to achieve the purpose of the study, it was considered necessary to perform the following tasks:

1. Analysis of psychological, pedagogical and scientific-methodical literature; identification of opportunities and conditions for the formation of students' creative activity and

[1] Rustamov, I.M. Development of students' theoretical knowledge in geometry through problem solving (grades VII-IX): / Author's abstract of the doctoral dissertation on pedagogy - Baku, 1997. - 23 p.

[2] Palangov, A.Q. Practical and laboratory work of geometric measurement as a means of forming students' geometric knowledge (VII-IX grades): / abstract of the dissertation of the doctor of philosophy on pedagogy - Baku, 1996. - 22 p.

[3] Hamidov, S.S. Methods of teaching mathematics in I-IV grades / S.S Hamidov. – Baku: ADPU, - 2012, - 330 p., Again his: Hamidov S.S. Development of students' theoretical knowledge through problem solving in geometry / S.SHamidov, I.M.Rustamov. - Baku, ADPU, - 1997, - 84p.

[4] Shardakov, M.N. Schoolchild's thinking / M.N. Shardakov. - Moscow: Enlightenment, – 2003. – 140 p.

[5] Istomina, N.B. Methods of teaching mathematics in primary grades / N.B. Istomina. - Moscow: Education, - 2003 .-- 420 p.

relevant practical skills and habits on geometric quantities and their measurement in the learning process.

2. Discovering the concept of quantity, its types and the essence of measurement in the study of geometric materials
3. Discovering the relationship between the concepts of quantity and numbers in mathematics teaching, substantiation of the fact that the expansion of the concept of numbers depends directly on the measurement of quantities
4. Detection of functional dependences between geometric quantities in the learning process and their connection with the concept of numbers
5. Taking into account scientific, pedagogical and methodological features in the process of teaching geometric quantities.

Research methods;

-theoretical analysis (theoretical generalization), systematic analysis, modeling, constructive approach,

-diagnostic approach and assessment,

-pedagogical experiment (quantitative and qualitative analysis based on numerical facts),

- drawing conclusions based on the obtained statistical facts.

Scientific novelty of the research;

In the teaching of geometric quantities improving the quality of learning through the application of concrete-inductive, abstract deductive and axiomatic methods appropriate to their age and level of knowledge in the context of students' activity

Provisions submitted for defense;

1. Substantiation of didactic functions of measurement of geometric quantities in the formation and development of students' spatial imagination at school
2. Substantiation of the role and importance of geometric quantities in the emergence, expansion and development of the concept of quantity, in particular, the concept of numbers
3. Identify ways to substantiate and implement issues of formation and development of students' practical skills and

habits of constructive construction in the process of integrative training of the school's mathematics course "Measurements" with the line "Geometry" in accordance with the requirements of the new Education Program (curriculum)

4. Theoretical substantiation and experimental testing of the methodical system of the effective option of geometric quantities measurement teaching in school education

The use of thinking operations (analysis, synthesis, generalization, abstraction, concretization and analogy) in the teaching of mathematics, in fact, necessitates the direct application of quantities. Psychological-methodical researches of P.M.Erdniyev, N.A.Menchinskaya, S.L.Rubinstein, researches on scientific and theoretical bases of school mathematics course of A.N.Kolmogorov, A.I.Marku-shevich, A.Y.Xinchin, I.Dedonne, introduction of modern pedagogical technologies in training based on the “mathematics” model, made it necessary to implement interdisciplinary relations. The use of synthesis of scientific knowledge in various subjects in the learning process - provides students with the formation of knowledge about real life.

Mathematics has two important first concepts, quantitative and numerical concepts. They are as complex as they are simple, and one stimulates the development of the other. The measurement of quantities has expanded the concept of numbers. The concepts of "common dimension" and "common dimensionless segments" that exist in mathematics are proof of how close that connection is.

Just as every science has a system of concepts, foundations, research methods and methodology, as a science mathematics has:

1) a system of first concepts,
2) first system of relations,
3) a system of initial propositions (axioms).

Mathematical knowledge is formed and developed on these bases.

The need to develop a methodology for teaching geometric quantities in the school's mathematics course on the basis of new pedagogical technologies is related to the study of school experience, a

comprehensive analysis of shortcomings in students' knowledge and practical skills in geometry, including geometric quantities.

Chapter I of the thesis is called: "Scientific pedagogical-methodological issues of the problem" and is explained in six sub-chapters In a special case, it is possible to show the concept of quantity, the essence of the measurement problem, the measurement of geometric quantities, psychological and pedagogical issues in solving the problem.

Chapter II is entitled "Scientific, psychological and general pedagogical issues of the problem" and explained in five subchapters. In a special case: the problem is set in the educational and methodical literature and pedagogical research, the issues of teaching geometric quantities in I-XI grades are reflected.

It should be noted that the teaching of geometric concepts in I-VI grades is mainly visual-practical, so the methodology of these issues is preferred.

A pedagogical experiment was conducted as the main research method to test the validity and suitability of the proposals put forward in the research hypothesis in real training. The pedagogical experiment was conducted in three stages in urban, settlement and rural schools.

Theoretical and practical significance of the research; Axiomatic methods of measuring quantities, application ways of modern integral and differential calculus elements increase the theoretical and practical significance of the developed work. The development of a methodology for teaching the measurement of geometric quantities will be useful for school teachers.

Approbation and application of research; The topic of the thesis was discussed and approved at the meeting of the Scientific Council of Nakhchivan State University on February 13, 2015 and at the meeting of the Scientific Council on Pedagogy and Psychology of the Republican Council for Coordination of Scientific Research on November 3, 2017. The main provisions of the thesis are reflected in the doctoral student's scientific articles published in scientific publications recommended by the Supreme Attestation Commission

under the President of the Republic of Azerbaijan, as well as in his reports at national and international scientific conferences.
The thesis can be used to substantiate the theoretical problems of teaching geometric quantities by concrete-inductive method in accordance with the content of the preparatory course of geometry in I-VI grades, to study the theoretical problems of teaching geometric quantities on deductive basis in VII-XI grades and to develop methods of teaching geometric quantities for school teachers.
Organization where the thesis is carried out;
The thesis was carried out at the department of "Methods of teaching subjects and technology teaching" of Nakhchivan State University.
Structure and scope of the thesis; The thesis consists of an introduction, two chapters, pedagogical experiment materials, results and suggestions, literature. “İntroduction” 10 pages – 15940 characters, I chapter 73 pages – 109950 characters, II chapter 62 pages – 95167 characters, result 4 pages – 4766 characters, used literature 8 pages –
10571 characters. The total volume of the thesis consists of 160 pages –
240075 characters.

MAIN CONTENT OF THE DISSERTATION

In the "Introduction" part of the thesis, the relevance and use of the problem are substantiated; the methodology, scientific innovation, theoretical and practical significance, and the defense rules are explained.

The first chapter of the thesis is called **"Scientific, pedagogical and methodological issues of the problem"**. The first subchapter entitled **"The concept of quantity and its application in the school mathematics course"** states that quantity is one of the basic concepts used in mathematics, physics, chemistry and other sciences. The concept of quantity is considered the primitive concept, such as set, straight line, plane and others. Therefore, the concept of

quantity is not defined, but explained on the basis of concrete examples. Quantity means an object that is distinguished from another object by its own characteristic or important property, and these belong only to it. For example, distance (length), area, volume, mass, temperature, speed, acceleration, etc. Three features of quantity:

a) measurable,

b) has a certain value,

c) has a unit of measurement.

There are two types of quantities in mathematics:

1. Discrete quantities. These include quantities related to determining the number of items. The natural numbers are used for counting and the unit of measurement is 1 (one).

2. Continuous quantities. First of all, let's remember the concept of "continuous function of set": if any ordered set (ie if the elements are arranged in a strict sequence and it is clear which element comes before or after which) is given and it is possible to specify at least one intermediate element for any two elements, then such a set is called a dense set.

Length, area, mass, force, volume, etc. can be an example of continuous quantities. If these quantities are measured in a predetermined (or accepted) unit of measurement, the resulting numbers can be any real number.

The features of the quantity:

1) Each quantity has its own special units of measurement;

2) Each quantity has the largest and smallest units of measurement.

Abstract numbers obtained as a result of measuring a quantity indicate how many times the unit of measurement is in that quantity. This number is called the value of the quantity.

The value of a quantity varies depending on its unit of measurement. For example, the mass of an object can be expressed as 5 kg or 5000 g.

Unlike discrete quantities, the process of measuring continuous quantities is complex. In addition, the methods of measuring continuous quantities are also different.

It is known that mathematics education at school is directly related to problem solving, so all the goals of mathematics education are realized.

It is necessary to establish a certain methodological system for teaching the concept of quantity. This system consists of the solution of two problems that serve the same purpose:

1. To acquaint students with the concept of direct measurement of quantity in a practical way.
2. To convey to students the formal logical essence of the concept of quantity.

Depending on the nature of mathematics training in school, the quantitative concept is taught in a concentric way. Primary school students imperceptibly master the properties of quantities.

When talking about geometric quantities, it is necessary to distinguish three facts:

1) Geometric figure,
2) Geometric quantity,
3) The value of the quantity.

Two methods for comparing quantities:

1. Direct comparison of quantities,
2. Comparison of numbers expressing the values of quantities.

In 10^{th}-11^{th} grades of the school, students are introduced to the strict axiomatic definitions of the system of additive-scalar quantities.

The second subchapter is called **"The essence and methodological issues of the measurement problem"**. It should be noted that geometric quantities and their measurement play a leading role in the school mathematics course. The knowledge gained by students about geometric quantities is vital in measurement and practical applications.

The problem of measuring geometric quantities is both theoretically and methodologically complex.

Thus, the definition of quantity as a general concept is not given in connection with the consideration of measuring objects such as length, area, volume.

Sometimes unreasonable notation such as asm · bsm = absm^2 is used to select area or volume units. This writing shows that the author confuses the functions of units of measurement of length and area quantities and does not understand the essence of quantitative measurement.

The length of the line segment can be an example of the additive quantity. It is also necessary to indicate non-additive, scalar quantities.

The process of quantitative measurement consists of the following sub-processes or activities:

- We select any certain elements from the given quantity set and call it a unit of measurement;
- Implementation of the measurement process;
- Setting a real number for each element of a given set, corresponding to the applied unit of measurement - this number represents the value of the quantity.

The values obtained as a result of the measurement should meet the following two conditions:

1) Equal values should correspond to equal elements of the set;
2) The sum of the two elements should correspond to the sum of their values.

In general, it is necessary to distinguish between the concept of "measurement unit of quantity" and the concept of "dimension of quantity".

The third subchapter is called **"Measurement of Geometric Quantities"** and deals with the addition, subtraction, multiplication and division of line segments.

This subchapter discusses "Measurement of areas". In addition, several definitions are given here.

1) The region which is formed by the triangle is called triangular region.
2) Polygonal region - consists of triangular regions.
3) A polygonal region is the union of a finite number of triangular regions such that if two of them do not intersect, that intersection is either a point or a line segment.

In school practice, the calculation of areas by the analytical method is applied to polygons, disks, balls.

The properties of the areas of polygons allow to determine the means and methods of measuring the areas of all rectilinear figures.

It is known that the concepts of "congruent", "equivalent" figures, "identical figures" are rarely used in school mathematics courses. Only the notions of congruent figures are found in the "Geometry" content lines of the upper classes. In fact, there are figures with the same areas and different shapes, and this is reflected in some issues.

Figures having same areas are known as same size figures. If two polygons can be divided into equal pairs of equal polygons, they are called equilateral polygons. This is because the sum of the area dimensions of the polygons that make up the polygon will be the same in both cases.

This subchapter considers scientific-methodical issues of volume measurement.

The theory of measuring volumes is similar to the theory of measuring areas in general.

In the fourth subchapter of the first chapter, entitled **"Linking theory and practice in the teaching of geometric quantities and the possibility of their implementation in school"**, the connection of geometry to life, the nature of polytechnic training - strengthening the theoretical and practical ties of knowledge.

In order to fulfill the tasks of polytechnic training in the school mathematics course, students need the following:

1) To gain theoretical knowledge of geometry;

2) To show how the properties of space forms are used in scientific and practical activities of people in the process of learning geometric materials.

The application of theoretical knowledge of geometry in science, technology, agriculture and other fields is an objective reality.

In educational documents and pedagogical press, special attention is paid to the development of critical thinking in students,

the discovery of effective solutions to the problem, initiative and creative activity, interest in solving constructive issues. *
The connection of theory (theoretical knowledge) with practice in geometry is based on the following content:
1) The relationship of geometry with other sciences,
2) The relationship of geometry with technology and production,
3) Preparation of students for technical creativity.
When discovering the content of geometry, first of all, it is necessary to show the properties of spatial forms and their application in human life and practical activities.

Before teaching some theoretical material, it is possible to start by solving practical problems that help students to master new material.
If practical problems require the determination of the geometrical characteristics of a real object, then the student should be able to describe those objects in the form of geometric objects.

The teaching of geometric elements should serve the formation of the following qualities in students:
1) Formation of spatial imaginations,
2) Formation of observation and comparison skills,
3) Development of generalization and abstraction skills,
4) Application of geometric knowledge in life, practice.
In geometry classes on problem solving, students have to do the following:
- understand the need to apply mathematics in life (production) as a mathematician,
- gain relevant skills and habits in measurements and calculations,
- connect geometry's school training with life.

The fifth sub-chapter of first chapter is entitled **"The place of functional dependences between geometric quantities in teaching**". In the process of measuring each quantity, there is a mathematical relationship between the units measured, measurer, or units of measurement. The number expressed in this dependence depends on the value of the unit of measurement used.

The concept of number also allows us to determine the relationships between quantities, because in mathematics, functional dependence refers to the direct dependence between quantities. Of course, this means not only two quantities, but also the dependencies between three or more quantities. For example, atmospheric pressure, the speed of motion of an object, and so on.

There are certain dependencies between the quantities involved in the same process. The nature of these dependencies is that if two quantities are related by a certain dependence, then each value obtained by one of them corresponds to a certain value of the other quantity. In this case, a free variable is called an argument, and a dependent variable is called a function of a free variable.

Functional dependencies between quantities are divided into the following types according to their nature:

1. Directly proportional quantities.
2. Inversely proportional quantities.

The second chapter of the thesis is called **"Psychological and methodological issues of problem teaching"** and is explained in sixth subchapters. The first subchapter of this chapter is called "**The problem of teaching geometric quantities in the curriculum**".

The new education system reflects the following issues:

1) Learning outcomes on mathematics (for 1^{st}-4^{th}, 5^{th}-9^{th}, 10^{th}-11^{th} grades),
2) Content lines and their substantiation in mathematics,
3) Learning outcomes or standards for content lines,
4) The content of the subject of mathematics,
5) Integration in mathematics teaching.

The mathematics teaching strategy:

- Basic requirements for teaching mathematics,
- Methods and forms of organization of mathematics teaching,
- Time distribution of teaching material by grades (volume and content of material),
- Planning of teacher's learning activities,
- Types of assessment and monitoring,
- Material and technical support,

- Teaching-methodical support,
- Methodical recommendations[6].

Here the material is classified as follows:

1. In 1st-4th grades
2. In 5th-11th grades

The second subchapter of second chapter is entitled **"Criteria for the selection of teaching materials for geometry (grades 1-11)".**

The inspections conducted and the experience of leading teachers, the study of existing research in this area allowed us to note the following facts:

- Compiling exercises similar to the problem or task in the textbook;
- Selection of practicing exercises;
- Selection of problems, developmental works that serve to strengthen the new knowledge or to make new generalizations;
- Selection of works that serve to form the necessary practical skills and habits and achieve their application.

The third subchapter is called **"Characteristics of the teaching of geometric quantities"**. Here is an analysis of primary and secondary school textbooks and methodological research. The methodology of teaching quantities in the dissertation is adapted to the method of teaching numbers and is divided into the following stages:

I - Formation of general ideas about quantity
II – Comparison of quantities (homogeneous) by observation and direct measurement
III - Familiarity with the unit of measurement and measuring devices
IV - Addition and subtraction of quantities (addition and subtraction of numerical values)
V - Correlation of numbers by concentrations with units of measurement

[6]Subject curricula for I-IV grades of secondary schools / - Baku: Education,– 2008, – p. 8

VI - Dividing and conversion of named numbers
VII - Addition and subtraction of complex numbers
VIII - In relation to the anonymous (abstract) problem of nominal numbers and the purpose of the study, it is directly related to quantities (their measurement).[7]

The fourth subchapter of the second chapter is called **"Problem Statement in Textbooks".** The primary mathematics course is an integrative course. This means that the different materials (arithmetic, algebra, geometry, physics, probability, etc.) included in this course must be taught in a coherent manner. The didactic significance of this is that students learn the connections between subjects. On the other hand, their knowledge is complete and objective about the real being. The knowledge gained in the mathematics course of primary school develops in 5^{th}-11^{th} graders, because in secondary school, students learn the basics of sciences. The knowledge gained in the later stages of education is based on that initial one. This shows that the basic, honest (without distortion) knowledge gained in secondary school should be considered as the most necessary factor. Therefore, the teaching of subjects in secondary school, including mathematics, should be based on the right methodology and taken into account in the future. This chapter also reflects the problem in methodological research.

The fifth sub-chapter of the II chapter is about psychological and pedagogical features in the analysis of geometric quantities. The fact that geometry is a deductive science is reflected in the learning process at school, requires a new approach from the teacher. Therefore, the psychological factor must be taken into account in the teaching of geometry. Although geometric concepts are accompanied by pictures and drawings, the quality of mastering is lower than in other subjects.

Standard drawings of geometric figures do not enrich students' spatial imagination. That is why the drawing does not provide the necessary

[7]Majidova, A.A. Formation and development of the concept of numbers in I-IV grades: / Doctor of Philosophy dissertation on pedagogy - Baku 2007. – p. 72-73

support in the interpretation of the theoretical material on geometry, in the solution of the problem.

The varied depiction of a geometric figure enriches students' spatial imagination.

Perception and imagination are the initial stages in the formation of a concept, and their richness in content ensures the rapid formation of the concept. Distinguishing between identical and non-identical figures given in different situations and in different sizes - develops students' geometric imagination.

In some cases, the main feature of the concept in the teacher's oral interpretation is not fully understood by some students. As a result, the main feature of the figure (concept) is replaced by its feature for special cases.

Academician I.P Pavlov wrote about the power and role of the word in cognition: "Of course, speech, like other means, is a real conditional irritant to man, and together it has great potential for comprehension.[8]

The understanding of the connection and correspondence between the word and the image occurs in students when the shape and position of the displayed figure are given in different variations and accompanied by the teacher's explanation. There is no need to increase the number of variations unnecessarily.

The sixth sub-chapter of the II chapter of the thesis is devoted to the teaching of geometric quantities in the school mathematics course. The following issues are discussed here:

1. Formation of geometric imagination:
2. Development of geometric thinking
3. Formation of spatial perceptions (reflects spatial perceptions)
4. Teaching geometric material in relation to other mathematical material
5. Formation of graphic-measuring habits
6. Application of visual – technical means

[8] Pavlov I.P. Complete works / I.P. Pavlov. - Moscow: - 1951, - p. 429

The thesis concludes with a pedagogical experiment and its results. The most important and effective pedagogical research is a methodological-pedagogical experiment.

In the first stage, the concept is put forward, the object, subject and purposes of the research are defined. This stage is called the defining stage.

The next stage of the pedagogical experiment is called the teaching stage. The research proposals are implemented in the training process. Defects that occur at this stage are eliminated and reintroduced into the training in the third stage of the pedagogical experiment. Therefore, the last stage of the experiment is called the test or application stage.

A pedagogical experiment was conducted in the city and district schools of the Nakhchivan Autonomous Republic to test the suitability of the author's version on the teaching of geometric quantities in the school's mathematics course. The classes in the experimental schools were grouped into “supervision” and “experiment” to compare the quality indicators correctly

The level of knowledge of students was calculated based on the following formula and summarized in the appropriate tables given in the thesis:

$$M = \frac{\sum X}{N} \times 100$$

Here:

M - level of knowledge of students,

$\sum X$ - the sum of the number of students who answered correctly;

N - indicates the total number of students.

The following formula was obtained to check the percentage of mastery of our methodology:

$$K_{m.f} = \frac{Y}{N} \cdot 100\%,$$

$$K_{k.f} = \frac{Z}{N} \cdot 100\%,$$

Here:

$Km.f$ - success rate;

$Kk.f$ - percentage of quality;

Y - the number of answers on l III and IVevels;

Z - the number of answers on II, III and IV levels;

N - indicates the total number of students.

The results of the test experiment are expressed as a percentage in the tables

Table 1

Schools	Classes	Number of students	Rates				Success (%-)
			IV	III	II	I	
Nakhchivan city school № 1, 5 and Garnizon high school	N	75	20	23	23	9	88
	E	74	29	27	14	4	94
Shahbuz district secondary school № 1	N	39	8	11	12	8	79
	E	40	12	14	10	4	90
Sharur district secondary school № 2	N	22	5	8	5	4	81
	E	23	10	8	4	1	95

In Table 1:

The first level group of answers (insufficient answers) includes the answers of students who are unable to answer the questions correctly or they cannot refer to any logic in substantiating their proposals.

Second level answers are considered incomplete answers. This group includes students' answers in such a way that their knowledge of geometric concepts, including geometric quantities, is less than 2/3 of the total knowledge. These students make certain mistakes in the mathematical relations between the units of measurement of geometric quantities.

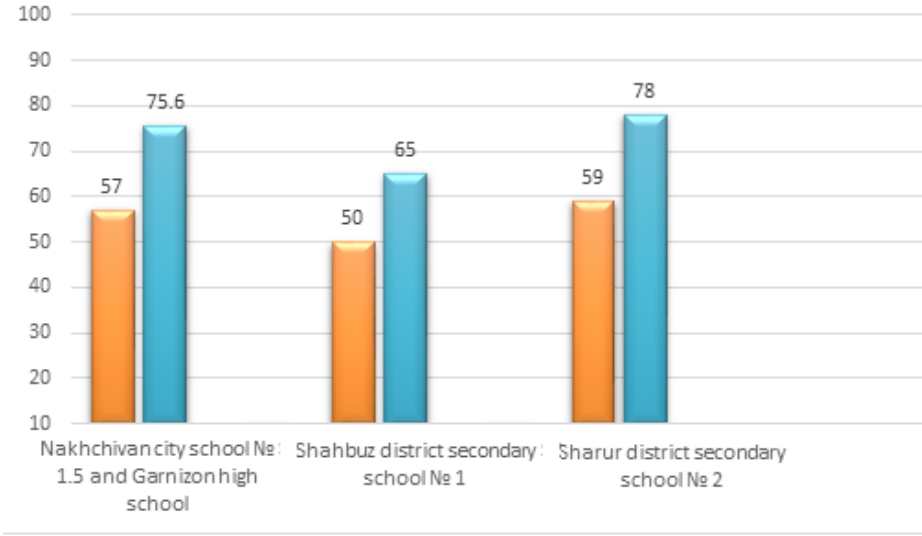
The third level of answers is considered to be a partial or complete answer, as the student has mastered 2/3 of the knowledge defined in the didactic model and is mainly able to apply it in problem solving.

Fourth level answers - exemplary answers are considered that the student knows the definition and application of geometric concepts and is able to apply the units of measurement of geometric quantities, mathematical relationships between them in problem solving.

As can be seen, the experiment was successful and the correctness of the concept put forward by the author was confirmed.

Table 2

Schools	Quality percentage		The difference in mastery (%)
	In experimental classes (%)	In surveillance classes (%)	
Nakhchivan city school № 1; 5 and Garnizon high school	75,6	57	18,6
Shahbuz district secondary school № 1	65	50	16,3
Sharur district secondary school № 2	78	59	19



Classification and assessment of students' knowledge by the above criteria in the process of pedagogical experiment - is necessary to determine the degree of development of their spatial thinking, and thus the possibility of applying innovations in the teaching methods of the subject.

In the "Conclusion " part of the thesis, the research was summarized, generalized and the obtained results were analyzed.

1. "Geometry" and "Measurements", the leading content lines in the school mathematics course, play an important role in the formation and development of students' spatial thinking, provides theoretical knowledge and practical skills and habits related to quantities and their measurement.

2. It is expedient to study the measurement of geometric quantities such as length, area, volume, angle in school mathematics, which is an integrative course, from the point of view of inheritance, to perform it in three stages in I-IV, V-IX, X-XI grades.

The first stage can be considered visual-concrete-inductive.In the second stage, problem-solving and practical measurements should be preferred, using theoretical elements in practice.

By referring to the theoretical knowledge of students in algebra and mathematical analysis, The third stage can be called the stage of studying the theoretical foundations of geometric quantities in close connection with practical applications. Because, up to this stage, students have enough theoretical and practical training.

3. In the teaching process, the teacher should have specific information about the geometric knowledge of students related to the program material and take into account development level of them:

1) information about quantity and its properties,
2) knowledge related to the axiom of mathematical operations on quantities,
3) quantities' units of measurement and relations between them,
4) definition of scalar, vector quantities and scalar additive uninterrupted quantities,
5) the concept of sequence, the necessary and sufficient conditions of assembly,
6) comparison of real numbers and basic theorem,
7) measurement of segment length: invariance and additivity of length measurement,
8) general definition of area size. The presence of the area size of a rectangle and a polygon. Additivity and invariance of these measurements,
9) general definition of volume size. The presence of the volume of a flat cylinder. The result obtained from the formula;
10) derivation from the Cavalier principle and Simpson's formula. applications of the theorem to the derivation of volumetric measurements of basic bodies (for cylinder, cone and sphere),

11) formulas for calculating the surface area of a cylinder, cone and sphere.

4. Expanding the scope of “Geometry” and “Measurements” content lines in VII-XI grades strengthens students' theoretical and practical knowledge and skills on measuring geometric quantities as they move from class to class.

5. Implementation of measurements in school with the application of differential and integral calculus methods of modern mathematics by moving from the inductive method to the deductive method of measuring geometric quantities allows students to form and apply theoretical and practical skills.

6. Testing the hypothesis (system of theses) put forward in connection with the pedagogical experiment makes it necessary to make the following suggestions:

1) teachers’ “service” is not less in solving serious problems such as ““a sm · b sm= absm^2” in solving problems related to area and volume;
2) When calculating the size of a quantity, the definitions of the multiplication operation should be used: the sum of a finite number of equal sums is defined, when calculating the area of a rectangle, the unit of measurement is determined first and multiplication is applied.

7.Acquaintance with geometric figures and their properties helps to develop students’ skills of graphics, measurement and calculation. Therefore, it is useful to organize laboratory work “Working with geometric figures” in the 4th-9th grades.

The main content of the thesis is reflected in the following published works of the author:

1. On the geometric quantities teaching // Regional development and great culture: international conference on origin, harmony and typology.- Nakhchivan: Qeyrat, October 25-26, 2013, - 2013. - p. 62-63

2. Quantitative concept in high school mathematics course //- Baku: Pedagogical University news, department of pedagogical-psychological sciences, - 2014. . №-1, - p. 413-415
3. On the teaching of geometric quantities in primary school / - Baku: News of Pedagogical University, department of pedagogical-psychological sciences, - 2014. №-3, - p. 473-475
4. Geometric quantities in the school course of mathematics // - Kherson: Ministry of Education and Science of Ukraine Kherson State University, – 2016. LXX.Том.1. – pp. 47-50.
5. Measurement of geometric quantities in the school course of mathematics // - Nakhchivan: "Nakhchivan" University Scientific Works, - 2018. №-1, (11), - p. 284-287.
6. Teaching the concept of volume in the school course of mathematics // - Nakhchivan: "Nakhchivan" University Scientific Works, - 2020. №-2, (17), - p. 271-275.
7. Consideration of psychological and pedagogical features in the process of teaching geometric quantities / MODERN SCIENTIFIC CHALLENGES AND TRENDS: a collection scientific works of the International scientific conference - Warsaw: Sp. z o. o. "iScience", – 2021. – (7-9 June, 2021). – Part 1. – p.134-140
8. Teaching the concept of area in the school course of mathematics // - Nakhchivan: Nakhchivan Teachers' Institute, III regional scientific conference of doctoral students and masters on "Unity of education, research and innovation", Nakhchivan - 2021. - p. 282-284.

The defense of the dissertation will be held on 26 November 2021 at 11:00 at the meeting of the Dissertation Council FD 2.40 of the Supreme Attestation Commission under the President of the Respublic of Azerbaijan operating at the Nakhchivan Teachers' Institute.

Address: AZ 7003, Nakhchivan city, Heydar Aliyev avenue 1, Nakhchivan Teachers' Institute

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