Research Article

Received: 11 March 2024 / Accepted: 19 June 2024 / Published: 05 September 2024

Foundations of the Methodology for Continuity of Teaching Mathematics at School and University in the Context of Digital Renewal of the Educational Environment

A. E. Abylkassymova[1]

Y. A. Tuyakov[1]

Zh. S. Yerkisheva[2]

Zh. N. Turganbayeva[2]

A. Bazhi[1]

[1]Kazakh National Pedagogical University named after Abay, Almaty, Kazakhstan
[2]Akhmet Yassawi International Kazakh-Turkish University, Turkestan, Kazakhstan

DOI: https://doi.org/10.36941/ajis-2024-0161

Abstract

This article examines the issue of teaching elements of mathematical analysis based on continuity in high schools and higher education institutions in the context of digital education. The meaning of the concept of "continuity", methods of continuous teaching of elements of mathematical analysis in high schools and higher educational institutions, as well as the reasons for the lack of academic hours for studying mathematical subjects in higher educational institutions and the deterioration of mathematical training of school graduates entering higher educational institutions are determined. At the same time, in the context of digital education, this is due to the creation of a methodological system for the consistent teaching of elements of mathematical analysis in the course of teaching the course "Algebra and the beginning of analysis". External factors are identified when developing a methodological system. In order to clarify the content components and simplify the explanation of complex tasks to students, in the procedural component we used the capabilities of computer technologies, which are the basis for the development of pedagogical science in the context of digital education. The effectiveness of the proposed methodological system has been introduced into the educational process in secondary schools of the Turkestan region and the city of Turkestan and has been proven experimentally.

Keywords: *school, university, continuity, mathematical analysis, structure of the methodological system, research, ICT*

1. Introduction

Currently, the widespread use of digital technologies, involving the use of computers in various types of activities, requires improving the mathematical training of graduates of various levels: secondary and higher educational institutions. Therefore, there is a problem of deeper and better study of mathematics, the development of mathematical abilities of schoolchildren and students in schools and higher educational institutions. In the 21st century, it is very important to prepare a new generation of teachers with a high level of thinking and analytical abilities. It is clear that solving this problem is of particular importance in the training of mathematics teachers in higher educational institutions, since graduates of these educational institutions must not only acquire the necessary knowledge and skills, but also have a sufficient level of development of their mathematical knowledge and abilities. Because, the professional qualities of mathematics teachers are a crucial factor in the sustainable development of the school. In addition, through continuing education, teachers can improve their professional knowledge and skills in student-centered teaching.

In the Law of the Republic of Kazakhstan "On Education", the main principles of state policy in the field of education are the continuity of the educational process, ensuring the continuity of its levels (Law of the Republic of Kazakhstan, 2007).

In the course of teaching mathematics, it is possible to solve the problem of improving the level of students education of the educational program for training teachers of mathematics in higher educational institutions, the purpose of which is to adapt students to study in higher educational institutions to apply and to implement an adapted learning system. However, one of the ways to solve this problem is the issue of continuity of education.

In recent years, scientific and pedagogical research on the integration of computer technology capabilities in teaching mathematics in digital education has provided various opportunities for teachers of educational institutions in many countries to develop skills in working with information and computer technologies. countries including the USA, Great Britain, Lithuania, Finland, Korea, Japan, Singapore, Turkey and Kazakhstan (Stephens, 2018; Kadijevich et al.; 2023, Li et al., 2020).

Since the global pandemic, the use of digital educational resources in the educational process, the introduction of mobile devices and computer information technologies have made education accessible to all.

In the context of digital education, the integration of computer technology into the teaching of a subject allows students to explore their problems more deeply, as well as present their conclusions using a variety of alternative answers.

To this end, the researchers focused on the importance of digital education for the development of practical and logical thinking skills in mathematical education and stated in their work that an educational environment equipped with the use of information and computer technologies can improve the understanding and quality of the educational system (Alabdulaziz, 2021; Tamur at al.).

It is also stressed the need for new goals and objectives of mathematical education related to changes in the modern digital world, and formulated that, turning to innovations in teaching mathematics, this contributes to increasing the interest of students in studying mathematics (Semenov, Abylkassymova, & Polikarpov, 2023).

In the context of digital education, it was noted that new goals of mathematical education can be achieved through the development of students' intellectual abilities, the formation of mental qualities inherent in mathematical activity, and specific mathematical knowledge, skills necessary for practical application (Abylkassymova, 2023).

Using technology to actively and creatively teach mathematics helps people develop the skills and knowledge needed to meet the expectations of 21st century education and society (Kadijevich, 2019; Tyncherov et al., 2020).

Therefore, in the digital age, new requirements and tasks are being imposed on mathematics teachers of all educational organizations and university teachers in each subject. Thus, the teacher, in addition to having high-quality knowledge in his subject, have to apply the acquired knowledge in practice, correctly convey it to students, choose digital educational resources, teaching and evaluation methods, and provide feedback. And this is related to the student's success in achieving the expected results and learning goals in mastering the studied material on the subject of mathematics.

At the same time, teachers of higher education, future teachers of mathematics, should be ready for new tasks demanded by society and look for new ways of improvement in order to successfully carry out their activities in the changing conditions of the educational environment.

During the teaching of professional subjects to 1st-year students who entered the university, it was noticed that the consequence of their lack of knowledge to master this subject was their incomplete mastering of mathematical knowledge in secondary schools. Mathematical analysis is one of the subjects that are difficult for university students to master.

The methodological system of teaching mathematics does not sufficiently take into account the possibility of using digital and computer technologies in teaching elements of mathematical analysis in schools and universities on the basis of continuity, which requires a comprehensive consideration in the process of teaching mathematics.

Therefore, in the context of digital education, it is important to have a continuity of learning between the content of the taught material, teaching methods, assessment and control of academic achievements of high school and university students, relying on the help of computer technology.

Hence objective of the article is to develop and experimentally validate a methodological system for the continuous teaching of elements of mathematical analysis in high schools and higher education institutions within the context of the digital renewal of the educational environment. The main tasks include exploring the concept of "continuity," integrating digital technologies into the teaching process, and enhancing the mathematical preparation of students to ensure a successful transition from secondary to higher education.

2. Literary Review

Continuity fulfills the general didactic function of such categories of pedagogy as education, upbringing, and development. The quantitative characteristic of a student's readiness for the next level of education in continuing education is an indicator of continuity. For the effectiveness of the pedagogical process of continuing education, a general continuity is necessary.

The effectiveness of continuing education in the pedagogical process was demonstrated by academician A.E. Abilkasymova (2018), in her research, stated that "modern conditions pose new challenges to mathematical education at school, i.e. every student should be able to achieve the required level of mathematical knowledge. In this regard, the content of mathematical education in higher educational institutions is focused on the implementation of the principle of continuity of mathematics courses, the integration of related departments of mathematics, including methodological subjects, which will significantly improve the quality of professional training of mathematics teachers in the future" – she pointed it out.

The analysis of various aspects of continuity in science, pedagogy and education and the theoretical basis of its research problem, the role and features of continuity in the acquisition of knowledge, competence and skills were reflected in the works of Abylkassymova et al. (2023), Tuyakov (2011), Mubarakov (1999), Attard (2013), Grootenboer and Marshman (2016), Carmichael (2015), Cantley et al. (2020), Nicolescu and Petrescu (2015).

According to Abylkassymova (2023) and others that the concept of continuity includes requirements for the knowledge and skills of students at each level of education.

Tuyakov (2011), in his work, considering the continuity of the mathematics course content at school and university, emphasized that a correct understanding of continuity is great benefit for using the learning process and its individual stages in the lesson organization. He also identified the following types of education: "When implementing continuity in teaching mathematics at school and university, the relationship between the topics of the mathematics course is characterized by stability; it helps to identify important parts of a concept or topic and establish appropriate connections between their individual parts and study it; there is a situation when students constantly repeat well-known topics from the school course and memorize them in case of forgetting; yesterday's higher school student, today's university student will not have additional difficulties in mastering the materials of the mathematics course, on the contrary, it will be easier for him to assimilate new material, increase his enthusiasm for a full understanding of a new topic, give him the opportunity to remember it; as a result of combining topics with new ones, the creative activity of both the teacher and the student, the quality of education increases; high school students study educational materials and methods of teaching mathematics at universities" – makes a conclusion.

According to Mubarakov (1999), continuity can be used as a universal basis as a methodological principle of the educational process at different stages of education.

Nicolescu and Petrescu (2015) identify the following basic prerequisites for effective training of mathematics teachers to ensure continuity in teaching: future teachers should know the problem of continuity, understand the peculiarities of educational activities of secondary schools and higher educational institutions, get acquainted with the ways of interaction between secondary schools and higher educational institutions, study methods of pedagogical diagnostics, determine the abilities of students and analyze their educational achievements, etc.

Attard (2013), Carmichael (2015), Cantley et al. (2020), Grootenboer and Marshman (2016) noted in their research that useful points of continuity in teaching and learning will contribute to improving the quality of students' education if they are used in the curriculum on the subject of mathematics learning at different stages starting from elementary grade.

One of the main conditions and mechanisms of continuous professional development of a person is the continuity of education.

Therefore, we understand that continuity is a necessary condition for the creation of continuing education, continuity is primarily a law related to the components that define and implement educational programs of different levels and directions, generally binding educational standards, that is, the content and technology of education at different levels. At the same time, continuity ensures the interconnection of individual stages of the development of the educational system during the transition to a new stage. By continuity in education, we understand the connection between different stages of education development, preserving certain elements that manifest themselves at a new stage. Modern times place new demands on knowledge: nowadays, the process of collecting, processing and applying knowledge is important.

3. Materials and Methods

3.1 Research methods and stages

Active forms of mathematical education organization were used to teach elements of mathematical analysis based on continuity in the senior classes of general education organizations of secondary education and students of the educational program for the training of mathematics teachers. In particular, design methods, problem and research methods, heuristics, critical situations, etc.

Level learning methods have been used to achieve consistent assessment of learning objectives at convenient learning levels that organize student interest and motivation. Differentiated learning is a way to optimize the learning process and eliminate knowledge gaps (Abylkassymova, 2020). Level—based differentiated learning is the presentation of tasks for evaluating students and their learning outcomes at several levels. Bloom's taxonomy was used in each lesson in the formation of students mathematical knowledge, competence and practical skills in continuous learning of mathematical analysis elements at school and higher education institutions.

Experimental work has been carried out to evaluate the effectiveness of teaching methods of mathematical analysis elements based on continuity in school and university. The experiment was conducted on high school students of the specialized boarding school named after N.Ondasynov, IT-lyceum №23 named after Zhumabek Tashenov and students of the training program for mathematics teachers of the International Kazakh-Turkish University named after Kozha Ahmet Yasavi.

The main purpose of the experiment definition period was to study and analyze the pedagogical practice of developing knowledge, skills and abilities of high school students in teaching elements of mathematical analysis at school.

The significance of the school mathematics course is determined by analyzing the continuity in the study of mathematical subjects in higher education.

Currently in Kazakhstan, the general education of school graduates is assessed by means of a national unified test (NUT). To determine the level of students' mathematical knowledge, nationally standardized test tasks were used as a benchmark. National unified test items were used as a benchmark to determine the level of students' mathematical knowledge. The math problems in the Nationally Unified Test patterns consist of 3 levels – first level (simple tasks) — 36%; Second level (medium difficulty) — 40%; third level (more complex) — 24% questions. The test questions included educational materials on mathematics developed on the basis of the state standard of general secondary education.

We conducted a survey to determine the interest (in life, profession, education) of students who wish to pursue higher education in a mathematics education program. The diagnosis shows that there is a differentiation of students' desires and interests in mathematics education. But in general during the survey, using the principle of continuity in teaching mathematics, using the possibilities of information technology, students feel more confident in solving mathematical problems and spend less time to solve the problem, etc. it was noticed that errors in calculations are unacceptable.

Wide use of computer technology capabilities in continuous mathematics education allows all teachers to update the methodology of practical and laboratory classes.

3.2 Experimental base and research participants

At the beginning of the experiment the methodological system effectiveness of teaching continuity realised of mathematical analysis is tested in schools and higher educational institutions.

A total of 204 students participated in the study and the study was conducted in several phases.

The defining-search period for the 2019-2020 school year;

Study and analysis period for the 2021-2022 school year;

2022-2023 school year is observation period.

In pedagogical-experimental work was established to verify the effectiveness of the created methodological system of using computer technologies in teaching elements of mathematical analysis on the basis of continuity in school and university.

The main objective of the study is to clarify the methodological approaches that contribute to the realization mathematical analysis elements' teaching effectiveness on the basis of continuity in schools and pedagogical universities.

During the defining-search period, diagnostic work was conducted for students using the problems identified in the NUT tests. The final results of the exam were obtained in the experiment. Experimental groups -10 «A» and 10 «B», 11 «A» and 11 «B» classes (104 students), control groups – 10 «V» and 10 «G», 11 «V» and 11 «G» classes (100 students). As a result of the experiment, there was a positive dynamic of the student's education quality indicators of the experimental group.

4. Results

4.1 The structure of the teaching methodological system of mathematical analysis elements at school and university on the basis of continuity

Currently, the goal of the secondary educations generally binding standards of the Kazakhstan Republic in the subject "Algebra and Beginnings of Analysis" of general secondary school is the development of the student's personality with a wide range of skills (creative use of knowledge; critical thinking); research work; use of information and communication technologies). It is said to create a suitable educational space for harmonious formation and development. The content of the curriculum for the subject "Algebra and Beginnings of Analysis " is aimed at the development of mathematical knowledge systems and skills, as well as mathematical culture and functional literacy, necessary for students to successfully study at the next level of education. It is also aimed at solving practical problems (Ministry of Education and Science of the Republic of Kazakhstan, 2022).

We can say that in the content of the sample program of the subject "Algebra and Beginnings of Analysis" for students of 10-11 grades, the sections "Derivative, first function and integral" and their applications are among the most difficult sections. The study of these topics will provide future graduates with the basic knowledge and skills necessary to study the subject of Mathematical Analysis in higher education.

Therefore, "Mathematical Analysis" is a subject that develops the mathematical thinking skills formed in the study of the subject "Algebra and Beginnings of Analysis" in school, and develops the skills of continuing, theoretical and research activities of the school course in higher education institution.

In the training of mathematics future teachers, "Mathematical Analysis" plays an important role in preparing graduates for future professional activities at school. For example, the teacher should teach students not only to find the derivative or antiderivative function of a function, but also to understand the need to find them, to justify and deduce ways of finding them, to apply the acquired knowledge and skills in practice.

Today, despite the deep elaboration of the continuity education problems by many scientists, it is necessary to further study the problems of continuity teaching of mathematical subjects and obtained results implementation in practice. Recently, the authors of many scientific and methodological publications have noted that students studying in technical and pedagogical institutions have poor mathematical training (Orazbekova, 2015; Botuzova, 2020; Briggs, 2012).

Consequences of the low level of mathematical knowledge of schoolchildren, during the preparation for NUT students do not pay attention to the solution of problems, memorize the way of solving problems, but do not know that the learned information is quickly forgotten by a person. That is why students who continue their studies in higher education do not know how to receive and process information on mathematical subjects, how to work with the material independently. First year students have poor computational skills, mathematical speech, and do not know some basic education level math concepts and definitions. They poorly understand the graphs of functions and cannot explain the geometric meaning of the functions properties, they have not developed the working skills with tasks, using analysis, synthesis, analogy and other methods in the search for a solution to the problem. The experience of teaching mathematical subjects in this higher education institution, particularly mathematical analysis, also confirms the inadequate preparation of students.

Turganbayev (2021) studies the methodological aspect of continuity, creates a model of the learning process based on continuity in teaching mathematics, and believes that for continuity in teaching. It is necessary to determine the student's vocabulary necessary for mastering any topic in teaching mathematics. At the same time, the author showed that the level of first-year students training is insufficient for successful mastering of mathematical analysis, and identified a group of difficulties faced by students in mastering the subject:

a. most students have algorithmic thinking, can solve standard problems, but have difficulties in justifying the solution;
b. most students have difficulty understanding the main points of definitions, theorems and methods, deriving formulas, and proving theorems;
c. it is difficult for students to work and search on their own.

He emphasized that one way to overcome these difficulties depends on continuity between school and university.

Fully agreeing with the opinion of the mentioned author, the school teacher should explain the possibilities of continuation in higher education when teaching elements of the mathematical analysis course in the school course and form calculation skills.

This is due to the academic freedom of Kazakhstan universities in solving the problem of ensuring the educational programs continuity in educational institutions preparing teaching staff for higher education institutions, in accordance with the content of the model curriculum of the subject "Algebra and Beginnings of Analysis" level of general secondary education.

Therefore, in the curriculum of educational program 6B01509-Mathematics, created in accordance with the requirements of credit technology in the International Kazakh-Turkish University named after Akhmet Yassawi, the number of hours allocated for the study of mathematical subjects is reduced, and priority is given to the organization of the student's own work in the educational process in accordance with generally binding standards of higher education. A student of a higher educational institution, whose mathematical knowledge and skills are not fully formed within the walls of the school, experiences difficulties in performing independent tasks in the study of mathematical subjects. And in determining the content of mathematical analysis by credit technology, it is necessary to carry out the content that is considered as the relationship between knowledge and action.

Therefore, continuity is one of the main conditions for ensuring the continuity of education at all stages of education.

Thus, analyzing a large body of literature on our research, it is shown that continuity in the content, forms and methods of teaching is the basis of successful teaching of mathematics to schoolchildren and students of higher educational institutions.

According to Pyshkalo's (1978) methodological point of view, continuity is related to the components of the methodological system (methodology). Continuity is seen here as "the phenomena connection in the process of development, excluding the old in the creation of the new and preserving some of its elements".

Pyshkalo (1978) from his methodological point of view noted that the manifestations of the continuity problem in internal and external methodology are the teaching system of each individual subject, in particular, the purpose, content, methods, means and organizational forms of teaching.

The linear-concentric structure of the mathematics school course allows us to distinguish two directions of ensuring continuity in teaching the subject:

1) continuity between adjacent levels;
2) continuity at each course level:
a) continuity in each course of mathematical subjects;
b) continuity between mathematics courses.

Guided by the methodological approach of Pyshkalo (1978), in accordance with the continuity principle of mathematical analysis elements of students, according to the structure of using the methodological system information and computer technologies in teaching, were created:

- *external factors,* the need to improve students' mathematical knowledge and skills through the possibilities of digital educational resources and computer technologies in the continuous teaching of mathematical analysis elements;
- *targeted component,* the choice of method is aimed at the implementation of educational goals and objectives through systematic familiarization, the format of organization, methodology and technology, content and motivation of learning are clearly defined;
- *content component,* to determine a didactic and methodological principles' set of methodical approach to the use of digital educational resources and computer technologies in teaching students elements of mathematical analysis on the basis of continuity;
- *process component,* to determine the formation ways of methodical approach, content, structure, organizational form, methods and algorithm of teaching, providing effective use of digital educational resources and computer technologies in teaching students of mathematical analysis elements on the basis of continuity;
- *evaluation and efficiency component,* checking the quality of knowledge and skills in digital

educational resources and computer technologies in teaching students mathematical analysis elements, which contain criteria and indicators of evaluation, as well as learning outcomes.

Development of critical thinking technology, technology of problem-based learning, technology of developing learning, technology of active learning as the main teaching technology in the use of digital educational resources and computer technology in teaching mathematical analysis elements on the basis of continuity in general educational organization.

Each constituent component has its own tasks in creating a methodological system.

The task of the target component of the methodological system is to teach high school students mathematical analysis elements in the conditions of continuity between school and university. In this component, we identified the correspondence between the elements of mathematical analysis.

In the methodical system content components, it is necessary to choose methods and principles of its development with the conditions of continuity between school and higher education institution in teaching mathematical analysis elements.

Includes subject-matter content of the learning process by analyzing the mathematical analysis elements on the basis of continuity between school and higher education. Teaching content on basis of the Kazakhstan Republic Law "On Education" and standards of compulsory state education, model curricula, the content of the textbook on the subject "Algebra and Beginnings of Analysis" is defined as follows:

- System of tasks "Limit and continuity of a function";
- A system of reports "The derivative and its applications";
- Antiderivative Function Reporting System;
- A system of reports "Integral and its application".

The content part of the created methodological system reflects the main idea of the teaching methodology algebra and beginnings of analysis to high school students. The mathematical analysis elements are training based on the continuity of school and university, a system of tasks that allows to increase the level of learning development activities in solving problems of the mathematical analysis course in higher education. Teaching students to solve mathematical problems contributes to the readiness of graduates to continue their mathematical education. In the procedural component, it aims at identifying methods, forms and means of teaching that allow general secondary school graduates to adapt more quickly in higher education. The main objective of this procedural component is to develop mathematical knowledge and skills based on what they have learned in school. At the same time, when creating a methodical system, we chose teaching methods that promote the mathematical skills mastery. In particular: reproductive, problem-based, explanatory and visual, research, experimental, differentiated, problem-based, project-based, active learning methods, interdisciplinary communication, modelling, ICT and others. Forms of teaching: lesson, lecture, practical training, group, individual work, laboratory work, extracurricular work, independent work, scientific projects. School textbooks, problem sets, didactic materials as teaching tools.

Methods of teaching mathematical analysis elements based on continuity are used to improve students' mathematical knowledge skills using system-action approach, person-centered approach, communicative approach and research methods.

System approach is a set of components of the teacher education system. These are educational goals, content, methods and forms of education organization. *Within the framework of the systematic approach*, the learner's personal activity increases, and a positive attitude towards the formation of mathematical knowledge and literacy develops.

Person-centered approach is based on the psychological situation in each mathematical activity in terms of theoretical and practical plans. *The person-centered approach* connects the person and the subject under consideration on the basis of certain patterns.

A communicative approach is used to develop students' oral and written communication skills, developing mathematical language skills in solving algebra problems and analytical initiatives given in mathematics education.

The research method is a mathematical analysis course, which continues this topic by studying the subject of the algebra and beginnings of analysis. It helps to form cognitive activity and interest in solving textual problems, to develop research skills, to familiarize with the methods of scientific cognition.

In the process of lifelong learning in mathematics, the above methods facilitate students' independent or interrelated search for solutions to problems and answers to questions, understanding, analyzing, searching for information from various data sources, reading, comprehending, and transforming. provide evidence, summarize, and draw conclusions.

And the principles of systematicity, scientificity, continuity, content systematicity and applicability were used in the creation of this methodological system for the development of students' mathematical knowledge and its improvement.

The methods and principles mentioned in the proposed methodological system help high school students to form universal learning activities by solving a system of problems for each specific topic when teaching mathematical analysis elements.

We created a model of the structure of the above-mentioned methodological system (Fig. 1).

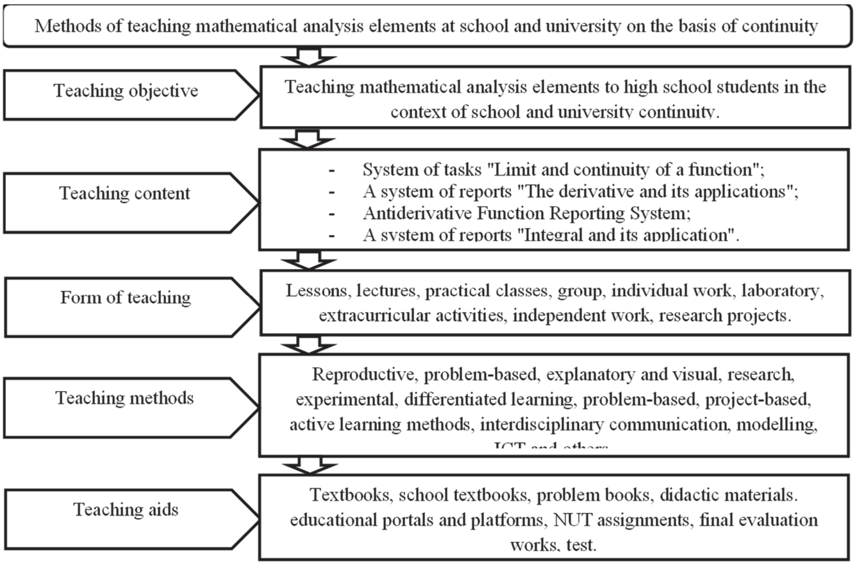

Figure 1: Methodology of teaching mathematical analysis elements at school and university on the basis of continuity

4.2 Methodology of using digital educational resources and computer technologies in teaching mathematical analysis elements on the basis of continuity.

When a student comes to college, he/she faces a lot of difficulties in solving problems in the subject of mathematical analysis. To study this subject in upper grades of general secondary education organizations, develop problem solving skills related to the concept of integral, function, sequence, limit, continuous function, argument and increasement of function, derivative proposition, geometric and mechanical values of the derivative, rules for calculating derivatives, derivatives of simple functions, complex function, derivative of complex function, derivatives of higher orders, differential of function, tangent and normal vectors must be thoroughly mastered.

The geometric meaning of the product, finding the instantaneous velocity of a material point, and studying the inverse of these problems will prepare students to understand the concept of the integral. Creating a table of derivatives and differentials, to study of finding inverse problems using these tables significantly contributes to the formation of the concept of the integral. Also, it leads to the concept of integral in the problem of finding the surfaces of figures or the an arcs length.

We used interactive methods of teaching mathematics when teaching topics related to mathematical analysis elements in schools and universities, in particular, when teaching the derivative, theory of limits, integral and its applications. Specifically, to increase students' desire for mathematical knowledge, we used the capabilities of the Maple computer math system with traditional teaching tools. In addition, we utilized the LearningApps.org platform to enhance and measure student learning on the topic.

Integration of different learning technologies in mastering any subject is considered as an important educational innovation to improve teaching and learning processes (Akhmed-Zaki et al., 2019; Xie, et al. 2018).

Maple is mathematical software that combines the world's most powerful mathematical engine with an interface that makes it easy to analyze, explore, visualize, and solve mathematical problems. It helps to solve math problems easily and accurately (Maple, 2017).

In the works of Chiu-Liang and Cheng-Chih (2019), it was shown that the tasks of mathematical analysis can be simplified by using the information technology capabilities and increase the students interest.

Many researchers have used Maple software in teaching mathematics. In particular, Salleh & Zakaria (2015) proposed an effective strategy for teaching integral calculus, Turmetov (2020) showed ways of solving higher mathematics problems in Maple system, Alharbi, Tcheir, and Siddique (2016) proposed a way to understand mathematics by using Maple animation.

Let's look at the application of this computer math in teaching the task of integrals.

Maple uses a special int command to calculate definite and indefinite integrals. we will fulfill the order to find the indefinite integral of a function f(x), do the following: int(f(x), x).

In Maple, when you calculate an indefinite integral using the int function, the result of the integral is displayed on the screen, but the operations performed are not displayed. However, in recent versions of Maple, it is possible to see the additional operations performed in integral calculus now. The Hint() and Rule[]() functions of the Student[Calculus1] package are used for this purpose.

Example 1.

> **restart;**

> **with(Student[Calculus1]):**

infolevel[Student[Calculus1]] := 1:

> **f:=x->x*sin(x);**

$f := x \rightarrow x \sin(x)$

> Int(f(x),x);

$\int x \sin(x)\, dx$

> Hint(%);

Creating problem #1

$[parts, x, -\cos(x)]$

> Rule[%](%%):simplify(%);

$\int x \sin(x)\, dx = -x \cos(x) + \int \cos(x)\, dx$

> int(cos(x),x);

$\sin(x)$

In this $f(x) = x \cdot \sin x$ example, we learn that this integral have to be integrated partial by using the Hint(%) command while integrating the function.

Example 2.

$f(x)=\frac{x}{(x+1)\sqrt{x^2+x+1}}$ function should be integrated

```
> restart;
> with(Student[Calculus1]):
infolevel[Student[Calculus1]] := 1:
> f:=x->x/(x+1)/sqrt(x^2+x+1);;
```

$$f := x \rightarrow \frac{x}{(x+1)\sqrt{x^2+x+1}}$$

```
> Int(f(x),x);
```

$$\int \frac{x}{(x+1)\sqrt{x^2+x+1}}\,dx$$

```
> Hint(%);
```

Creating problem #1

Hints:

Convert the rational part of the integrand to partial fractions and split integrand into a sum of simpler expressions.

Complete the square and make a change of variable.

$$\left[rewrite, \frac{x}{(x+1)\sqrt{x^2+x+1}} = \frac{1}{\sqrt{x^2+x+1}} - \frac{1}{(x+1)\sqrt{x^2+x+1}}\right],$$

$$\left[change, u = x+\frac{1}{2}, u\right]$$

```
> Rule[%](%%);
```

$$\int \frac{x}{(x+1)\sqrt{x^2+x+1}}\,dx = \int \frac{1}{\sqrt{x^2+x+1}} - \frac{1}{(x+1)\sqrt{x^2+x+1}}\,dx$$

```
> int(1/((x^2+x+1)^(1/2))-1/((x+1)*(x^2+x+1)^(1/2)),x);
```

$$\operatorname{arcsinh}\left(\frac{2\sqrt{3}\left(x+\frac{1}{2}\right)}{3}\right) + \operatorname{arctanh}\left(\frac{-x+1}{2\sqrt{(x+1)^2-x}}\right)$$

Example 3. $\int \frac{\sin x}{3\sin x + 2\cos x}dx$ let's look at the process of calculating an integral with ways to perform the operations.

Solution.

```
> restart:
> with(Student[Calculus1]):- add package
> B:=Int(sin(x)/(3*sin(x)+2*cos(x)),x);
```

$$B := \int \frac{\sin(x)}{3\sin(x)+2\cos(x)}\,dx$$

```
> C1:=[Hint(B)]:C:=C1[1]: print(B,C);
```

Let's understand the steps that have been taken

$$\int \frac{\sin(x)}{3\sin(x)+2\cos(x)}\,dx,\ [change, u = \tan(x), u]$$

- change $u = tgx$

```
> while nops(C)<>0 do B:=Rule[C](B);C1:=[Hint(B)]:
C:=C1[1]; print(rhs(B),C);od:
```

$$\int \frac{u}{3\,u^3 + 2\,u^2 + 3\,u + 2}\,du,\ [partialfractions]$$

- partiafractions – division of a rational fraction into simple fractions

$$\int -\frac{6}{13\,(3\,u+2)} + \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [sum]$$

- divide an integral by the sum of two integrals

$$\int -\frac{6}{13\,(3\,u+2)}\,du + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [constantmultiple]$$

- constantmultiple – putting a constant in front of the sign of the integral

$$-\frac{6}{13}\int \frac{1}{3\,u+2}\,du + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [change,\ u1 = 3\,u+2,\ u1]$$

- variable substitution in the first integral

$$-\frac{6}{13}\int \frac{1}{3\,u1}\,du1 + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [constantmultiple]$$

- in the first integral put a constant in front of the integral sign

$$-\frac{2}{13}\int \frac{1}{u1}\,du1 + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [power]$$

- integrate the first integral as a power function

$$-\frac{2}{13}\ln(u1) + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [revert]$$

- return to the old variable in the result of the first integral

$$-\frac{2}{13}\ln(3\,u+2) + \int \frac{2\,u+3}{13\,(u^2+1)}\,du,\ [constantmultiple]$$

- in the second integral put a constant in front of the integral sign

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\int \frac{2\,u+3}{u^2+1}\,du,\ \left[rewrite,\ \frac{2\,u+3}{u^2+1} = \frac{2\,u}{u^2+1} + \frac{3}{u^2+1}\right]$$

- variable substitution in the second integral

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\int \frac{2\,u}{u^2+1} + \frac{3}{u^2+1}\,du,\ [sum]$$

- decompose the second integral into the sum of two integrals

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\int \frac{2\,u}{u^2+1}\,du + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [constantmultiple]$$

- decompose the second integral into the sum of two integrals

$$-\frac{2}{13}\ln(3\,u+2) + \frac{2}{13}\int \frac{u}{u^2+1}\,du + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [change,\ u1 = u^2+1,\ u1]$$

- variable substitution in the third integral

$$-\frac{2}{13}\ln(3\,u+2) + \frac{2}{13}\int \frac{1}{2\,u1}\,du1 + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [constantmultiple]$$

- in the third integral, put a constant before the integral sign

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\int \frac{1}{u1}\,du1 + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [power]$$

- integrate as an exponential function

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\ln(u1) + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [revert]$$

- revert to the old variable

$$-\frac{2}{13}\ln(3\,u+2) + \frac{1}{13}\ln(u^2+1) + \frac{1}{13}\int \frac{3}{u^2+1}\,du,\ [constantmultiple]$$

put a constant in front of the integral

$-\frac{2}{13}\ln(3u+2)+\frac{1}{13}\ln(u^2+1)+\frac{3}{13}\int\frac{1}{u^2+1}\,du$, [change, u = tan(u1), u1]

variable substitution in the integral

$-\frac{2}{13}\ln(3u+2)+\frac{1}{13}\ln(u^2+1)+\frac{3}{13}\int 1\,du1$, [constant]

integral over a constant

$-\frac{2}{13}\ln(3u+2)+\frac{1}{13}\ln(u^2+1)+\frac{3\,u1}{13}$, [revert]

revert to the old variable

$-\frac{2}{13}\ln(3u+2)+\frac{1}{13}\ln(u^2+1)+\frac{3}{13}\arctan(u)$, [revert]

revert to the old variable

$-\frac{2}{13}\ln(3\tan(x)+2)+\frac{1}{13}\ln(1+\tan(x)^2)+\frac{3}{13}\arctan(\tan(x))$, [ ]

Result: $-\frac{2}{13}\ln(3\tan(x)+2)+\frac{1}{13}\ln(1+\tan(x)^2)+\frac{3}{13}\arctan(\tan(x))$, [ ]

Example 4. Now let's calculate step by step the indefinite and definite integral of the function $f(x)=\frac{x^2}{x+1}$ between [0,2].

```
> restart:
> with(Student[Calculus1]):
> B:=Int(x*2/(x+1),x):
> C1:=[Hint(B)]:C:=C1[1]:
print(B,C);while nops(C)<>0 do B:=Rule[C](B);
C1:=[Hint(B)]:C:=C1[1];print(rhs(B),C);od:
```

$\int\frac{2x}{x+1}\,dx$, [constantmultiple]

$2\int\frac{x}{x+1}\,dx$, $\left[rewrite, \frac{x}{x+1}=1-\frac{1}{x+1}\right]$

$2\int 1-\frac{1}{x+1}\,dx$, [sum]

$2\int 1\,dx+2\int-\frac{1}{x+1}\,dx$, [constant]

$2x+2\int-\frac{1}{x+1}\,dx$, [constantmultiple]

$2x-2\int\frac{1}{x+1}\,dx$, [change, u = x + 1, u]

$2x-2\int\frac{1}{u}\,du$, [power]

$2x-2\ln(u)$, [revert]

$2x-2\ln(x+1)$, [ ]

```
> restart:with(Student[Calculus1]):
> B:=Int(x*2/(x+1),x=0..2):
> C1:=[Hint(B)]:C:=C1[1]:
print(B,C);
```

$\int_0^2\frac{2x}{x+1}\,dx$, [constantmultiple]

```
> while nops(C)<>0 do B:=Rule[C](B);
C1:=[Hint(B)]:C:=C1[1];print(rhs(B),C);od;
```

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 2\int_0^2 \frac{x}{x+1}\,dx$$

$$C1 := \left[\left[rewrite, \frac{x}{x+1} = 1 - \frac{1}{x+1} \right]\right]$$

$$C := \left[rewrite, \frac{x}{x+1} = 1 - \frac{1}{x+1} \right]$$

$$2\int_0^2 \frac{x}{x+1}\,dx, \left[rewrite, \frac{x}{x+1} = 1 - \frac{1}{x+1} \right]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 2\int_0^2 1 - \frac{1}{x+1}\,dx$$

$$C1 := [[sum]]$$

$$C := [sum]$$

$$2\int_0^2 1 - \frac{1}{x+1}\,dx, [sum]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 2\int_0^2 1\,dx + 2\int_0^2 -\frac{1}{x+1}\,dx$$

$$C1 := [[constant]]$$

$$C := [constant]$$

$$2\int_0^2 1\,dx + 2\int_0^2 -\frac{1}{x+1}\,dx, [constant]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 4 + 2\int_0^2 -\frac{1}{x+1}\,dx$$

$$C1 := [[constantmultiple]]$$

$$C := [constantmultiple]$$

$$4 + 2\int_0^2 -\frac{1}{x+1}\,dx, [constantmultiple]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 4 - 2\int_0^2 \frac{1}{x+1}\,dx$$

$$C1 := [[change, u = x+1, u]]$$

$$C := [change, u = x+1, u]$$

$$4 - 2\int_0^2 \frac{1}{x+1}\,dx, [change, u = x+1, u]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 4 - 2\int_1^3 \frac{1}{u}\,du$$

$$C1 := [[power]]$$

$$C := [power]$$

$$4 - 2\int_1^3 \frac{1}{u}\,du, [power]$$

$$B := \int_0^2 \frac{2\,x}{x+1}\,dx = 4 - 2\ln(3)$$

$$C1 := [[\ ]]$$

$$C := [\ ]$$

$$4 - 2\ln(3), [\ ]$$

Example 5. You need to find the area of the figure measured along the lines y=1-x and y=3-2x-x2 .
> plot([1-x,3-2*x-x^2],x=-5..5,y=-5..5);
As a result, function graphs appear on the screen.

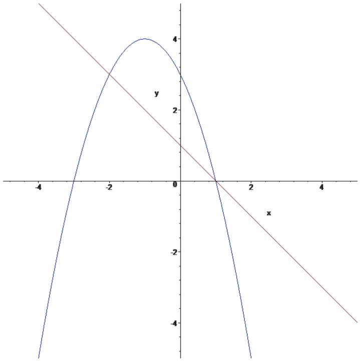

Figure 2: Graph of functions y=1-x and $y=3-2x-x^2$

> int(((3-2*x-x^2)-(1-x),x=-2..1)); $\frac{9}{2}$

Threfore, the answer of the problem is. $\frac{9}{2}$.

Maple helped students understand the algorithm for solving math problems. In addition, we used the LearningApps.org platform, shown in Figure 3, to determine students' mastery of the task "Integral".

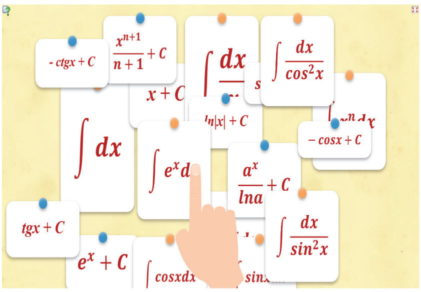

Figure 3. Using the LearningApps.org. platform in teaching the task "Integral"

4.3 *Experimental verification of the effectiveness of using information technologies methods in teaching mathematical analysis elements on the basis of continuity.*

A pedagogical experiment was conducted, in order to prove the validity of the proposed methodology and the scientific prediction accuracy. 101 students of the specialized boarding school named after N. Ondasynov in Turkestan city and 103 students of N23 IT-lyceum named after Zhumabek Tashenov took part in the pedagogical experiment. 51 students at 10th grade and 50 students at 11th grade of N. Ondasynov specialized boarding school in Turkestan city 53 students at 10th grade and 50 students at 11th grade of N23 IT-lyceum named after Zhumabek Tashenov. The conducted pedagogical experiment consisted of three stages:

- the defining - research experiment focused on addressing the following objectives;
- definition of stages of realization of continuity in teaching elements of mathematical

analysis in higher school;
- to show pupils ways to realize continuity in teaching mathematical analysis elements;
- defining the principles of creating an exercises' system used for the purpose of continuity in teaching mathematical analysis elements in secondary school, determining their types, creating an exercises' system, using the capabilities of information computer technologies in reporting on mathematical analysis elements and its implementation in the educational process.

At this stage the implementation stages of continuity in teaching mathematical analysis elements in high school were defined, the ways of continuity implementation in teaching mathematical analysis elements to schoolchildren were shown: system of exercises, experimental tasks, use of ICT. There was no education level difference in the experimental and control classes during the search experiment. The method effectiveness was studied in schools where 3rd year and 4th year students of the 6B01509 - mathematics education programs at the International Kazakh-Turkish University named after Akhmet Yassawi had a continuous 15-week teaching practice and 8-week industrial practice respectively.

The following tasks were set in the forming experiment:
- selection of schools and classes for pedagogical experiments;
- to determine the initial level of experimental and control classes students knowledge in the subject under study;
- conducting classes on the proposed methodology in experimental classes in order to prove the validity of the proposed methodological system and the accuracy of the scientific prediction;
- after the finishing of the experiment to determine the knowledge levels on mathematical analysis elements of control and experimental classes students.

The appropriateness of the methodology developed using the proposed methodological system and the scientific prediction accuracy were tested using the following assumptions:

H_0 - "no progress in the students educational level in mastering the mathematical analysis elements";

H_1 - "there is progress in the students educational level in mastering the mathematical analysis elements".

Students' proficiency levels in learning the mathematical analysis elements:

Reproductive level - the task is given on the basis of universal normative knowledge. Such tasks depend on the knowledge students have acquired in previous lessons.

Algorithmic level - here the student performs using information from the teacher's explanation.

Heuristic level - the student responds by searching and utilizing additional literature.

Creative level - students study a new topic independently, using the possibilities of information and computer technologies in creative search.

We have presented the criteria for assessing the mastery of these levels in Table 1.

Table 1. Criterion for assessing the knowledge of continuous learning mathematical analysis elements.

Number of points to be gained depending on the educational level	Heading	Educational achievements levels
0-39%	Has difficulty mastering the learning objective. The student accepts the material after a long preparation, including incomplete, has difficulty in the process of highlighting the important, performs tasks only according to the sample. It takes a long time to fully internalize the material.	Satisfactory
40-64%	Knows, understands the topic for instructional purposes. The learner perceives the material after a certain preparatory stage, can identify the main one. Applies knowledge gained after extensive training to new situations.	Good
65-84%	Knows, understands the topic for instructional purposes. Does not immediately identify what is important, applies learned knowledge and techniques to new situations. It takes time to get to the top level.	
85-100%	Possesses strong knowledge in mastering the topics of the learning objective. The student learns the material fluently, quickly identifies the main statements, has readiness for new conclusions, freely applies the accumulated knowledge in new situations, quickly performs tasks. Demonstrates higher level thinking skills.	Excellent

The results of determining students' mastery of knowledge in learning mathematical analysis elements are presented in Table 2.

Table 2. Indicator by levels of knowledge assimilation of students in the study of elements of mathematical analysis.

Groups		Assessment			
		Excellent %	Good %	Satisfactory %	Unsatisfactory %
Before the experiment 10 grades	EG	11,2	51	31,3	6,5
	CG	14,8	53,5	24,5	7,2
after the experiment 10 grades	EG	17,6	60,3	19,8	2,3
	CG	11,3	52,3	30,6	5,8
Before the experiment 11 grades	EG	15	35,4	43,6	6
	CG	15,8	33,2	54,12	5,12
after the experiment 11 grades	EG	20,2	48,2	28,7	2,9
	CG	15,65	36,3	42,3	5,75

Analyzing the results of the conducted pedagogical experiment, EG (10 and by 11th grades) the education level of pupils up to we made sure that it is constantly growing.

The conclusion of the methodology effectiveness and students solving mathematical analysis elements using computer technology, that is, conducting statistical research on the creativity levels, is carried out according to the criterion χ^2 comparison of the results of the experimental groups (EG) and control groups (CG). To do this, using the random sampling method from 11 grades were selected 50 people and formed the experimental and control groups.

Table 3. Indicator of students' mastery levels in learning the elements of the calculus course.

Groups		Levels			
		Unsatisfactory	Satisfactory	Good	Excellent
Before the experiment 11 grades	EG	13	20	11	6
	CG	15	21	8	6
after the experiment 11 grades	EG	5	11	26	8
	CG	12	21	11	6

The condition for fulfilling the H_0 hypothesis is as follows: $\chi^2_{эмп} < \chi^2_{1-\alpha}$, where α is the significance level equal to 0.05. Moreover, the value of the criterion χ^2, which corresponds to the degree of freedom we have chosen, L-1=4-1=3 and the degree of significance, is equal to 7.82.

For the compared samples the calculation of the empirical value of $\chi^2_{эмп}$ was performed according to the corresponding formula: $\chi^2 = \sum_{i=1}^{r}\sum_{j=1}^{c}\frac{(O_{ij}-E_{ij})^2}{E_{ij}}$

According to this formula, the empirical value of $\chi^2_{эмп}$ is equal $\chi_{эмп}{}^2 \approx 1{,}94$.

And, as it turned out $\chi_{эмп}{}^2 \approx 1{,}94 < 7.82 = \chi_{0.05}{}^2$, the following proposal was considered as a hypothesis H_0, which we checked: there is no difference between the initial levels of students in the study of mathematical analysis elements in the control and experimental groups.

Empirical value of $\chi^2_{эмп}$ after the experiment:

$$\chi^2_{эмп} = 50 * 50 * \left(\frac{\left(\frac{5}{50}-\frac{12}{50}\right)^2}{5+12} + \frac{\left(\frac{11}{50}-\frac{21}{50}\right)^2}{11+21} + \frac{\left(\frac{26}{50}-\frac{11}{50}\right)^2}{26+11} + \frac{\left(\frac{8}{50}-\frac{6}{50}\right)^2}{8+6}\right) = 2500 * \left(\frac{49}{2500*17} + \frac{100}{2500*32} + \frac{225}{2500*37} + \frac{4}{900*14}\right) \approx 12{,}37$$

since $\chi^2_{эмп} = 12{,}37 > 11{,}34 = \chi^2_{0{,}01}$, the difference in authenticity of the relative results of the final work carried out in the control and experimental groups is 99%.

Therefore, when analyzing the results of the pedagogical experiment, we conclude that the proposed methodology according to our H_1 – assumption has achieved its goal, and the scientific hypothesis has been proven.

So, the methodology for teaching the mathematical analysis elements developed by us on the basis of continuity in school and higher educational institution in high school and higher education. It made it possible to raise the process of implementing the continuity of teaching mathematics in educational institutions at a high level in practice.

5. Discussions

Continuity is the establishment of the necessary connections and relationships between the student's knowledge at different stages of learning.

Continuity in the teaching of mathematics is understood as a didactic principle, which requires the constant provision of an unbroken connection between and within individual mathematical disciplines, chapters and tasks of teaching mathematics.

Many scientists have been working on the concept of continuity, including the problem of teaching mathematical disciplines in continuity in schools and universities, and have given a different description of the concept of "continuity".

According to the Abylkasymova et al. (2023), they analyzed the definition of the concept of "continuity", determined the continuity of teaching mathematics in school and pedagogical universities, "aimed and systematic use of knowledge acquired in secondary school for the development of the personality of students in the course of higher mathematics in pedagogical universities, ensuring the interaction of content, forms and means the principle of learning".

Botuzova (2020), in her research, considered the necessity to ensure continuity between general and vocational education at the level of general secondary education, to prepare school graduates for mastering vocational higher education programs, and proposed favorable factors that ensure continuity of teaching mathematics between school and higher education.

Attard (2013), Carmichael (2015), Cantley et al. (2020), Grootenboer and Marshman (2016) found in their studies that difficulties in moving from one generation to the next were associated with a decrease in the level of students' knowledge and proposed new theoretical foundations for studying the continuity of students ' learning experience.

Tuyakov (2011), in his research, if the principle of continuity is applied in teaching mathematics, then when mastering this discipline, the relationship between the subjects of the discipline becomes stable, as a result of linking past topics and new tasks. He identified factors that contribute to improving the creative abilities of students and the quality of knowledge.

Thus, based on the opinions of researchers and factors ensuring continuity, we have established and experimentally proved that teaching mathematical analysis elements in schools and universities on the basis of continuity has an impact on consolidating, deepening and expanding the knowledge and skills acquired from the previous educational material, which form the content of the curriculum.

The effectiveness of the developed methodology is shown in Table 2. As indicated, the 10th and 11th grades exhibit an improvement in knowledge mastery levels among students in the experimental groups (EG) compared to the control groups (CG).

- In the 10th grade experimental group (EG), the proportion of students achieving an "excellent" grade increased by 6.4% (from 11.2% to 17.6%), whereas the control group (CG) experienced a decline of 3.5% (from 14.8% to 11.3%).
- In the 10th grade EG, the proportion of students achieving a "good" grade rose by 9.3% (from 51% to 60.3%), compared to a decrease of 1.2% (from 53.5% to 52.3%) in the CG.
- In the 11th grade EG, the proportion of students achieving an "excellent" grade increased by 5.2% (from 15% to 20.2%), while the CG saw a reduction of 0.15% (from 15.8% to 15.65%).
- In the 11th grade EG, the proportion of students achieving a "good" grade increased by 12.8%

(from 35.4% to 48.2%), in contrast to a 3.1% increase (from 33.2% to 36.3%) in the CG.

An analysis of the data in the tables reveals that the experimental groups (EG) show a significant improvement in knowledge mastery levels in mathematical analysis following the experiment. These findings support the efficacy of the methodology for continuous learning of mathematical analysis elements using computer technology.

6. Conclusion

The study of the methodology for continuity in teaching mathematics at high schools and universities in the context of digital renewal of the educational environment reveals significant findings. The importance of continuity in mathematical education is highlighted as a crucial factor for improving the mathematical skills and knowledge of students transitioning from secondary to higher education. The research identifies the challenges posed by the insufficient mathematical preparation of school graduates entering universities and underscores the necessity of a consistent methodological system that bridges this gap.

In the course of implementing the continuity of teaching mathematical analysis elements in the senior classes of a comprehensive school and a higher educational institution, we determined the essence and content of the "continuity" concept.

The discussed methodological system emphasizes the integration of digital technologies to enhance the teaching and learning process. By utilizing computer technologies, such as Maple software and LearningApps.org, the study demonstrates the potential for improved understanding and retention of mathematical concepts. These tools aid in simplifying complex mathematical tasks, fostering critical thinking, and enhancing problem-solving skills.

Experimental results validate the effectiveness of the proposed system, showing a positive impact on students' mathematical performance in both high school and university settings. The findings suggest that a well-structured methodological system that incorporates continuity and digital tools can significantly improve the quality of mathematical education, better preparing students for higher education and future careers.

In conclusion, the research underscores the necessity of continuity in mathematical education, enhanced by digital technologies, to ensure a seamless transition for students from high school to university. This approach not only addresses the existing gaps in mathematical knowledge but also equips students with the skills needed to succeed in a digitally evolving educational landscape.

7. Acknowlegment and Funding

The work was supported by the Scientific Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (grant no. AP19680007; Abylkasymova A.).

References

Abylkassymova A. E. (2018). On Mathematical-Methodical Training of Future Mathematics Teacher in the Conditions of Content Updating of School Education //Modern Journal of Language Teaching Methods (MJLTM). ISSN: 2251 – 6204. Vol. 8, Issue 3, March 2018. – Iran. – Pp.411–414 (Web of Science)

Abylkassymova, A., Bazhi, A., Dyussov, M., Ardabayeva, A., Zhadrayeva, L., Tuyakov, Y., Kenzhebek, K. (2023). Mathematical Problems as a Means of Developing Students' Research Skills in the Context of School Education Content Updating. JOURNAL OF LAW AND SUSTAINABLE DEVELOPMENT, pages: 01-20. https://doi.org/10.55908/sdgs.v11i4.607

Abylkassymova, A., Mubarakov, A., Yerkisheva, Z., Turganbayeva, Z., &Baysalov, Z. (2020) Assessment of Financial Literacy Formation Methods in Mathematics Education: Financial Computation -International Journal of Emerging Technologies in Learning (iJET). – eISSN: 1863-0383. – Vol.15. – No.16. – Germany, -P.49-67. doi:10.3991/ijet.v15i16.14587

Abylkasymova A.E., Kaskataeva B.R., Tuyakov E.A., Bazhi A.A., Umiralhanov A.N. (2023) Kazakstandagy orta mektep pen pedagogikalyk zhogary oku oryndarynda matematikany okytudyn sabaktastyk maseleleri // Kazakstan Respublikasy Ulttyk gylym akademiyasy RKB-nin Habarshysy. №4(404). –7-25 b.
Akhmed-Zaki, D., Alimzhanov, Y., & Mussabayev, N. (2019). Digital enhancement of student-centred learning in universities. 11th International Conference on Education and New Learning Technologies, 7780–7786. https://doi.org/10.21125/ edulearn.2019.1883
Alabdulaziz, M.S. (2021) COVID-19 and the use of digital technology in mathematics education. Educ Inf Technol 26, 7609–7633. https://doi.org/10.1007/s10639-021-10602-3
Alharbi A., F. Tcheir, and M. Siddique. (2016) A Mathematics E-book Application by Maple Animations. Int'l Conf.Frontiers in Education: CS and CE (FECS'16)
Attard, C. (2013). "'If I had to Pick any Subject, it Wouldn't be Maths': Foundations for Engagement with Mathematics During the Middle Years." Mathematics Education Research Journal 25 (4): 569–587
Botuzova Yuliia. (2020). Factors of Providing the Continuity of Teaching Mathematics During Transition from High School to University. // Universal Journal of Educational Research 8(3): 857–865, 2020. http://www.hrpub.org DOI: 10.13189/ujer.2020.080316.
Briggs R.J., Clark J. & Hall I. (2012). Building Bridges: Understanding Students' Transition to University, 2012. – C. 3–21. https://doi.org/10.1080/13538322.2011.614468
Cantley, I., O'Meara, N., Prendergast, M., Harbison, L., & O'Hara, C. (2020). Framework for analysing continuity in students' learning experiences during primary to secondary transition in mathematics. Irish Educational Studies, 40(1), 37–49. https://doi.org/10.1080/03323315.
Carmichael, C. (2015). "Transitioning to Secondary School: The Case of Mathematics." Australian Journal of Educational & Developmental Psychology 15: 13–23
Chiu-Liang, C., & Cheng-Chih, W. (2019). Students' behavioral intention to use and achievements in ICT-Integrated mathematics remedial instruction: Case study of a calculus course. Computers & Education, 103740. doi:10.1016/j.compedu.2019.103740
Grootenboer, P., and Marshman M. (2016). Mathematics, Affect and Learning: Middle School Students' Beliefs and Attitudes About Mathematics Education. Singapore: Springer
Kadijevich, D. (2019). Cultivating computational thinking through data practice. In D. Passey, R. Bottino, C. Lewin, & E. Sanchez (Eds.), Empowering learners for life in the digital age (pp. 24–33). Springer
Kadijevich, D.M., Stephens, M., Rafiepour, A. (2023). Emergence of Computational/Algorithmic Thinking and Its Impact on the Mathematics Curriculum. In: Shimizu, Y., Vithal, R. (eds) Mathematics Curriculum Reforms Around the World. New ICMI Study Series. Springer, Cham. https://doi.org/10.1007/978-3-031-13548-4_23
Law of the Republic of Kazakhstan "On Education" (2007). "Bilim turaly" Kazakstan Respublikasynyn 2007 zhylgy 27 shildedegi № 319-III Zany (KR 14.07.2022zh. №141-VII sajkes ozgertuler men tolyktyrular engizilgen).
Li, Y., Schoenfeld, A.H., diSessa, A.A. et al. (2020) On Computational Thinking and STEM Education. Journal for STEM Educ Res 3, 147–166. https://doi.org/10.1007/s41979-020-00044-w
Maple (2017) https://www.maplesoft.com/
Ministry of Education and Science of the Republic of Kazakhstan. (2022). Mektepke dejingi tarbie men okytudyn, bastauysh, negizgi orta, zhalpy orta, tekhnikalyk zhane kasiptik, orta bilimnen kejingi bilim berudin memlekettik zhalpyga mindetti standarttaryn bekitu turaly [Order No. 348 of August 3, 2022, on the approval of state mandatory standards for preschool education and training, primary, basic secondary, general secondary, technical and vocational, and post-secondary education].
Mubarakov A.M. (1999) Matematikany okytudagy sabaktastyk. – Pavlodar, –230b.
Nicolescu, B. N., & Petrescu, T. C. (2015). On the Continuity Mathematics Curriculum Between Primary and Secondary School. Procedia - Social and Behavioral Sciences, 180, 871–877. doi:10.1016/j.sbspro.2015.02.231
Orazbekova L.N. (2015). Puti realizacii preemstvennosti obucheniya matematike v usloviyah perekhoda na dvenadcatiletnee obuchenie v shkolah Kazahstana.// Izvestiya RGPU im. A. I. Gercena.
Pyshkalo, A. (1978) Continuity in Teaching Mathematics: A manual for teachers. Digest of Articles, Prosveschenie, Moskow.
Semenov, A.L., Abylkassymova, A.E. & Polikarpov, S.A. (2023) Foundations of Mathematical Education in the Digital Age. Dokl. Math. 107 (Suppl 1), S1–S9. https://doi.org/10.1134/S1064562423700564
Stephens, M. (2018). Embedding algorithmic thinking more clearly in the mathematics curriculum. In Y. Shimizu & R. Vithal (Eds.), School mathematics curriculum reforms: Challenges, changes and opportunities. Proceedings of the twenty-fourth ICM1 study conference (pp. 483–490).
Tamur, M., Jehadus, E., Nendi, F., Mandur, K., & Murni, V. (2020). Assessing the effectiveness of the contextual teaching and learning model on students' mathematical understanding ability: a meta-analysis study. Journal of Physics: Conference Series, 1657, 012067. doi:10.1088/1742-6596/1657/1/012067

Turgunbaev R. (2021) Methodical aspects of continuity in teaching mathematics // Norwegian Journal of Development of the International Science. №77-2. DOI: 10.24412/3453-9875-2021-77-2-20-23

Turmetov B.H. (2020) Zhogary matematika panderin okytuda Maple zhujesin koldanu. Oku kuraly. Tүrkistan: «Turan», 2020. – 183 b.

Tuyakov Y. A. (2011) Mektep pen zhogary oқu ornyndagy matematika kursy mazmunynyn sabaktastygy // Bilim. Obrazovanie. - № 5-6. - B. 80-83.

Tyncherov K.T. et al (2020) J. Phys.: Conf. Ser. 1661 012086 DOI 10.1088/1742-6596/1661/1/012086

Xie, K., Di Tosto, G., Chen, S.-B., & Vongkulluksn, V. W. (2018). A systematic review of design and technology components of educational digital resources. Computers & Education. doi:10.1016/j.compedu.2018.08.011

Zakaria E., Salleh T. S. (2015) Using Technology in Learning Integral Calculus. Mediterranean Journal of Social Sciences. MCSER Publishing, Rome-Italy, Vol 6 No 5 S1, pp. 144-148