

# Forming future teachers' competence in developing electronic educational resources using HTML5 as an alternative to Adobe Flash\*

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**Abstract.** In the modern educational space regarding the realities of the information society special importance is attached to issues related to the provision of a high level of informatization of education, which implies teachers' mastering the necessary competencies and the ability to introduce electronic educational resources into education and training practice.

Adobe Flash as one of the platforms for creating web applications and multimedia presentations enjoys the greatest popularity with users including teachers. However, in connection with the announcement of discontinuing Adobe Flash support in 2020, the issue of choosing an analog to create web applications and presentations for use in teaching purposes is becoming particularly relevant. This makes it necessary to train future teachers to write programs and create products on HTML 5. This paper provides a comprehensive analysis of developing electronic educational resources by teachers using Adobe Flash and HTML5 for teaching maths in primary school.

**Keywords:** developing interactive educational applications, Adobe Flash, HTML5, future primary school teacher.

## 1 Introduction

### 1.1 The relevance of the study

The rapid development of information technologies results in changes in the content and organization of labor, in the requirements for the level of personal qualities of school leavers who must be able to think critically, have systematic knowledge, as well as skills of team cooperation, and manage dynamic processes. This emphasizes the need for developing education based on new progressive concepts; introducing modern information and communication technologies (ICT) and scientific and methodological achievements in the educational process; training a new generation of school teaching

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staff, beginning with a primary school teacher. Modern elementary schools cannot be left out of the processes of informatization of education. Primary school as an important and inalienable stage in the education of each individual has to do with all world tendencies and innovations: competency-based approach, personality-oriented learning, variability, informatization, integration, etc. Such tendencies include increasing the level of future teachers' readiness to develop electronic educational resources (EER). This actualizes the objective need for the development of new electronic teaching means, in particular for teaching mathematics in primary school based on modern computer technologies, taking into account the available pedagogical experience and achievements of psychological and pedagogical sciences [2 - 4, 6, 10, 11, 16-18]. Effective use of all the possibilities of electronic educational resources in the education of junior school-children depends on the fulfillment of these tasks.

## **1.2 Purpose and objectives of the study**

The purpose of this paper is to describe the phenomenon of forming future primary school teachers' competence in developing electronic educational resources for teaching mathematics using the HTML5 standard and compare it with the formation of the same competency using the Adobe Flash multimedia software platform.

According to the purpose, the main objectives of the research have been determined: to analyze the state of the problem, the degree of its development in pedagogical theory and practice, and to form a categorical-conceptual research apparatus; to determine the role of HTML5 and Adobe Flash as a means of future teachers' developing electronic educational resources for teaching mathematics in primary school; to work out models for developing electronic educational resources for teaching mathematics in primary school using Adobe Flash and HTML5, to describe the methods of forming future teachers' competence in developing EER using Adobe Flash and HTML5.

## **2 Materials and methods**

### **2.1 Theoretical and empirical methods**

To achieve the purpose and solve the objectives stated above the following research methods were employed at various stages of the research:

- empirical: pedagogical questionnaire, interviewing, conversations with teachers and learners, observation of the process and results of developing electronic educational resources in mathematics for primary school with the use of Adobe Flash and HTML5 aimed at increasing quality of education, activating primary school students' cognitive activity, raising the level of future primary school teachers' level of readiness to professional activity [8 – 10];
- methods of mathematical statistics: for quantitative and qualitative analysis of the results of the pedagogical experiment.

## 2.2 The research base

The pedagogical experiment was being conducted on the base of Yevpatoria Institute of Social Sciences (branch) and Humanities and Education Science Academy (branch) in Yalta of V. I. Vernadsky Crimean Federal University.

The experimental work on developing electronic educational resources for mathematics lessons in primary school was being conducted from 2015 to 2019 with students of the training area 44.03.01 “Pedagogical education”, skills profile “Mathematics”. In all, 420 students participated in the experimental work. Four groups took part in the experiment: experimental ones (E1, E2), 110 and 100 students respectively, and control ones (C1, C2), 107 and 102 students respectively [10, 14].

## 2.3 Stages of the research

The pedagogical experiment was carried out in three stages: ascertaining, searching, and forming ones.

At the ascertaining stage of the experiment, a questionnaire was conducted for primary school teachers of the Republic of Crimea to determine the level of their use of EER developed with the help of Adobe Flash and HTML5 and comparing these indicators with those related to using other multimedia tools. Student questioning was carried out, the state of teaching developing EER in higher educational institutions included in the experiment was studied; there were determined the directions of effective forming a future primary school teacher’s competence in developing EER using the Adobe Flash and HTML5 [10].

At the searching stage of the experiment, the students were developing EER and giving pilot lessons in basic schools using information-communication technologies.

# 3 Designing electronic educational resources

## 3.1 Literature review

Modern information technologies make it possible to develop systematic scientific thinking, constructive figurative thinking, spatial and associative thinking, the variability of thinking and the sense of novelty, imagination, creative abilities. According to Y.M. Huang, S.H. Huang & T.T. Wu (2014), digital game learning (DGBL) is seen as a sensible learning strategy in increasing the learner’s motivation and interest in many disciplines, including mathematics [18]. In this study, the DGBL model is used employing the diagnostic mechanism strategy for the primary school mathematics course to examine the impact of teaching methods on the level of anxiety of a junior school-child, motivation for learning, and learning satisfaction in terms of attention, relevance, and trust. It has been proved that communication with the computer rises a keen interest in children, at first as a game activity, and then as an educational one. This interest underlies such important structures as cognitive motivation, voluntary memory and attention, and it is these qualities that provide a high level of cognitive development and creativity of students.

Modern primary school, no doubt, need a teacher who is capable of creative search of creative ways in professional activity, works in a new format and is competitive. Today the teacher should be not only psychologically, but also technically prepared for developing and using information technologies in his professional activities. From this point of view, the results of a long-term study by Gluzman, N.A (2014), in which the author observed the introduction of educational technologies for primary school teachers in teaching mathematics, deserve attention [10]. Inductive qualitative analyzes have shown that the use of participant technologies was focused on technologies such as presentations, use of the interactive whiteboard potential; computer technologies or interactive activities were used less. Nevertheless, the studies have shown that primary school teachers try to integrate computer technologies into teaching as much as possible, which confirms their didactic significance.

One of the means of creating educational multimedia presentations, websites and games enjoying popularity with teachers is Flash technology. This platform has proved its effectiveness in the process of teaching various disciplines to school students, for example, mathematics Bakhom (2008) [4], biology Milada Teplá, Helena Klímová (2015), chemistry Roberto Ma. Gregorius et. al (2010), social sciences Weinstein, Y. (2013).

Unfortunately, in July 2017 Adobe announced ending support of Flash technology in 2020 (The Blog.Adobe (2017)). The main replacement for Flash technology is the open standard for the development of HTML5 web content, the standard of which was published relatively recently, in 2014 (World Wide Web Consortium (2017)).

“HTML5” in the presented study is understood not only as of the markup language that in itself does not determine the ways of creating animation and interactivity on a web page, but also as the additional related special JavaScript programming languages and style sheet language CSS 3. Adobe Flash is also presented in a bundle with ActionScript, the programming language to create interactivity.

It should be noted that HTML5 is a technology designed to make the Internet faster, easier and more affordable for each user, which also, in conjunction with CSS3, can successfully replace Adobe Flash in many of its niches, including educational ones. In addition to this, HTML5 is the only unified markup language that fully works alongside the native programming languages of most modern operating systems, such as Android, iOS, Windows Mobile, Blackberry, while the Apple operating system iOS does not support Flash.

In contrast to what has been said, it should be noted that Adobe Flash has already established itself as an effective tool for creating multimedia presentations and games for teaching mathematics in primary classes (see e.g. [http://www.learninggamesforkids.com/math\\_multiplication\\_games.html](http://www.learninggamesforkids.com/math_multiplication_games.html), <http://www.primaryinteractive.co.uk/maths.htm>, <https://www.coolmath4kids.com/>), while HTML5 is a new technology, the mastering of which requires additional research and analysis [7, 13].

The carried out analysis on the issues of preparing primary school teachers for the use of electronic educational resources makes it possible to assert that the problems of the training and professional development of teachers in the application of electronic educational resources in school education are as follows: insufficient awareness of their application in the teaching process; absence of purposeful formation of the necessary

competences, habits of working with electronic educational resources and of creating conditions for their daily use in the educational process; teachers' uncertainty of electronic educational resources expanding their professional capabilities.

It is established that the task of computerization of the primary school, introduction of modern electronic educational resources in academic disciplines in its teaching process, in particular mathematics, requires the development of theoretical and methodological foundations of their development by future teachers (Zhong Sun & Yuzhen Jiang (2015), Do Kyun Kim, Lucian F. Dinu & Wonjun Chung (2013).

There has been developed the general model of developing electronic educational resources for teaching mathematics in primary school using Adobe Flash and HTML5 and the following models for developing EER for teaching mathematics in primary school using Adobe Flash and HTML5: developing presentations, developing interactive spreadsheets, mathematics in primary school didactic game programs, developing test tasks, developing electronic manuals using Adobe Flash / HTML5 that are the basis for creating electronic educational resources for teaching mathematics in primary school (P. Drijvers, M. Doorman, P. Boon, H. Reed & K. Gravemeijer (2010).

The advantages of Adobe Flash have been revealed, namely: the platform contains built-in interactive educational components as means of developing author electronic educational resources and is a powerful environment for development author electronic means of teaching, which will provide future teachers with the opportunity to develop presentations for lessons, interactive spreadsheets, didactic game programs, test tasks, and e-learning manuals. The built-in graphical tools of the Adobe Flash platform provide ample opportunities for the development of electronic educational resources, and the ActionScript programming language ensures implementation of effective management of the software product (G.-J. Hwang, H.-Y. Sung, C.-M. Hung, I. Huang, & C.-C. Tsai (2012).

HTML5 technology is a powerful tool that can enrich the experience of using a web application.

Besides, this technology will facilitate the process of creating web applications. The leading IT companies in the world, such as Apple, Google, Facebook, Twitter, and Microsoft are engaged in the promotion of HTML5. Since HTML5 is the unified markup language present in most operating systems of modern mobile platforms, its application aimed at providing a better experience to the user during the distance learning process is one of the directions in the development of the sphere of developing electronic educational resources [1, 7-9, 11 – 13, 15 - 18].

Recommendations have been developed on the formation of future teachers' competence in developing electronic educational resources for teaching mathematics in primary schools using Adobe Flash and HTML5 that can be used by both university students and students of refresher courses, and by practicing teachers in their professional activity.

### **3.2 Forming future teachers' competence in developing electronic educational resources**

The competence of future primary school teachers in the field of designing EER was analyzed according to complex criteria: motivational-target, cognitive (educational-content one), technological (organizational-activity one), reflexive-prognostic.

To determine these criteria, there was worked out the system of indicators reflecting different directions of the influence of the new approach to developing the system of pedagogical diagnostics on the teaching process by the hypothesis of research (N.A. Gluzman, N.V. Gorbunova & N.Yu. Fominykh (2015), namely:

The motivational-target criterion reflects professional-personal self-determination in the direction of developing and using EER in primary classes, allows for determining the future teacher's value attitude to developing and using EER in mathematics lessons in primary school, his awareness of the value of the ability to develop and use EER or successful professional activity and self-realization in the future pedagogical activity. The future primary school teacher understands the importance of developing and using EER in his professional activity (A.N. Privalov, Y.I. Bogatyreva, V.A. Romanov & V.N. Kormakova (2017)).

The cognitive (educational-content) criterion at the forming stage of the pedagogical experiment was determined by the availability of the amount of knowledge necessary for developing EER for the primary school; completeness, operativeness, flexibility and systematic character of the knowledge were taken into account. The students' understanding of the goals and objectives and the vision of the ways and results of applying EER in teaching mathematics in the primary classes were also considered.

The technological (organizational-activity) criterion reflected the ability to develop author EER and to use them in conducting trial mathematics lessons in primary school, the skills to use the created EER in elective mathematics classes in primary school. There were taken into account a student's ability to mobilize his energy, perseverance and will to achieve the goal – developing EER for the lessons of mathematics in primary school. Correspondence of the nature and scope of the learning tasks to the student's possibilities for independent implementation at a sufficiently high level of difficulty was also considered.

According to the criteria and indicators, the levels (sufficient, medium, low) were formulated, according to which the state of formation of future primary school teachers' competence in developing and using EER in primary classes was studied.

There were employed two variants of conducting the forming stage of the pedagogical experiment.

According to the first variant of the experimental training (1-4 years of study, E1), the professional training of the students of the skills profiles "Primary education" for the use of Adobe Flash technology in the teaching of mathematics to junior school children has carried out during the study of the disciplines "Informatics and information technologies in primary school". In the experimental groups, the workshops included tasks aimed at future primary school teachers' developing educational resources using Flash technologies. The HTML5 language was not studied. The control group (C1) mastered the Adobe Flash technology in the process of self-education using electronic

manuals “Information-communication technologies in mathematics lessons in primary school” and “Developing educational resources using Flash technology.”

According to the second variant of the experimental training (1-4 years of study, E2), the electronic manual “Developing educational resources using HTML5-technology” was used, and the author’s integrated special course “Methodology of using computer technologies in lessons in primary school” was studied. The control group (C2) mastered HTML5 technology in the process of self-education using the training manual “Developing educational resources using HTML5-technology”. The Adobe Flash platform was not studied. The sets of students in different groups did not intersect.

It was determined that the purpose of using Adobe Flash and HTML5 as a means of developing electronic educational resources for primary school is the formation of a specialist capable of successfully developing and using electronic educational resources in their professional activities.

It was revealed that the task of the methodology of developing EER using Adobe Flash and HTML5 in the process of teaching the development of electronic educational resources for primary school is the formation of the professional abilities of future teachers of primary education. The ability to develop EER will allow for deepening the fundamental training of students of the skills profile “Primary education” and for their successful adaptation to the demands of the information society in their future professional activities (N. Zeqiri & A. Luma (2007).

The students were taught in three stages: the theoretical stage was connected with mastering the issues of the theory of developing and methods of applying EER in teaching; the practical stage was devoted to forming skills of EER development, the probation stage was connected with the acquisition of experience in the activity aimed at preparation and conducting of training classes with the use of developed training tools, self-evaluation and expert evaluation of the experience of implementing results of the EER development in the teaching process, preparing publications on EER development results, the participation of students in seminars and conferences.

The processing of the results of the experiment and the evaluation of the effectiveness of the developed methodology was carried out by the methods of mathematical statistics of Miller and Salkind (2002). The results of the forming stage of the experiment in determining the level of future primary school teachers’ competence in developing electronic educational resources are presented in Tables 1; 2.

**Table 1.** Levels of formation of future primary school teachers’ competence in the sphere of developing electronic educational resources using Adobe Flash in the experimental (E1) and control groups (C1) (Varian 1) at the end of the experiment

Experimental group (E1)		Control group (C1)	
Level	Number of students, %	Level	Number of students, %
Sufficient	11	Sufficient	27
Medium	51	Medium	58
Low	38	Low	15

**Table 2.** Levels of formation of future primary school teachers' competence in the sphere of developing electronic educational resources using HTML5 in the experimental (E2) and control groups (C2) (Variant 2) at the end of the experiment

Experimental group (E2)		Control group (C2)	
Level	Number of students, %	Level	Number of students, %
Sufficient	8	Sufficient	26
Medium	48	Medium	54
Low	44	Low	20

In general, quantitative and qualitative data analysis allows for concluding the positive dynamics of forming the future primary school teacher's competence in developing EER in mathematics for primary school using the Adobe Flash and HTML5, which proves the effectiveness of the methodology developed by us.

This was confirmed in the results of questioning students at the end of the experiment with open questions:

- a) Do you consider it possible to learn Adobe Flash (for the first variant) and HTML5 (for the second variant) by yourself? If not, why?
- b) Which theme did you find most challenging in the learning process?
- c) Do you intend to use this knowledge in your professional activity?
- d) In the experimental groups, the following question was additionally asked:
- e) What sources did you use for self-study of Adobe Flash (for the first variant) and HTML5 (for the second variant)?

It has been established that the methodological system of preparing students of higher pedagogical educational institutions for the development of electronic educational resources includes the following interrelated stages: the theoretical one, connected with acquisition of issues of the theory of development and methods of application of EER in the teaching process; the practical stage aimed at the formation of EER development skills; the stage of approbation associated with the acquisition of experience in preparing and conducting classes with the use of the developed means of teaching, self-evaluation and expert evaluation of the experience of implementing results of the development in the teaching process, preparing publications on the development results, students' participation in seminars and conferences.

Qualitative and quantitative data obtained in the result of the experiment indicate that the level of competence in developing electronic educational resources for teaching mathematics in primary school by the means of the Adobe Flash and HTML5 has significantly increased in the experimental group in comparison with the control one in both variant 1 and variant 2. At the same time, the level of formation of the competence understudy in the experimental group (E2) in variant 2 is higher than that in variant 1 (E1), which testifies to the effectiveness of the methodology of its formation. This can be grounded by the fact that in variant 2, where the training was carried out at the educational-qualification levels "bachelor" and "specialist" and both technology (Adobe



Flash, HTML5) were mastered, the formation of the competence in question turned out to be more productive because more time was allocated for its development; besides, students had an opportunity to apply the received theoretical knowledge in the framework of all kinds of pedagogical practice. In variant 1, only the production-trainee pedagogical practice was assigned for the improvement of the competence in developing EER using Adobe Flash, since during teaching didactic-methodological disciplines at the basic stage of experimental teaching this process was not given due attention, and the HTML5 was mastered in the framework of students' autonomous work.

Also, the students of the experimental group studying both the Adobe Flash and HTML5 technology had notably higher interest and motivation both to the learning process and to the future professional activity. It should also be noted that experimental teaching has contributed to improving the students' readiness for autonomous work, which gave impetus to the development of the skills to acquire and use new knowledge throughout their professional activity.

The number of students with a sufficient and average level of the formation of the competence in developing EER in mathematics for primary school has significantly increased; there has been a decrease in the number of students with a low level of competence in developing EER in mathematics for a primary school in experimental groups.

With the use of Adobe Flash and HTML5 technology, the future teacher is allowed to develop didactic game programs in such a way that the student will be solving a significant number of examples without being aware of tedious learning; he will master the learning material planned by the teacher using the tips that the junior schoolchild gets when he answers questions incorrectly.

The Adobe Flash and HTML5 technology are a means of creating software tools designed for test control in mathematics for primary school. In the Adobe Flash and HTML5 environment, one can create tests with the choice of one correct answer from several suggested ones, tests with the introduction of a response from the keyboard and multiple-choice tests.

It has been proved that the Adobe Flash and HTML5 is a tool for modeling and creating electronic manuals in mathematics for primary schools. Electronic manuals are an effective didactic tool that can be used at different stages of training: to master new knowledge, consolidate and improving knowledge, habits, and skills, as well as checking and correcting the pupils' academic achievements. The use of electronic manuals promotes the intensification of the work of both the teacher and the student.

However, it is not rational to recommend the training of future teachers to Adobe Flash, since not only the Adobe company declared it obsolete and stops supporting it, but even the launch of previously-written educational games in browsers will be impossible. Microsoft announced that on December 31, 2020, Flash will be completely removed from all browsers through Windows Update.

As an option, there remains the use of Adobe Air technology, an environment that allows the transfer of web applications to PCs and mobile devices. Using AIR, you can port your web application as a regular application and use it locally.

This makes sense to preserve the ability to work with previously created applications, for local use, without browsers, for educational games. But the development of new ones is impossible. Also, the Adobe roadmap for Air support is in doubt.

## Conclusion

The results of pedagogical research are the basis for the conclusion: an experimental test of the methodology using Adobe Flash and HTML5 technologies shows that both of them are comparable in development and effective means of developing electronic educational resources for teaching mathematics in elementary school. However, due to the system flaws confirmed by the developers, Adobe Flash - excessive load on the central processor, insufficient error control, browser malfunction, a large number of security vulnerabilities, as well as due to the approaching end of support and removal from browsers - as a recommendation of this technology as a tool for developing educational applications denied.

Therefore, according to the results of the study, it is the development of electronic educational resources in HTML5 that needs to be trained for future teachers.

The study does not exhaust the solution to the whole range of problems associated with the development of electronic educational resources for teaching mathematics in primary school. We consider promising the use of the proposed methodology for developing EER for teaching mathematics in preschool educational organizations and educational institutions with inclusive education. The offered methodology of developing electronic educational resources can also be employed for teaching other disciplines in primary school, creating Web-resources for teaching mathematics and other disciplines in primary school using HTML5 technology.

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