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HOME   Revista ESPACIOS ⌄   ÍNDICES / Index ⌄   A LOS AUTORES / To the AUTORS ⌄

Developing informatics competencies of computer sciences students while teaching differential equations

Formación de las competencias de informática de los estudiantes de la especialidad "ciencias de la computación" durante enseñanza de ecuaciones diferenciales

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Contents

ABSTRACT:

The article considers the method of teaching differential equations to students using computer support. It is shown that computer support of teaching differential equations is appropriate to organize as the content of the educational website. The article covers the concept of the educational website and analyzes its content. The UI of the website helps select and combine methods, forms and tools of teaching that help find, organize and analyze the required data from different sources, conduct high-performance computations based on cloud services.
Keywords: professional training, informatics competencies, students, Computer Sciences, educational website, differential equations

RESUMEN:

En ese artículo se hace referencia a la metodología de enseñanza de ecuaciones diferenciales a los estudiantes mediante computación. Se muestra, que enseñanza del curso cabe organizar mediante un sitio web educativo. Se muestra, como UI del sitio web ayuda a seleccionar y combinar los métodos, formas e instrumentos de enseñanza, que contribuyen a la búsqueda, sistematización, analisis de los datos de diversas fuentes, realización de computación de gran rendimiento, basándose en los servicios de la nube.
Palabras clave: C

1. Introduction

The continuous improvement of computer-oriented technologies provides for using them in the educational process, makes them a powerful tool for students' obtaining of various information as well as an effective means for increasing interest in learning, enhancing motivation, visual and scientific character etc. The introduction of such technologies into the

learning process in a certain way changes the traditional didactic system, helps to take into account the peculiar features of disciplines teaching, promotes good governance of students' educational and cognitive activities, and provides educational interactivity when future professionals study the disciplines in classrooms as well as while doing self-study.

We have analyzed the works from different authors Dubovicki & Balen (2018), Barbosa-Chacón & Castañeda-Peña (2017), Lee (2015), Bender et al. (2015), diSessa (2018) and the others', in order to establish the foundation for the research.

Leininger (1977) described the objectives and the technology for developing a computer-based course for teaching students mathematical disciplines, in particular, differential equations. The author states that the accessibility of such courses promotes students' analytical and systems thinking. Claus-McGahan (1998) proved the advantages of employing computer for calculating and working out projects in the differential equations course.

While studying the process of teaching mathematical disciplines, LeMasurier (2006) proposed an effective way to demonstrate the application of students' mathematical skills in various professional fields by means of multimedia technologies. The scientist confirmed the increase in students' interest in studies.

Kember et al. (2010) found out, that the use of the Internet potential contributes to setting up the constructive dialogue between the students and teachers, which, in its turn, provides the interactivity of the students' learning activities. Under this approach to learning, according to the scientists, the students develop communication skills and absorb learning material more efficiently.

Llorens et al. (2013) discovered the discrepancy between the information and communication technologies development and the existing programmes for training engineering specialties students. According to the authors' opinion, the elimination of such drawbacks in the study process will contribute to the development of students' basic competencies. Gainsburg (2013) also conducted an experimental study of various levels of engineering education with the use of computer technologies for the presentation of mathematical models. The scientist showed the importance of applying such technologies in the field of modelling. Lee (2015) looked into the impact of using computer technologies in the educational process on the choice of an education field. The scientist confirmed the fact that students prefer both STEM education and mathematical education. The results obtained by the scientist indicated the improvement in the quality of education through the increased motivation to study.

The works of the other scientists also confirm the effect of the computer and information technology on forming students' motivation. Bender et al. (2016), studied the impact of using Internet technologies while teaching computer science with the purpose to develop students' competencies. The researchers conducted the analysis of the learning content and confirmed the effectiveness of training specialists, enhancement of their motivational orientation and convictions about their future profession.

Pozniç & Pečjak (2017) demonstrated the use of predictive power e-textbooks in the process of developing students' self-study skills. The scientists emphasize the importance of growing students' experience in working with teachers' electronic instructors. The use of such technology in the learning process, according to the scientists, reduces students' anxiety, which provides for achieving better results.

Furthermore, Dubovicki & Balen (2018), who researched the impact of modern technology on students' motivation and satisfaction during their studies, state that the use of such technologies improves the students' perception and comprehension of the content of the learning material. The study of the impact of the online Learning Management System (LMS) on the various types of students' interactive activities is presented by Mijatovic et al. (2012). The scientists point out the importance of establishing more interactive online communication for achieving a higher level of training outcomes. The research results show the students' willingness to participate in more complex activities, perform more sophisticated tasks.

In their articles, the scientists pay attention to the reasonability of using technologies to

form students' competencies.

diSessa (2018) demonstrated the use of a computer with the purpose of making fundamental changes in STEM education, focusing on mathematics. The scientist provided practical tips on working out a learning path for mathematics teachers, with the focus on computer calculations. The research proved the development of students' key competencies via using computer technologies.

Among the key competencies for a modern specialist, the European Commission has distinguished the informatics one. Research on developing students' informatics competencies in higher education institutions (HEI) was conducted (Zhaldak, 2013, Estriegana et al., 2019, Ferrari, 2012, **Leutner** et al.**,** 2017, Dubovicki and Balen, 2018, Barbosa-Chacón and Castañeda-Peña, 2017).

Tryus & Kachala (2014) introduced the use of computer-oriented systems of teaching mathematical disciplines and suggested using cloud technologies in the educational process, Rakov (2010) gave the description of the education informatization process for the purpose building up forming students' informatics competencies in pedagogical universities; Zelinskyi (2016) studied the issues of developing informatics competencies during professional training of technical specialities students; Yatsko (2016) paid attention to the development of such competencies in students of economic specialties; Bondaruk (2017) showed the importance of developing informatics competencies in future EFL teachers for their professional growth and the possibility of improving these competencies while studying English. It wouldn't be an exaggeration to say that for students, whose future professional activity is related to computer technologies, the task of developing informatics competencies (IC) is of paramount importance. The basis for building up such competencies in students can be provided during their study of mathematical disciplines. Differential equations (DEs), as a section of higher mathematics and as an independent discipline, can contribute to the development of students' IC through their understanding of the applied and practical orientation of mathematics. The search for and usage of learning material, solving of a large number of typical tasks according to a certain procedure, conducting bulky transformations while solving the systems of DEs require the use of computer technologies that allow for the students to master databases, visualization tools, hypertext and hypermedia systems, cloud answer books, etc. In addition, the demand for information technology (IT) specialists is constantly increasing and the requirements for their training are changing. The existing methodologies do not take into account the rapid development of computer-based technologies that largely accompany the daily lives of students for whom informatics competencies are professional. Moreover, the application of the existing methodologies cannot help a teacher to organize a professionally oriented students' activity. Therefore, working out the methodology, which contributes to the development of informatics competencies, for teaching DEs to students of Computer Sciences (CS) specialty is seen as a current need.

Thus, the aim of the article is to give the description of the interdisciplinary study of the system of developing professional informatics competency in Computer Sciences speciality students. There have been presented the results of applying the developed computer-oriented methodology for teaching DEs, according to which the choice and the connection between its components are made possible by means of educational website content (Vlasenko & Sitak, 2016). The research proves the hypothesis that the use of the resulting methodology contributes to rising the development level of the informatics competencies of CS speciality students.

2. Methodology

The experimental study of the computer-oriented teaching of DEs to Computer Sciences speciality students consisted of three main stages (ascertaining, searching, formulative) and was based on the application of the following methods and methodologies: questionnaire, interrogation, polling, testing, interviewing, pedagogical observation, and also statistical methods.

In the first stage of the experiment, educational manuals, textbooks and the Internet

content that enable mastering differential equations were analyzed; the methodological support of the DEs discipline was studied regarding its repletion with professionally oriented tasks for IT students; training programmes for the Computer Sciences specialty, syllabi and curriculum programmes of the differential equations discipline (as an independent one and as a part of higher mathematics) were studied; lectures and practical classes in DEs in higher educational institutions were attended; the survey and testing of the corresponding specialty students was done concerning their use of the Internet content while studying the discipline; questionnaire surveys among the teachers of higher technical education institutions were conducted.

The pedagogical experiment involved first-year and second-year students of HEIs, in particular, Computer Sciences speciality students of Donbas State Engineering Academy (95 students) and of the Institute of Chemical Technology (Rubizhne) of Volodymyr Dahl East Ukrainian National University (79 students). The detailed description of the experimental subjects is given in Table 1. According to the pedagogical experiment requirements, the experimental (EG, 89 students) and control groups (CG, 85 students) were formed.

Table 1
Description of the Subjects of the Pedagogical Experiment

Name of HEI	Duration of the experiment	Title and Code of Speciality	Total number of the experimental subjects	Size of the EG	Size of the CG
Institute of Chemical Technology (Rubizhne) of Volodymyr Dahl East Ukrainian National University	2013-2014	6.040302 - Informatics	29	14	15
	2015-2016	122 – Computer Sciences and Information Technologies	25	12	13
	2016-2018	122 – Computer Sciences	25	13	12
Donbas State Engineering Academy	2013-2016	122 – Computer Sciences and Information Technologies	29	15	14
	2016-2018	122 – Computer Sciences	24	13	11
	2013-2018	124 – System Analysis	42	22	20
Total:			174	89	85

During the pedagogical experiment the validity of the results obtained was ensured by the following factors: the observations in the groups were carried out according to a pre-designed programme in the true educational process conditions; the students of the control and experimental groups studied similar in content educational materials; tests in the experimental and control groups were carried out simultaneously; all the measurements were made on the basis of the same questionnaires, survey papers, tests, and assessment papers; the teachers involved in the experiment were previously introduced to the computer-oriented teaching methodology.

During the second, searching phase, the theoretical foundations for developing all the components of the differential equations teaching methodology were determined. Specifically, the content of the DEs discipline was specified by selecting the system of both typical and professionally oriented tasks for Computer Sciences speciality students, the choice of methods, forms and tool for teaching DEs, including the computer-oriented ones,

was made. In addition, the introduction of the developed methodology into the process of teaching differential equations was started. Selecting and linking of the methodology components was carried out on the basis of the Differential Equations website, for which the conception was built up (Fig. 1).

Fig. 1
Differential Equations
Website Concept

«Differential Equations»
Developed for <TARGET AUDIENCE>

Computer Sciences speciality students, who study differential equations as a separate subject or as a section the discipline of Higher Mathematics, teachers of HEIs
Aimed at <OBJECTIVES AND TASKS>

Objective: implementation of the computer-oriented methodology of teaching DEs to CS students

Tasks:
- providing lectures classes with computer-based learning tools, in particular, visualization tools;
- using website content during practical classes on the disciplines;
- organizing and managing of students' independent work;
- providing a continuous assessment (online testing);
- creating communication opportunities on the website (online consultations with a teacher, discussions of certain issues during chat sessions, ability to comment, evaluate and share material on social networks);
- providing prompt access of the authorized users to online achievements sheets, training materials, site newsfeed;   **Achieved by <TOOLS>**
- forming of the educational resources system on the discipline (literature guidance, useful links, e-library).
- tools for managing information content of websites and portals (Content Management Systems, CMS) WordPress;
- interactive tools for exercising communication, administrative and other functions;
- operational filling with content (author's developments, educational video materials, additional sources, etc.)

Based on <PRINCIPLES>

Integrity. Providing for the creation of the holistic self-sufficient mixed system of teaching differential equations to technical university students.
Accessibility. Giving the necessary educational and methodological support for effective online training on Differential Equations discipline.
Interactivity. Providing effective interaction among students and between students and a teacher.
Compliance with the current development level of computer-oriented technologies. The main design solutions of the website are based on the achievements of modern WEB technologies.
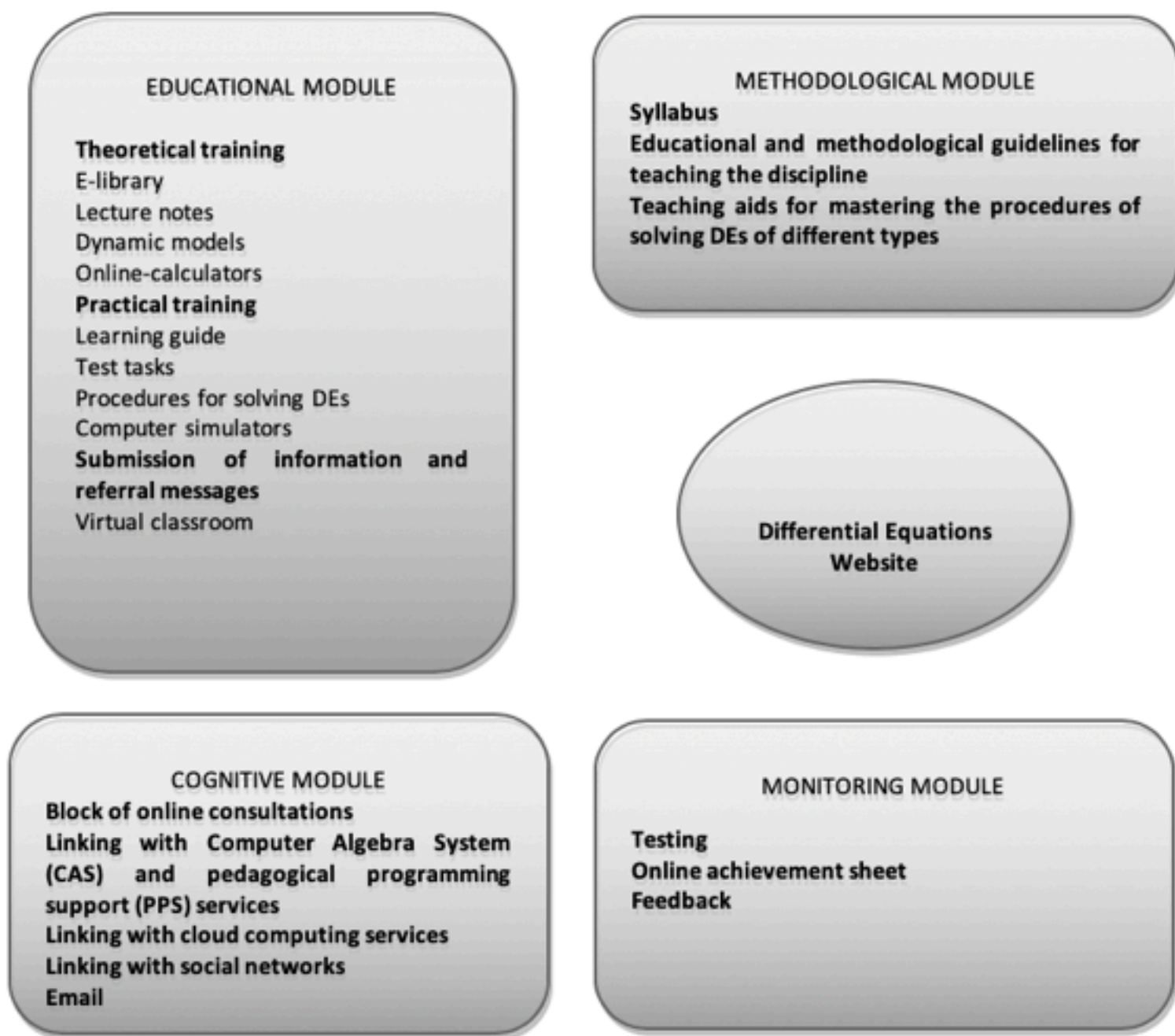**Practical orientation.** Providing effective online training for any user of the site according to their individual needs and capabilities.   **Leads to <RESULTS>**
Content updating. Timely and regular filling of the website content with educational materials.

Effective implementation of the computer-oriented methodology of teaching differential equations to Computer Sciences speciality students in order to form their informatics competencies

We may now review the structure of the website. The content of the site is grouped according to the target audiences: students, teachers. The site consists of four modules: educational, methodological, cognitive and monitoring (Fig. 2).

Fig. 2
Structure of the Differential
Equations Website

EDUCATIONAL MODULE

Theoretical training
E-library
Lecture notes
Dynamic models
Online-calculators
Practical training
Learning guide
Test tasks
Procedures for solving DEs
Computer simulators
Submission of information and referral messages
Virtual classroom

METHODOLOGICAL MODULE
Syllabus
Educational and methodological guidelines for teaching the discipline
Teaching aids for mastering the procedures of solving DEs of different types

Differential Equations Website

COGNITIVE MODULE
Block of online consultations
Linking with Computer Algebra System (CAS) and pedagogical programming support (PPS) services
Linking with cloud computing services
Linking with social networks
Email

MONITORING MODULE
Testing
Online achievement sheet
Feedback

The tasks completed by the students were systematized according to five complexity levels. All tasks were posted on the website.

The first level computer test tasks were to develop the students' ability to find, systemize, analyze, organize and transform the required data from different sources.

Solving the tasks of the second complexity level was aimed at reproducing a simpler algorithm of actions while solving DEs and using training software, in particular, CAS Maxima, Scilab and GRAN, as well as cloud-based computing services.

The tasks of the third complexity level provided for the students mastering standard procedures used in computer simulators and required using computer mathematics systems for computing operations.

The practical tasks of the fourth complexity level required making an effective choice of software products to solve the tasks given.

The tasks of the fifth complexity level are professionally oriented tasks-cases. Dealing with solving such tasks required from the students analyzing and designing mathematical models of processes, data mining with visualization of the results.

3. Results

At the beginning of the experiment, the survey was attended by 108 university students and 87 high school students. 58 participants were interviewed using paper questionnaires, and 137 – through the website (Vlasenko & Sitak, 2014) via the Facebook social network. According to the results of the survey, 51.4 % of the respondents spend on the network between 1 and 3 hours daily for study purposes. With the help of the Internet resources, students prepare for lessons, write library research reports, do course papers and tests etc. Social networks are the most popular – 88%, as well as online libraries – 42%. Online answer books and essay banks are used by 30%, the smallest number of students use cloud

storages – 16%. Additionally, 87% of the respondents claim that they are not able to do their homework themselves and require help from the outside, preferably free of charge; 76% want to get help online; 64% mention the lack of available educational and methodological literature that could help with mastering theoretical material; 92% of the students do not understand how differential models are obtained while solving tasks. The answers from 100% of the respondents confirmed the necessity of creating an online learning resource that would contain educational and learning materials.

The attitude of higher mathematics teachers to the problem of managing differential equations teaching through computer-oriented technologies was stated. For this purpose, the questionnaire survey and interviewing of the teachers (73 scientists) in higher technical educational institutions was conducted. According to the results from the analyzed responses, 90% of the teachers believe that students experience significant difficulties in mastering DEs. The introduction of computer-oriented technologies into the educational process (90%) and organization of students' independent work (86%) can help with it. In order to provide assistance to students while studying DEs, 94% of the teachers suggest that more time should be given for consultations, 86% of the respondents point out that it's advisable to provide students with online counseling (with the possibility to learn asynchronously), 73% of the scientists emphasize the need for developing websites that can accompany any kinds of students' independent educational activities. The interviewed scientists note that on educational websites with DEs there should be hypertext lectures and practical tasks - 67%, computer simulators - 72%, test tasks - 69%, tools that enable visualizing and modeling of processes being studied - 74%. Almost all the respondents point out that there is no Internet content that would meet the requirements specified and provide for the computer-based teaching of differential equations. Thus, the relevance of developing a computer-oriented method of teaching DEs to Computer Sciences speciality students has been confirmed.

The criteria for estimating the efficiency of the proposed methodology in the process of teaching Computer Sciences speciality students were the levels of their informatics competencies development.

To establish the initial level of the Computer Sciences speciality students' informatics competencies, the incoming test was conducted using the Microsoft Corporation Digital Literacy Certificate test for determining the level of a person's computer literacy (very low, basic, standard, high, very high). The results of the test are presented in Table 2.

Table 2
Incoming Test Results of the
Informatics Competencies Level

Groups	Level									
	Very low		Basic		Standard		High		Very high	
EG $n1=89$	$Q11=7$	7,9%	$Q12=40$	44,9%	$Q13=27$	30,3%	$Q14=8$	9,0%	$Q15=7$	7,9%
CG $n2=85$	$Q21=5$	5,9%	$Q22=46$	54,1%	$Q23=24$	28,2%	$Q24=5$	5,9%	$Q25=5$	5,9%

To find out the levels of the students' informatics competencies, two hypotheses were suggested: null and alternative. The notation p_{ki} is the probability that a subject from k-sample will fall into i-category ($\forall i = \overline{1;5}$, $k = \overline{1;2}$). Null-hypothesis H_0 was that the probability of the subjects the first and second samples falling into each of the three categories is equal, i.e, $p_{1i} = p_{2i}$. In this regard, we had the alternative hypothesis H_1: $p_{1i} \neq p_{2i}$ at least for one category, i.e, the difference between the two samples distributions is quite significant. To test the above hypothesis, with the help the distribution-free test of fit χ^2 the value of the test statistics $T=1,863$ was calculated (Table 3 presents the calculations of the test statistics using Microsoft Excel spreadsheets) by the formula:

$$T = n_1 \cdot n_2 \cdot \sum_{i=1}^{L} \frac{\left(\dfrac{Q_{1i}}{n_1} - \dfrac{Q_{2i}}{n_2} \right)^2}{Q_{1i} + Q_{2i}}. \tag{1}$$

where n_1 – first sample size, i.e, the number of students in the experimental groups (EG);

n_2 – second sample size, i.e, the number of students in the control groups (CG);

L – the number of levels of students' competencies;

Q_{1i}, Q_{2i} – the number of students in the first and second groups related to the level $\kappa = i$.

Table 3
Calculations of the Fitting Criterion
(ascertaining experiment)

Levels	EG results		CG results		Interim calculations
	number	%	number	%	
Very low	7	7,9	5	5,9	3,2763E-05
Basic	40	44,9	46	54,1	9,78594E-05
Standard	27	30,3	24	28,2	8,66176E-06
High	8	9,0	5	5,9	7,42292E-05
Very high	7	7,9	5	5,9	3,2763E-05
Total	89	100	85	100,0	0,000246276
Value of the fitting criterion					1,86308016

For the test significance 0,05 and $L - 1 = 4$ critical value $\chi^2_{0,05} = 9,49$, thus, $T < \chi^2_{0,05}$. The result based on the calculations confirmed the homogeneity of the control and experimental groups formed at the beginning of the experiment.

The third formative stage of the experiment was aimed at implementing, testing and refining of the developed computer-oriented teaching methodology. At this stage the methods, forms

and means of teaching DEs were specified; the experimental data were processed and analyzed, the conclusions were formulated. The purpose of this stage was to determine the efficiency of the suggested teaching methodology. The conducted monitoring and assessment activities allowed to determine the informatics competencies level of the students in the experimental and control groups. The tasks for the summative assessment were posted on the Differential Equations website (Vlasenko & Sitak, 2014). Solving the tasks involved using software tools for constructing cumulative curves, using computer simulators, cloud calculators, spreadsheets, software tools for visualization of the research results. The results of the summative assessment are given in table 4.

Table 4
Results of the Summative Assessment of
the Students' Informatics Competencies

Groups	Level									
	Very low		Basic		Standard		High		Very high	
EG $n1=89$	$Q11=5$	5,6%	$Q12=28$	31,5%	$Q13=39$	43,8%	$Q14=10$	11,2%	$Q15=7$	7,9%
CG $n2=85$	$Q21=5$	5,9%	$Q22=45$	52,9%	$Q23=20$	23,5%	$Q24=9$	10,6%	$Q25=6$	7,1%

The summative assessment was performed in accordance with five levels - very low, basic, normative, high, very high. The results of the summative assessment of the experimental and control groups can be illustrated by a histogramme (Fig. 3). As we can see, at the end of the experiment in the EG there was a redistribution of the students' percentage in favor of standard, high and very high levels. The total growth was 15.7% compared to 1.2% in the CG.

Fig. 3
Dynamics of Changes in the Informatics Competencies Levels of the Students
in the Experimental and Control Groups at the End of the Experiment
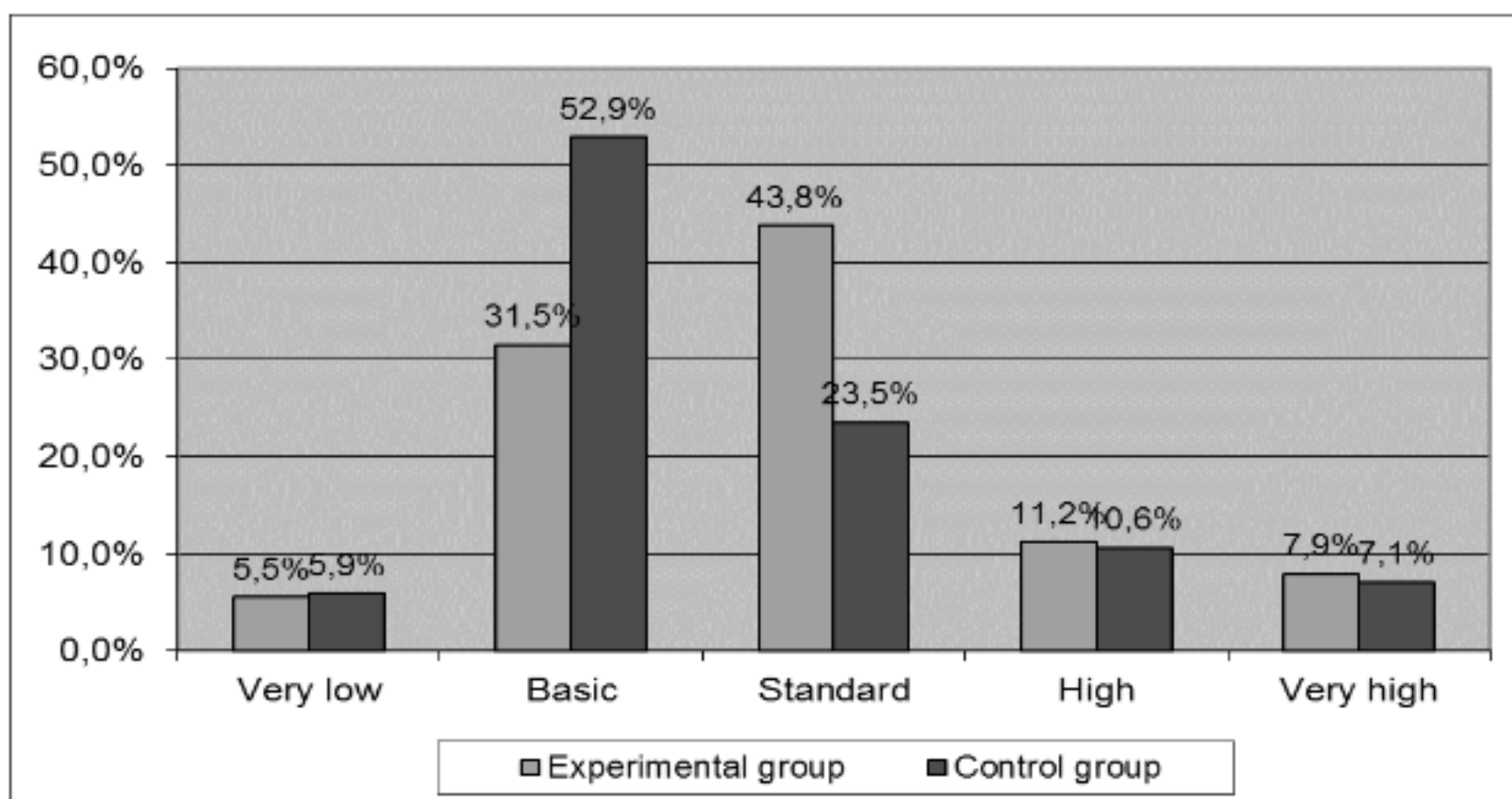
To prove the effectiveness of the developed computer-oriented teaching methodology on developing students' informatics competencies, two hypotheses were put forward: null and alternative. Null-hypothesis: the difference in the students' achievement levels in the

experimental and control groups is insignificant. Alternative hypothesis: the distribution of the samples differs significantly, which is seen as the result of imlementing the computer-oriented methodology for teaching differential equations to Computer Sciences speciality students. To test the hypothesis, with the help of the distribution-free test of fit X^2 the value of the test statistics T=10,120was calculated (Table 5 shows the calculation of the criterion using Microsoft Excel spreadsheets)andby formula (1) the null hypothesis was rejected and the alternative was accepted, namely, the significant difference between the results is the effect of implementing the computer-oriented methodology for teaching differential equations to Computer Sciences speciality students.

Table 5
Calculations of the Fitting Criterion (formative experiment)

Levels	EG results		CG results		Interim calculations
	number	%	number	%	
Very low	5	5,6	5	5,9	6,98944E-07
Basic	28	31,5	45	52,9	0,000632071
Standard	39	43,8	20	23,5	0,000697826
High	10	11,2	9	10,6	2,20811E-06
Very high	7	7,9	6	7,1	5,00148E-06
Total	89	100	85	100,0	0,001337805
Value of the fitting criterion					10,1204972

During the formative stage, after every type of assessment, the results of a student's progress were made available to see in the online achievement sheets, which were posted in the Virtual Classroom of the Differential Equations website (Vlasenko & Sitak, 2014). The Virtual Classroom, created with the aim of managing of the students' independent work, contributed to developing the students' self-organization skills and automating their own workplace. Figure 4, for example, presents the online achievement sheets of the students in two groups.

Fig. 4
View of the pages of the groups' online achievement sheets
in the Virtual Classroom of the Differential Equations website

Experimental group

Student's Name	CP$_0$ (8 б.)	CP$_1$ (8 б.)	CP$_2$ (8 б.)	CP$_3$ (8 б.)	CP$_{sum.}$ (8 б.)	TT (12 б.)	IT (14 б.)	CW (5 б.)	Cases (24 б.)	RW (5 б.)	Sum. (100
1. Veretennykova Anna	7	8	7	8	8	12	14	1	22	5	92
2. Danylova Anastasiia	4	5	5	5	5	10	10	2	18	2	66
3. Diehtiarova Oleksandra	4	6	6	5	5	10	11	2	18	3	70
4. Iefimtsev Pavlo	6	7	7	7	7	11	12	4	20	2	83
5. Zhyzhaiev Stanislav	7	8	7	7	7	11	10	4	20	4	85
6. Korzynka Krystyna	5	5	5	5	5	11	12	3	18	2	71
7. Markin Vladyslav	4	5	4	5	5	10	10	3	15	2	63
8. Molchanov Bohdan	5	5	5	4	5	10	10	4	18	2	68
9. Nikitin Vladyslav	5	5	5	5	5	10	10	2	14		61
10. Poliakov Stanislav	5	6	6	6	6	11	11	3	18	3	75
11. Potapov Ivan	5	6	5	5	5	10	12	3	15	2	68
12. Rzaiev Yusif	4	5	5	4	5	10	12	3	15	2	65
13. Sevostianova Maryna	7	8	7	8	8	12	12	2	24	5	93
14. Shabliienko Yurii	7	7	7	8	7	11	10	2	20	4	83
15. Iartseva Olha	5	7	6	6	6	11	10	2	18	3	74

Control Group

Student's Name	CP$_0$ (8 б.)	CP$_1$ (8 б.)	CP$_2$ (8 б.)	CP$_3$ (8 б.)	CP$_{sum.}$ (8 б.)	TT (12 б.)	IT (14 б.)	CW (5 б.)	Cases (24 б.)	RW (5 б.)	Sum. (101
1. Abdula Yevheniia	5	6	6	5	6	8	10	2	19	5	72
2. Aldakymova Tetiana	4	5	6	5	5	9	10	1	16	2	63
3. Antonov Vladyslav	4	6	5	4	5	10	11	2	17	3	67
4. Barabonov Artem	4	5	6	5	5	8	11	2	15	3	64
5. Vasko Anton	6	7	7	7	7	11	12	4	16	2	79
6. Yermakov Volodymyr	7	6	5	6	7	11	10	3	14	4	73
7. Zakopailo Oleksii	5	5	5	5	5	10	10	3	14	3	65
8. Kysla Liubov	4	5	4	4	5	8	10	3	15	2	60
9. Kolomatskyi Ivan	5	4	4	4	5	10	12	2	17	2	65
10. Miroshnychenko Mykhailo	5	5	5	5	5	10	10	2	14	4	65
11. Panchyshko Serhii	5	6	5	4	6	7	11	3	12	3	62
12. Petrov Anton	5	4	3	5	5	10	7	1	10	2	52
13. Pustovitova Kateryna	4	5	5	4	5	10	12	3	15	2	65
14. Triandofilidi Marichka	7	8	7	7	8	12	13	5	20	3	90
15. Firsov Danylo	7	6	5	9	7	11	10	3	15	4	77
16. Tsebrenko Oleksandr	5	7	6	6	6	12	10	2	16	5	75

TT – Test Tasks
IT – Individual Tasks
RW – Research Work, Blogging
CP – Control Paper
CW – Classroom Work
Cases – Cases Participation in solving, defending and reviewing cases
Sum. – Summative Assessment

The number of students with grades A-C is 7 people in the experimental group and 4 in the control group. The academic grade average according to the semester results for the EG students was 74.5 points (100-point grading system) compared to 68.4 points for the CG students.

During the final survey, the students' attitudes towards studying with the computer-based support was found out. Here are some of the students' answers.

Bogdan M.: 'Unlike usual classes, it was more interesting to study the differential equations, because we constantly used computer devices. I'm a future programmer, and the computer is my main working tool. Due to the constant accessibility of the educational materials, I can always get the answer to the question that arises.'

Oleksiy S.: 'I'm a person with limited mobility, often get sick and miss classes. It's very important for me that all the educational materials are on the site, and I can communicate with my teacher online.'

Marina S.: "I liked that while studying differential equations we were able to use different software tools to check our calculations and graphs plotting. This helped to avoid mistakes and save time. I've finally understood how interesting and useful my future work is.

Analyzing the results obtained, we can conclude that the ascertaining stage of the experiment confirmed the efficiency of the suggested methodology by showing a positive tendency to reduce the number of students with low and basic levels by way of their shift to standard, sufficient and high levels.

4. Conclusions

The absence of the unified approach to the definition of informatics competency is demonstrated by most of the current research (American Library Association, 2000). We clarify the definition of informatics competencies proposed by Zelinskyi (2016), Yatsko (2016) and Bondaruk (2017). Consequently, we consider the informatics competencies of Computer Sciences speciality students as a component of their professional competencies, which is characterized by the ability of future specialists to apply computer-oriented technologies in the process of mastering fundamental and professional disciplines, and their willingness to use such technologies in their professional activities.

Analyzing the ways of developing such abilities in the works by Ferrari (2012), Morze & Kuzminska (2011), Voronkova & Kyvlyuk (2017), Vlasenko & Chumak (2012), Uskoković (2018), Quezada Abad et al. (2018), we are agree with Zhaldak's (2013) recommendations. Therefore, we believe that developing informatics competencies occurs due to students reflecting on the experience gained while solving mathematical models of the tasks in the subject field with the use of various computer tools. While studying DEs, students accumulate experience in using modern computer-oriented technologies for mathematical modeling of objects, processes and phenomena, building computational models and algorithms for numerical solution of mathematical modeling tasks taking into account the errors of the approximate numerical solution of professional tasks. In the future, while studying specialized disciplines, students reflect this experience and improve it.

Following Llorens et al. (2013) recommendations, we use the mixed model of educational process organization. It was found out that the application of this teaching type requires from a teacher to provide a balanced combination of traditional and computer-oriented teaching technologies while ensuring the social interaction (student-teacher', 'student-student'). The natural way to make such interaction of Computer Science speciality students possible is educational websites. We consider the educational website as a holistic, conceptually grounded and structurally built system that combines interrelated web pages, the content of which is subject to the general idea and conveyed in the specific goals and objectives of each of them. The development of the website and the conception of its implementation are coordinated with the use of Content Management System (hereafter CMS) WordPress.

The developed conception should aim at providing computer-oriented support for the methods of teaching students and forms for organizing their activities while studying DEs. The interaction between the methods and forms of teaching through the website content may facilitate the organization of classes and management of students' independent activities (synchronous and asynchronous training). The use of the developed methodology promotes developing students' ability to use computer-oriented technologies for: finding,

systematizing, analyzing, organizing and transforming the required data from different sources; conducting high-performance computations based on cloud services; providing the organization of computational processes through the computer mathematics systems; automating their own workplaces and self-development; effective choice of software products for solving the tasks given; analyzing and building mathematical models of processes; data mining with the results visualization. According to Rakov (2010), Spirin (2009), Vlasenko (2008) the sufficient level of such abilities in students points to the efficiency of building up their informatics competencies.

Forming Computer Sciences speciality students' informatics competencies is a process that requires the study of the complex systems of interaction between methodological basics of teaching fundamental disciplines to HEI students and their professional training. Professional training of students calls for the development of their informatics competencies. Forming such abilities in undergraduate students should start during their study of the mathematical disciplines. Supporting the teaching of fundamental disciplines with computer-oriented learning tools lays the groundwork for developing a methodology. One of such tools may be a website, the content of which contributes to combining traditional and active methods and forms of learning. The efficiency of the introduction of a suchlike website is conditioned by the development of the conception. This approach contributes to ensuring individualization, accessibility and quality of teaching, and increasing the applied orientation in the contents of students' professional training. Computer-oriented support of classroom teaching of DEs and students' independent work should be systemic but with certain limitations. While preparing for classes and consultations, a teacher has the opportunity to plan the use of the computer-oriented learning tools that compile the content of the developed educational website http://difur.in.ua/. With this approach, while developing students' informatics competencies, it becomes possible to take into account their individual features, to give the research form to students' educational and professional activities while studying DEs, to contribute to improving the quality of students' training through the use of a professional language and means that accompany the work of a specialist in the IT-industry.

The obtained results make it possible to identify some lines of further research in the field of preparing HEI teachers for developing activity environments, using the technologies of distance and mobile learning, cloud technologies.

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