Selection of Mobile ICT for Learning Informatics of Future Professionals in Engineering Pedagogy

Viktoriia Tkachuk[1[0000-0002-5879-5147]], Serhiy Semerikov[2,3[0000-0003-0789-0272]], Yuliia Yechkalo[1[0000-0002-0164-8365]], Svitlana Khotskina[1[0000-0002-0297-930X]] and Vladimir Soloviev[2[0000-0002-4945-202X]]

[1] Kryvyi Rih National University, 11 Vitalii Matusevych Str., Kryvyi Rih, 50027, Ukraine
viktoriya.tkachuk@gmail.com,uliaechk@gmail.com, khotskinasv@ukr.net
[2] Kryvyi Rih State Pedagogical University, 54 Gagarina Ave., Kryvyi Rih, 50086, Ukraine
semerikov@gmail.com, vnsoloviev2016@gmail.com
[3] Institute of Information Technologies and Learning Tools of NAES of Ukraine, 9, M. Berlynskoho Str., Kyiv, 04060, Ukraine

Abstract. The research aims to theoretically justify and experimentally verify selection of mobile ICT for learning informatics to future professionals in engineering pedagogy. The research tasks include selecting groups of informatics subjects and mobile ICT tools for learning future professionals in engineering pedagogy. The research object involves selection of mobile ICT for the training process. The re-search subject is selection of mobile ICT for learning informatics to future professionals in engineering pedagogy. The research results imply analysis of the national and foreign researches into mobile ICT for learning informatics. The latest publications concerning selection of mobile ICT for teaching Informatics subjects (Mobile Learning Management Systems, Mobile Modeling and Programming Environments, Mobile Database Management Systems, Mobile Multimedia Authoring Tools, Audience Response Systems) are analyzed. Informatics subjects are united into 19 groups, mobile ICT tools – into five groups. The experimental research is conducted according to the syllabuses for Speciality 015.10 "Professional Education (Computer Technologies)". The expert assessment results for each of the content blocks of informatics subjects allow determining leading and auxiliary mobile ICT teaching tools.

Keywords: Mobile ICT, Mobile Learning Management System, Mobile Modeling and Programming Environments, Mobile Database Management Systems, Mobile Multimedia Authoring Tools, Audience Response Systems, Learning Informatics, Engineering Pedagogy.

1 Introduction

Pedagogical practice has accumulated sufficient experience of arranging the training process through distance learning technologies, mobile ICT being one of them. Application of mobile ICT provides students with access to educational resources anytime anyplace, enhances efficient organization of students' in- and out-of-classroom

activities through making training continuous and mobile, increasing the part of out-of-classroom work controlled by the teacher and creating conditions for integrating various forms of training [13, 15, 18]. Mobile ICT are aimed at supporting personality-oriented training. So, mobile ICT applied to teaching Higher Mathematics at technical universities provides students with an opportunity to watch training materials before doing a module or examination paper, look through lecture materials before practical classes, get responses to one's answers in class, maintain feedback with the teacher and other students, consult with the teacher and do assignment in mobile middleware [13].

Unlike distance learning, mobile learning is more accessible for most students, while mobile learning ICT are quite flexible to be used for supporting traditional learning [21].

Steffen Kersten analyzes approaches to further education in the field of engineering pedagogy for the development of qualifications for the design of teaching and learning processes in engineering education. He line, that quality management systems at German universities have increasingly focused their attention on the further pedagogical training programs for engineer-pedagogy [9].

In paper [11] described mobile ICT-enabled and collaborative learning opportunities for students. The research component of the project was designed to explore the adoption of video-conferencing technology and other collaborative Information and Communication Technologies (ICT) amongst educators. Authors develop purpose needs of in-service teachers necessary to enable them to organize video-conferencing based learning events.

Nina Tvenge and Kristian Martinsen in the research on selection of ICT-tools for manufacturing education, described that administration has had great influence on what tools were selected for teaching processes organization, and that this has led to both increased use and non-use of ICT in their teaching practice. However, authors noted that ICT for teaching is an enabling technology with a possibility for increased learning outcome in engineering education [19].

Cristopher J. Devers and Stefanie Panke, showed up an overview of learning with mobile ICT. The author provides a condensed overview of learning with mobile devices in higher education, and offer summaries of the relevant research for e-books, podcasts, audience response systems, and augmented reality, as related to mobile devices. The author suggest that technology is simply a medium or tool, and that future research should explore how mobile devices can support learning with evidence-based practices and Mayer's 13 principles of multimedia learning [4].

By selection of mobile ICT for learning informatics we have analyzed the latest publications on the following tools:

- Mobile Learning Management Systems in learning process researched by Luisa Sanz-Martínez, Erkan Er, Alejandra Martínez-Monés, Yannis Dimitriadis and Miguel L. Bote-Lorenzo [14], Valerii Yu. Bykov [2], Insook Han and Won Sug Shin [8];
- Mobile Modeling and Programming Environments are described by Badreldin Altayeb and Kostadin Damevski [1], Francesc-Josep Lordan Gomis [10];

- Mobile Database Management Systems researched by Deniz Mertkan Gezgin [6], Minzhe Guo, Kai Qian and Li Yang [7], Milan Eric, Slobodan Mitrovic, Miladin Z. Stefanovic and Aleksandar Djordjevic [5];
- Mobile Multimedia Authoring Tools have been reviewed by Yuliia V. Yechkalo, Viktoriia V. Tkachuk, Tetiana V. Hruntova et al. [20], Dian Tjondronegoro [17], Andrii M. Striuk, Maryna V. Rassovytska, Svitlana V. Shokaliuk [16];
- Audience Response Systems have been researched by Tan Fung Ivan Chan, Marianne Borja, Brett Welch and Mary Ellen Batiuk [3], Dylan M. Moorleghen, Naresh Oli, Alison J. Crowe, Justine S. Liepkalns, Casey J. Self and Jennifer H. Doherty [12].

2 Purpose

The research is aimed to theoretically ground and justify the selection of mobile ICT for learning informatics to future professionals in engineering pedagogy.

3 Results

To determine significance of mobile ICT application to teaching Informatics subjects, the survey Significance of application of mobile ICT to teaching Informatics to future professionals in engineering pedagogy of Speciality 015.10 "Professional Education (Computer Technologies)" was conducted (Fig. 1, available at http://goo.gl/CVsXcl). Eleven respondents from the University teaching staff were asked to assess efficiency of using mobile ICT by the 5-point quality scale (from 1 – inadvisable to use to 5 – advisable to use):

- Mobile Learning Management Systems (Moodle, Claroline, eFront, etc.);
- Mobile Modeling And Programming Environments (Web-environments to model and conduct researches like CoCalc, HPCCloud; online-IDE like Cloud9 IDE, PythonAnywhere, Eclipse Che, Pascal/C++/PHP Online, etc.);
- Mobile Database Management Systems (InterBase, SQL Anywhere, Microsoft SQL Server, IBM DB2 Everyplace, Oracle Database Lite, SQLite, etc.);
- Mobile Multimedia Authoring Tools (audio- and video-services like YouTube, Vimeo, etc.; online presentation editors like Prezi, Google Slides, etc.; animation editors like VideoScribe, etc.; graphical editors and augmented reality tools like Paint 3D, SketchUp, etc.);
- Mobile Audience Response Systems (Google Forms, EasyTestMaker, Online Test Creator, etc.) [18].

Informatics subjects using mobile ICT were united into 5 content blocks:

1. Theoretical principle of Informatics:

1) Discrete Programming, Operation Research, Computer Logic, Theory of Automatic Control;

2) Computer Cryptography;

2. Architecture of modern computing machines:
    3) Architecture of Computer Systems and Networks, Microprocessor Systems;
3. Basics of algorithmization and programming:
    4) Basics of Algorithmization and Elements of Programming;
    5) Visual Programming;
    6) Low-Level and Systems Programming;
    7) High-Level Programming Language;
    8) Web Programming;
    9) Software Design Technologies;
    10) Database Programming;

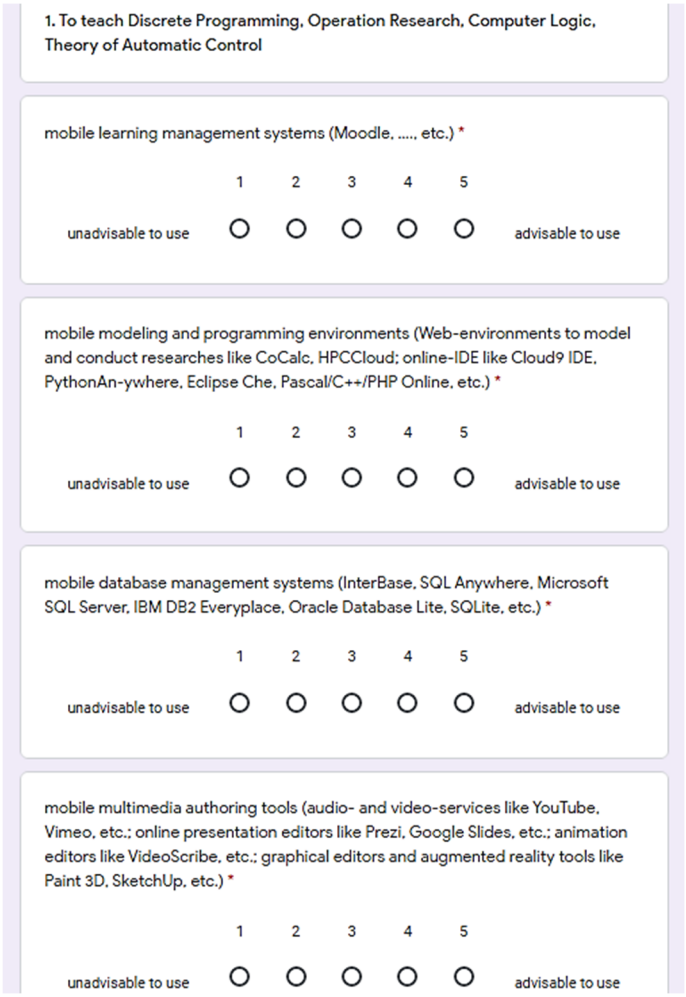

Fig. 1. Significance of application of mobile ICT to teaching Informatics to future professionals in engineering pedagogy of Speciality 015.10 “Professional Education (Computer Technologies)”

4. Software of computing systems:
    11) Project Management;
    12) Application Software;
    13) Systems Software;
    14) Basics of Information Security;
    15) Computer Design and Multimedia;
    16) Engineering and Computer Graphics;
    17) Computer Aided Design;
5. Computer technologies in professional activity of professionals in engineering pedagogy:
    18) Automation Systems for Document Management;
    19) Computer Pedagogical Technologies, Computer Ergonomics.

Table 1 presents assessment of efficiency of applying each of five tools for the 19 groups of Informatics subjects grouped into five basic content blocks.

Table 1. Assessment of efficiency of applying mobile ICT to teaching Informatics subjects to future professionals in engineering pedagogy, Speciality 015.10 Professional Education (Computer Technologies)

Content block	Group of Informatics subjects	Mobile ICT tools					Average efficiency estimate for subject **group**
		mobile learning management systems	mobile modelling and programming environments	mobile database management systems	mobile multimedia authoring tools	mobile audience response systems	
Theoretical principle of Informatics	Discrete Programming, Operations Research, Computer Logic, Theory of Automatic Controll	4.09	4.36	3.27	4.18	4.45	**4.07**
	Computer Cryptology	4.00	4.00	3.36	4.00	4.18	**3.91**
Architecture of modern computing machines	Architecture of Computer Systems and Networks, Microprocessor Systems	4.09	3.55	3.00	4.09	4.27	**3.80**
Basics of algorithmization and programming	Basics of Algorithmization and Elements of Programming	4.27	4.45	3.27	4.36	4.36	**4.15**
	Visual Programming	4.09	3.91	2.73	4.36	4.18	**3.85**

Content block	Group of Informatics subjects	Mobile ICT tools					Average efficiency estimate for subject **group**
		mobile learning management systems	mobile modelling and programming environments	mobile database management systems	mobile multimedia authoring tools	mobile audience response systems	
	Low-Level and Systems Programming	4.00	3.91	3.00	3.91	4.09	**3.78**
	High-Level Programming Language	4.09	4.45	3.55	4.27	4.18	**4.11**
	Web Programming	4.27	4.36	3.55	4.18	4.36	**4.15**
	Software Design Technologies	4.09	4.45	3.64	4.18	4.27	**4.13**
	Database Programming	4.09	4.27	4.82	4.09	4.27	**4.31**
Software of computing systems	Project Management	4.09	2,82	2.82	4.09	4.27	**3.62**
	Application Software	4.36	2.91	3.09	4.27	4.45	**3.82**
	Systems Software	4.09	3.45	3.18	3.91	4.27	**3.78**
	Basics of Information Security	4.09	3.00	3.09	4.00	4.27	**3.69**
	Computer Design and Multimedia	4.18	3.64	2.64	4.73	4.36	**3.91**
	Engineering and Computer Graphics	4.09	3.00	2.55	4.91	4.55	**3.82**
	Computer Aided Design	4.18	3.45	3.09	4.18	4.36	**3.85**
Computer technologies in professional activity of professionals in engineering pedagogy	Automation Systems for Document Management	4.27	3.36	3.45	4.09	4.36	**3.91**
	Computer Pedagogical Technologies, Computer Ergonomics	4.36	2.91	2.91	4.64	4.82	**3.93**
Average efficiency estimate of the tool		**4.15**	**3.70**	**3.21**	**4.23**	**4.33**	

After averaging, the obtained results ranged from 2.55 (application of mobile data-base management systems while studying the subject Engineering and Computer Graphics) to 4.91 (application of mobile multimedia authoring tools while studying the subject Engineering and Computer Graphics).

Numeric values were transformed into qualitative ones in the following way: the values from 4.00 to 5.00 correspond to the highest efficiency level; from 3.00 to 3.99 – to the medium level; below 3.00 – the low efficiency level of the tool application. Assessment of efficiency of applying mobile ICT tools to studying each Informatics subject is visualized in Table 1 in the following way: white represents estimates corresponding to the highest efficiency level; pink – the medium efficiency level; dark grey – the low efficiency level.

Fig. 2, 3, 4, 5, 6 shows an example of distributing estimates of efficiency of applying mobile ICT to teaching 1 group of Informatics subjects.

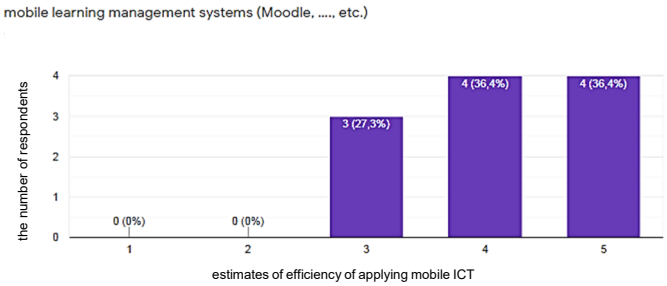

Fig. 2. Distribution of estimates of efficiency of applying Mobile Learning Management Systems

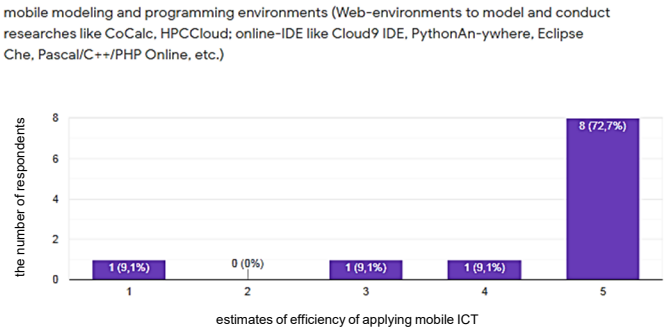

Fig. 3. Distribution of estimates of efficiency of applying Mobile Modeling and Programming Environments

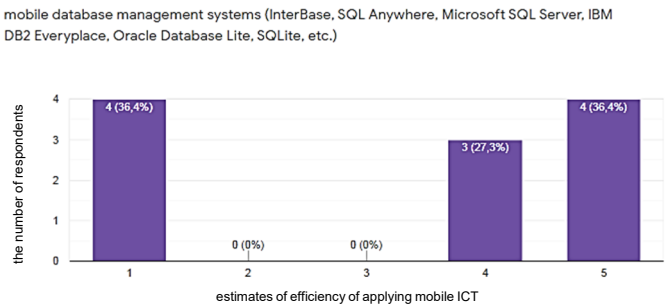

Fig. 4. Distribution of estimates of efficiency of applying Mobile Database Management Systems

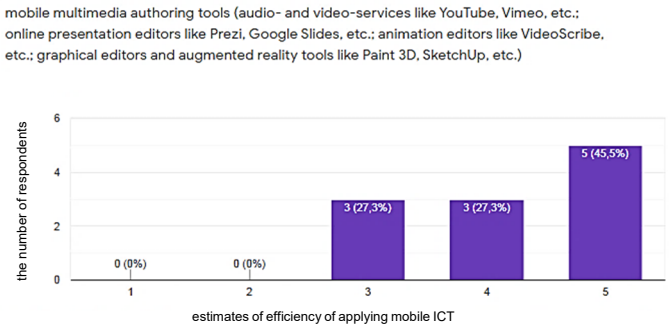

Fig. 5. Distribution of estimates of efficiency of applying Mobile Multimedia Authoring Tools

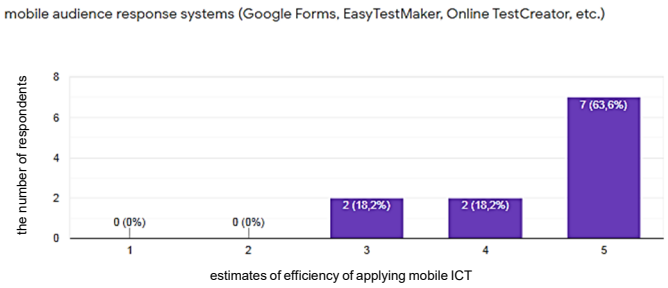

Fig. 6. Distribution of estimates of efficiency of applying Mobile Audience Response systems

To determine the average estimate of efficiency for the subject group, the value $\langle A \rangle$ is calculated:

$$\langle A \rangle = \frac{1}{n} \sum_{i=1}^{n} A_i, \quad (1)$$

where $\langle A \rangle$ is the average estimate of efficiency for each of the 19 subject groups.

To determine the average estimate of efficiency for each mobile ICT tool, the value $\langle B \rangle$ is calculated:

$$\langle B \rangle = \frac{1}{n} \sum_{i=1}^{n} B_i, \quad (2)$$

where $\langle B \rangle$ is the average estimate of efficiency for each of the five mobile ICT.

Analysis of the expert assessment results has revealed that:

- the most efficient mobile ICT tools for teaching Informatics subjects are mobile audience response systems and mobile learning management systems as for all the subjects they are noted for the highest efficiency level and can be considered universal mobile ICT tools of teaching Informatics subjects;
- mobile multimedia authoring tools have a high efficiency level of application for all Informatics subjects except for Low-Level and Systems Programming (for both subjects, the efficiency estimates equals 3.91) that also enables considering them universal;
- mobile modeling and programming environments have a high efficiency level for teaching the subject block of theoretical principles of Informatics and most subjects of the algorithmization and programming block (except for Visual Programming and Low-Level and Systems Programming);
- mobile database management systems have a high efficiency level of application (4.82) only for Database Programming.

Mobile ICT tools with a high efficiency level for a certain Informatics subject will be called leading mobile ICT tools for a given subject and those with a medium efficiency level – auxiliary mobile ICT tools for teaching a given subject.

Analysis of the averaged efficiency estimates for different classes of mobile ICT learning tools confirms the first and the second conclusions on universality of mobile audience response systems, mobile learning management systems and mobile multimedia authoring systems as their average efficiency estimates equal 4.33, 4.15 and 4.23. Mobile modelling and programming tools and mobile database management systems have a medium efficiency level (3.70 and 3.21 respectively).

Besides, the Informatics subjects with the highest efficiency level of applying mobile ICT tools were singled out, namely: Database Programming (4.31), Basics of Algorithmization and Elements of Programming (4.15), Web Programming (4.15), Software Design Technologies (4.13), High-Level Programming Language (4.11), Discrete Programming, Operations Research, Computer Logic, Theory of Automatic Control (4.07 for them all).

4 Conclusions

1. According to the expert assessment results for each content block of Informatics subjects, there are determined leading and auxiliary mobile ICT learning tools. It is revealed that mobile audience response systems and mobile learning management systems are universal tools for teaching Informatics subjects; mobile multimedia

authoring tools have a high efficiency level for all Informatics subjects, except for Low-Level and System Programming and System Software, this fact also enabling us to consider them universal. Mobile modelling and programming environments are leading tools for teaching Theoretical Basics of Informatics and Basics of Algorithmization and Programming (except for Visual Programming and Low-level and System Programming); mobile database management systems are leading mobile tools only for Database Programming.

2. The cooperative use of mobile multimedia authoring tools and mobile audience response systems to support the professional training of future professionals in engineering pedagogy is the driver for changing the Informatics' learning environment from virtual based to augmented.

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