Mobile applications design for digital education: IT-students' engagement experience on conditions of online learning the course "Mobile technologies"

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Abstract

The paper deals with current essential problems of mobile digital education provision with high-quality aids and the challenges of online training of IT specialists. Based on the recent studies review and educational practice analysis, the urgency of our research related to the problems of dropping students' motivation to learn and necessity to find out efficient ways to involve them into active and practically significant kinds of learning activities is revealed. Taking into account the great potential of mobile didactic aids and benefits of their using in the educational practice, the attempt to implement the project-based learning (PBL) strategy and engage the students of IT majors with development of practically meaningful projects within the "Mobile technologies" online course has been undertaken. Accordingly the purpose of the work is to highlight the branches of project themes, characterize the stages and the results of students' work. The preliminary analysis of the impact of such an activity on the students' learning motivation has been also provided. The preparation stage of the survey on the estimation of the students' motivation as an impact of PBL implementation has been provided. The survey consists of 20 items comprising 4 subsections corresponding to the amount of the revealed motivation dimensions (attention, appealing to learner's past experience, positive attitude, and satisfaction). To obtain preliminary results and test the designed survey reliability, it was conducted in groups of future IT specialists who completed the online course "Mobile technologies". The acceptable reliability of the scales has been proven. According to the score intervals, four levels of motivation were distinguished. The results of the survey, according to the levels of students' motivation, are presented and discussed. The results of the authors' observations according to the monitoring program have been also given and discussed. It has been concluded that the obtained results of the conducted survey and our monitoring program might be used potentially as a basis for carrying out comprehensive empirical research for the verification of the impact which the proposed PBL can make on the level of students' motivation. It is planned to widen respondents' range to generalize the survey results and to expand it by specifying the changes caused by the introduced methods, which makes a prospect of our work.

Keywords

IT students' engagement, mobile learning, project-based learning, mobile learning aids, motivation to learn

1. Introduction

In terms of digitalization of education, nowadays priorities are shifting in favour of mobile technologies application to the learning purposes. It is mostly caused by BYOD strategy implementation at all levels of education, raising across-the-curriculum using of mobile gadgets, and increasing needs for integration of various educational technologies enhanced with the digital tools. In this context, in some research papers several common benefits of mobile learning which seem to be essential for its didactically relevant and efficient use in educational practice at school and university are highlighted. These benefits include portability of mobile devices with permanent availability of mobile learning aids; quick access to necessary learning content; provision of opportunity to study everywhere provoking students to work out their skills, generate and probe their ideas etc.; facilities of content renewing and others [1, 2].

Therefore, the urgency of development of quality teaching aids designed to support efficiency of mobile learning both in the classroom and independent students' work is raising. The mentioned aids should provide learners with relevant functionality to illustrate and reinforce proper concepts (skills), to improve comprehension of the learning content and work out skills, to differentiate instruction and decrease anxiety and boredom presenting learning content in an exciting way and involving students into useful gripping learning activities.

On the other hand, in current situation of online training of pre-service specialists at universities, the problems related to dropping of students' motivation to study are admitted. Among the reasons the researchers and practitioners emphasize the disbalance of theoretical and practical aspects of training, lack of practical skills application to real-life tasks, insufficient level of interactivity while studying and finally, losing of interest to the subject of learning [3, 4]. These problems which are common nowadays for all of the specialists' training, are especially urgent for the students of IT specialities where practical component of professional training within a team of peers has even higher importance. One more challenge in this context is caused by the fact that university training is mostly guided by cognitive approaches rather than by the motivation theory, so, unfortunately, students' motivation to learn is undervalued [3, 5].

Thus, it is essential to find out the means of the IT students' involvement into the interactive and practically driven forms of work.

Minding the great potential of mobile didactic aids and benefits of their using in the educational practice depicted above, we undertook the attempt to engage the students of IT majors into development of practically significant projects within the "Mobile technologies" online course.

The purpose of the work is to highlight the branches of project themes, to characterize the stages and the results of students' work upon them, and to provide preliminary analysis of the impact of such an activity on the students' learning motivation.

The paper consists of the introduction where the urgency and purpose of the work are formulated; theoretical background presenting the analysis of current works on the topic and making the necessary theoretical basis for the research; the section of results and discussion where the progress and deliverables of the research are presented and interpreted; proper conclusions closing the paper.

2. Theoretical framework

The theoretical background of the work is made by the analysis of (1) didactic fundamentals of mobile learning and peculiarities of the mobile learning aids development; (2) project-based learning; (3) motivation theory basics.

The core idea of our study is to involve potential IT specialists into the project-based activity within the "Mobile technologies" course focused on the development of teaching aids for mobile learning. Therefore, it is essential to cover and use important pillars of mobile learning which will determine the functional and non-functional requirements to the mobile aids being developed by the students. Based on the recent studies, the mobile learning as learning with the help of different mobile devices has some peculiarities which have been distinguished according to the analysis of the recent studies [1, 6, 7, 8].

Mobile learning is characterized as more spontaneous and context aware than other learning strategies, meaning that students can learn everywhere and anywhere. Portable sizes of mobile gadgets and wireless technologies transform conventional classroom-based learning and make it more available and independent from time, duration and place [2, 7, 9]. In addition, mobile tools can satisfy the learners natural need for instant information and immediate answers to exact questions (like definitions, formulas, etc.), which facilitates learning activities. So, learning content of mobile apps has to meet this requirement by providing a learner with immediate, actual and structured information.

The next feature of mobile learning is its blended character, which causes implementation of the blended learning model in teaching [8, 10], combining classroom instructions and teacher's directed activities with the students' independent educational activities with mobile devices during doing home tasks, playing didactic games, virtual experimenting, projects participating etc. The said blended learning raises the benefits of both face-to-face and online studying [8, 10]. Thus, mobile learning applications have to provide different modes of work which give opportunities of blended learning.

Besides, mobile learning is characterized as a private type of learning when only one trainee at a time has access to the mobile device and their activity is completely independent of other students. On the other hand, mobile learning environments provide the high level of interactivity both between the student and their device, the student and teacher, and the student and other students, which enables collective learning activities and collaboration [11, 12]. As a result, students are not passive learners, but active participants of knowledge mastering and its implementation into practice.

The said fundamentals of mobile learning which determine the peculiarities of mobile learning aids and their development are implemented at the proper stages of organization of the students' projects-based activity during their "Mobile technologies" bachelor's course.

In terms of online learning, it is really important to retain students' motivation and involve students into interactive and practically meaningful work with the specific results. One of the approaches with these characteristics is project-based learning that was used in the progress of the said course and implemented grounding on its core theoretical basics.

According to didactic sources [13, 14], project-based learning (PBL) is a didactic approach which gives students the opportunity to earn knowledge and work out skills via engaging projects focused around real-life problems the trainees may face in the real world. It is also

characterized as a teaching method in which trainees learn by active involvement in real-world and personally significant projects.

Thus, using PBL, teachers make studying more alive and practically-driven for students. Students work on a project during an extended period of time that involves them in investigation and answering a complex question, and solving a real-world challenging task. In such a way students demonstrate their knowledge and skills by creating a real practical product addressed to a real target audience. As a result, students are encouraged to apply deep content knowledge and use higher-order thinking abilities as well as creativity, critical thinking, communication and collaboration skills to successfully work as a team. Besides, PBL tends to reveal a contagious, creative energy among students and teachers, which is really rewarding and essential, especially under conditions of physical disconnection of on-line learning.

To ensure the high-quality PBL, in the recent studies two core guidelines providing some basic rules which must be followed by the educational staff both in the process of the project tasks formulation and during the educational practice on the projects implementation are promoted. They include essential project design elements which make a framework for high quality projects and some project-based teaching practices to help educators to improve, elaborate and assess their practice.

Project design elements comprise the following requirements to the project task essence and formation [14, 15, 16]:

1) the project should be framed by a significant problem to be solved or a question to respond at the proper degree of challenge;
2) it should expect investigation engaging students in a rigorous and wide process of setting questions, searching resources, applying information, probing hypothesis etc.;
3) the project should comprise real-world context, problems, instruments, quality standards, or the project should appeal to personal concerns (interests) of the students' lives;
4) students' opinion should be taken into account, which allows them make some decisions about the project (how to work, what to create, etc.), and express their own thoughts in their own voice;
5) students and teachers must reflect on the learning, the effectiveness of their investigation and project activities, the quality of work, the obstacles that they face and strategies for their overcoming;
6) critique and revision are expected when trainees receive and use feedback to elaborate their process and improve the products;
7) the project should result in a public product which students share with and present to the audience beyond the classroom.

According to the said guidelines, it is recommended to educational staff to follow project-based teaching practices to ensure efficiency of this work [13, 15]. Thus, it is necessary for the teachers to follow the following recommendations and steps.

At the planning stage teachers have to create a project and tailor it for the context of the exact course (activity) and for students, and plan its implementation from the beginning to the ending, taking into account student's choice and voice. Planning the project, the teachers have to mind standards and make sure it addresses key competences from the subject areas.

Building the culture of PBL, teachers have to promote students' independence and progress, inquiry activity, attention to quality, and team spirit.

In the progress of students work upon the projects, the teachers should manage activities through the interaction with students to help them assign the tasks in team and agree the schedules, set checkpoints, search and use resources, develop products and publicize them.

Besides, it is essential for the teacher to initiate and support students' development applying a variety of instructional strategies to involve all the students in achieving project goals. It is also pointed out, that teachers should be engaged in learning and product creation alongside trainees, and identify when they need skill-building, knowledge extension, encouragement, and appraising.

At the assessment stage, teachers are recommended to apply formative and summative assessments of the revealed knowledge and skills including self and peer assessment of team and individual work. The depicted guidelines were used to organize, encourage and manage the students' work upon the projects within the "Mobile technologies" online course with the purpose of raising the students' motivation to learn.

Motivation to learn is considered by the researchers from both psychological and educational dimensions. It is seen as a trainee's energy and drive to learn, study effectively and realize their potential [3, 4, 17, 5]. It is also defined as the personal efforts which encourage to learning activities, ensure their continuity and point a direction to the activities with the aim at achievement of student's desired goals [4].

Learning motivation is characterized by experts as an essential contributor to students' academic achievements and can play an important role in raising the spirit of learning for individuals and for their retention in university education. The essential connection between motivation which provides enthusiasm in overcoming leaning difficulties and student's results of learning is also underlined . According to the researchers [5, 18], there are key factors affecting motivation in the process of learning. They include attention, regarding learner's past experience, positive attitude to learning, and satisfaction. It is claimed that provision of these components in the tutoring process may promote and sustain student's motivation to learn [5, 18]. Some essential rules to be followed in the progress of teaching to provide the said components [19, 20] are also shaped. The first rule expects implementing different learning strategies to attract and retain trainees' attention. The second rule recommends to set clear instructional goals and provide students with educational content which refers to their previous academic or work experience. The third rule, being responsible for shaping student's confidence, reminds to create the learning environment which promotes their positive attitude to the tutoring on the whole and suggests focusing towards success. The fourth rule says that it is essential to help students gain satisfactory feeling. It is also emphasized that under the condition of meeting the first three rules, the students' overall satisfaction will be accordingly enhanced [19, 20].

According to some works [21, 19, 20], motivation may have different kinds of influence on the student's behaviour towards their learning, academic achievements and subjects mastering. In fact, the motivation is able to: (1) raise initiation and persistence in doing learning activities; (2) increase efforts and energy; (3) direct student's behaviour towards proper aims; (4) boost cognitive processes; (5) lead to better performance.

There are two kinds of learning motivation which can be considered: internal and external

ones [5]. Internal motivation typically arises without an obvious reward. As a reward, it is taken accomplishing the learning task and achieving their learning aims. External motivation comes from the outside a student. It is driven by apparent rewards or appreciations for students to engage them in the learning activities. The motivational rewards may include verbal praise, higher points, special badges that can lead to academic privileges, certificates etc. The external motivation factors provide trainee's joy and satisfaction that the activity itself may not give to them. Therefore, it can be a challenge for a teacher to implement special incentives as motivation factors to provoke student's cognitive interest that may lead to increasing their internal motivation and taking joy of learning and achieved results.

The trainees' motivating to learning is considered as a way of involving them in productive cognitive activities and active mastering of the educational content. This process has the features of a certain cycle which is repeated at each stage of learning on higher level. Thus, teachers have to provide each stage of motivational cycle with the help of special techniques. In lots of works the connection of motivation with students' engagement and interactive strategies of learning which is consistent well with the stimuli for both internal and external motivation is proven. It is underlined, that interactive forms of practically-driven learning are able to demonstrate students their personal role in common productive work, to let them see the importance of their own contribution into team work result, to feel pleasure, which finally can influence on their learning motivation.

3. Results and discussion

The analyzed theoretical basics were implemented for students' engagement into PBL in terms of the "Mobile technologies" online bachelor's course which is one of the educational components of future IT specialist university training.

In order to raise students' motivation to learn, PBL was applied with involving different student teams into work upon different projects. One of the essential branches of the offered projects was devoted to the development of didactic applications for mobile learning implementation.

The project themes suggested for the students (future IT specialists) included the development of mobile aids for modeling different processes, mobile simulators to work out various learning skills for schoolchildren and students, mobile didactic games and others. In the process of the project themes elaboration, we tried to follow the project design elements and requirements to the project task essence and formation (depicted in the theoretical framework of the paper).

In particular, each of the projects was framed by a significant problem to be solved: to develop the learning aid (environment) which is able to provide the benefits of mobile learning of specific subject domain. All the projects expected inquiry engaging students in the extended process of setting questions, searching resources, applying information, developing the didactic application focused on the specific real-life problem resolving. The students' opinion was taken into account, which allowed them to make some decisions about the project (specify the topic of the project, decide what exactly to create, which stack of technologies to apply etc.). The students were informed as for the target audience and core features of their final product, the ways of receiving feedback, presenting the final product etc.

The stages of work were organized according to the teachers' practices recommended in the PBL guidelines depicted above.

At the planning stage, teachers formulated project themes and tailored them for the context of the "Mobile technologies" bachelor's course. General and special competences shaped by the course and can be addressed by the project were distinguished. The students at that stage had to choose the project and make the team. With the help of the teachers, they planned the project implementation from the beginning to the ending.

As the examples of successful PBL within the course we chose three projects devoted to the development of the aids for mobile learning: (1) an application for modelling processes with the help of Petri nets (Project 1); (2) an English mobile simulator for schoolchildren (Project 2); (3) a mobile game for logical thinking development (Project 3). So, some stages of project work will be characterized selectively using these projects.

In terms of building the PBL culture, teachers did their best to promote students' independence and progress, encouraged their inquiry activity and attention to quality.

For instance, in Project 1, the students were involved into learning of not only the features of mobile learning aids and their peculiarities. They also were engaged in the inquiry activity as for the basics of Petri net theory and its use for the simulation of different processes. The students' challenging tasks at the initial stages of Project 1 were focused on the analysis of Petri net formalism and understanding its facilities for dynamic models building and potential exploring of the modeled processes, which is important to mind in the process of development of mobile Petri net educational application. The students had to realize that Petri nets provided an intuitively clear tool corresponding to real-life processes components and their relationships, which enabled to create, visualize and explore a model of real process in its dynamics. The students were also focused by the teachers on the necessity to provide in the future mobile application facilities to manipulate the nets parameters and to change its state with observing immediate changes of the whole modelled process, which would make a Petri net mobile aid a powerful tool for potential users' training for developing their modeling skills. Thus, in such a way, the teachers promoted trainees' independence, extended knowledge usage, their inquiry activity, professional development in terms of attention to quality assurance.

According to next efficient PBL teacher's practice, in the progress of students work upon the projects, the teachers managed activities through the interaction with students to help them assign the tasks in team, agree the schedules, set checkpoints, search and use resources, develop the products and publicize them. For example, in the progress of Project 2 work, the team work was organized in a special way with focus on the high level of interactivity between the teacher, groups of students and a student within the group. These group discussions can be easily organized even in terms of online learning, for example in a Zoom room, using the advanced functionality of the teleconference to break the participants into several rooms for discussion.

The students (who chose to develop an English mobile simulator for schoolchildren) were suggested division on some groups of analytics, UX/UI designers, developers and quality minders, according to the roles which are typical for the applications developing. Within the groups and between them argumentized discussions were organized by the teacher with the help of the Socratic method of discussion to provoke students' critical thinking and come up with fruitful ideas. For instance, in the group of analytics the cooperative debates for the understanding

of their group mission were held where students were encouraged to answer the following questions:

(1) Who are potential users of our learning aid? What types of them may be? What is their personal (professional) profile?
(2) What tasks do the users can potentially solve with the help of the mobile aid?
(3) How are they going to solve their problems, and what is the difference of these tasks solving within the mobile and computer aid? What are the peculiarities of the digital language simulator for exactly mobile learning?
(4) Which benefits from the users' standpoint can application interface and functionality provide?
(5) How to collect the said data from the users?
(6) How can the collected information about users and their potential behaviour in the application be useful for other groups? and others.

Similar debates were encouraged by the teacher in other groups of UX/UI designers, developers and quality minders. At further stages of the project, interaction of all the groups was initiated in order to analyze the intermediate results of group work, and coordinate it.

As a result of these common and interactive discussions, each work group could get comprehensive understanding of their role in the whole iterative process of the mobile application design, and could correctly allocate the roles within the group with the vision by each member of their own responsibilities, potential work problems, and scope of necessary interaction with members of other groups.

It is relevant to point out that these approaches to team work organization were successfully applied by the teachers on all the projects. In such a way, educators initiated and supported students' development applying a variety of instructional strategies to involve all the students in achieving project goals. Moreover, the teachers were engaged in learning and product creation alongside trainees and effectively identified when they needed skill-building, knowledge extension, encouragement etc.

At the assessment stage, teachers applied formative and summative assessments of the revealed knowledge and skills including self and peer assessment of team and individual work.

All the mobile applications as final products developed within the students' PBL were successfully implemented into educational practice and got positive feedback from target users. The episodes of mobile learning with the help of the developed aids are presented in the figures (Fig. 1-3).

It is intuitively clear that depicted PBL which was implemented by the teachers in the educational process of the "Mobile technologies" online course could have positive impact on the students' learning motivation due to their high involvement into the solution of real-life tasks. However, to estimate the level of the students' motivation to learning it is necessary to do the survey according to proper criteria and indicators, and detect the levels of their revealing.

As it was mentioned above, according to psychological background of the motivation theory and its educational aspects, motivation to learn is defined as the personal efforts which encourage trainees to learning activities, ensure their continuity and concentrate a trainee on the activities with the aim to achieve their desired goals.
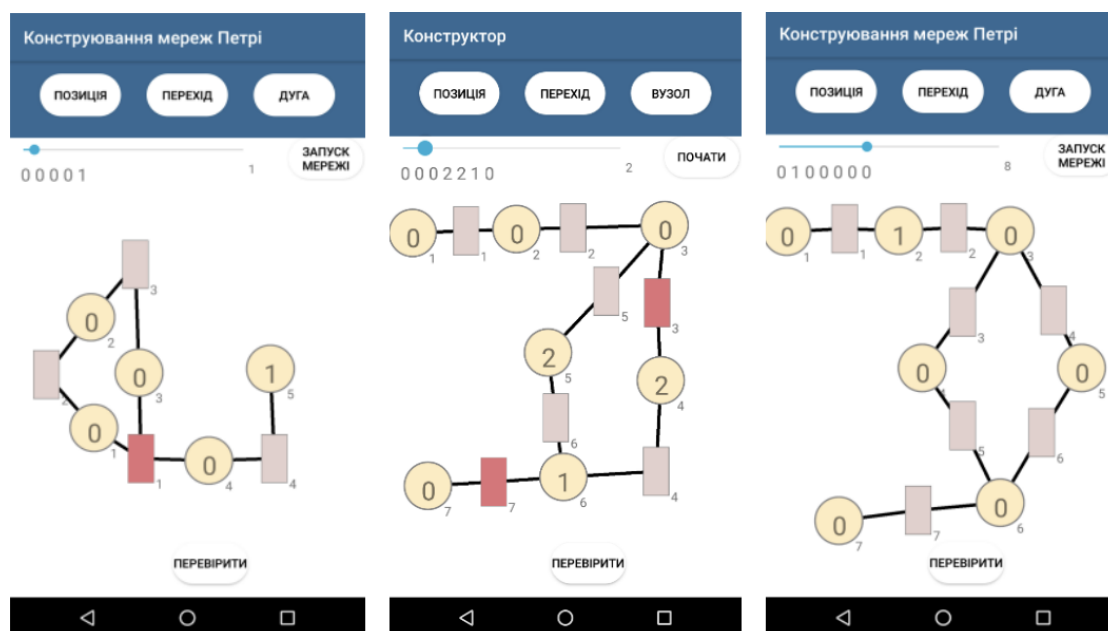
Figure 1: Episodes of mobile learning with the help of the Petri net mobile application designed as a result of Project 1. Modelling of the railway traffic.

Among the most influential factors which affect student motivation there are attention, appealing to learner's previous experience, positive attitude to studying, and satisfaction. Basing on this understanding of the learning motivation, and minding core rules for design of tutorial process and environment regarding motivation raising, we have revealed several indicators and their levels.

The core rules have been presented in the theoretical framework chapter and can be formulated in brief as follows:

- to apply methods for attraction and retaining learners' attention;
- to set clear instructional goals and provide learners with educational content which refers to learner's needs and experience (academic and/or working (life) one);
- to form student's confidence, creating learning environment which enables to promote learners' positive attitude to the tutoring process and suggest focusing towards success;
- to create conditions to help students gain feeling of satisfaction.

Thus, the survey has been created to evaluate whether the PBL introduced into the online learning the "Mobile technologies" course is in line with the mentioned rules for design of tutorial process and detect the students' motivation levels.

The prepared survey consists of 20 items comprising 4 subsections in accordance with the number of the said rules. Each subsection comprises five items to obtain a feedback from the students on each motivation dimension. It measures students' motivation level by applying a 5-point Likert-type scale (1 is strongly agree; 5 is strongly disagree).
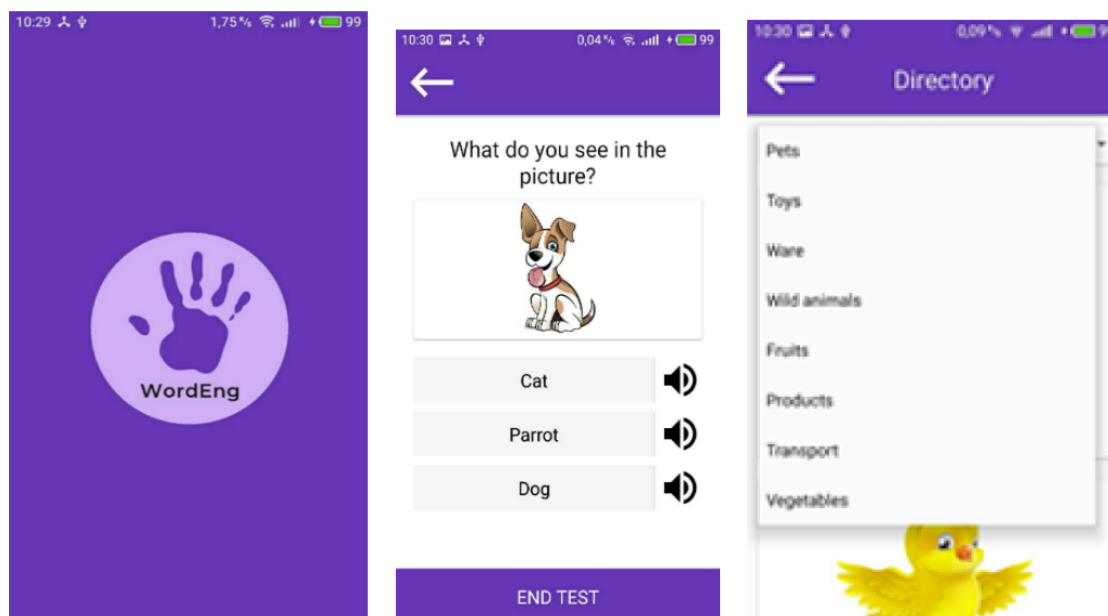
Figure 2: Episodes of mobile learning with the help of the English simulator for schoolchildren designed as a result of Project 2. Work out of vocabulary skills.

Table 1

The average score of the students' motivation level (n=27).

Motivation dimensions (5 items each)	Average score
Attention	3.42
Appealing to learner's needs and experience	3.61
Positive attitude	3.65
Satisfaction	3.63

To obtain preliminary results and test the designed survey reliability, it was conducted in some groups of pre-service IT-specialists (27 students in total) who completed the "Mobile technologies" online course in terms of implementation of PBL activities enhanced with interactive methods and built according to guidelines depicted above. The survey was posted on course forums of the distant learning system which was used during the course. Thus, the survey participants were the students who expressed their desire to do it. There were 2 female and 25 male participants, and their age ranged from 20 to 21.

The scale reliability test was held to estimate the result. The reliability of all the four scales (for each motivation dimension) on standardized Cronbach Alpha was 0.75 (*n=27* on 20 items), which proved an acceptable reliability of the achieved result [22].

The average score of the students' motivation level as for all motivation dimensions, detected during the survey is presented in Table 1.

According to the score intervals, four levels of motivation were distinguished:

High level (4.0-5.0),

Figure 3: Episodes of logical tasks solving with the help of the mobile game for logical thinking development designed as a result of Project 3.

Table 2
The students' motivation level as a result of the survey.

Motivation Level	Total N=27	Percent.
High	13	48,2%
Intermediate	6	22,2%
Pre-Interm.	4	14,8%
Low	4	14,8%

Intermediate level (3.5-3.99),

Pre-intermediate level (3.0-3.49), Low level (lower than 3.0).

The results of the survey, according to the levels of the trainees' motivation are presented in the Table 2.

As far as we can judge from the table 2, 13 (48.2%) out of the 27 respondents demonstrated high motivation level, 6 students (22.2%) had intermediate motivation level, 4 respondents (14.8%) revealed pre-intermediate level, and 4 respondents (14.8%) demonstrated low motivation levels. Thus, it was found out that the survey participants were mostly satisfied with the course material and PBL enhanced with interactive methods, with almost half of the respondents who had high level of motivation, and about 22% of them who revealed intermediate level of learning motivation. The obtained results of the survey are also coordinated with the teachers' observations of students' behaviour and results of their work.

4. Conclusion

The paper deals with the currently essential problems of mobile digital education provision with high-quality aids and the challenges of online training of IT-specialists.

Based on the recent research review and educational practice analysis, the urgency of our research related to the problems of dropping students' motivation to learn and necessity to find out efficient ways to involve them into active and practically significant kinds of learning activities is revealed. Minding the great potential of mobile didactic aids and benefits of their using in the educational practice, the attempt to implement the project-based learning strategy and engage the students of IT majors with development of practically meaningful projects within the "Mobile technologies" online course has been undertaken.

According to the goals the work to highlight the branches of project themes, the stages and the results of students' work upon them have been characterized. The preliminary analysis of the impact of such an activity on the students' learning motivation has been also provided.

The preparation stage of the survey on the estimation of the students' motivation as an impact of PBL implementation has been also covered. The survey consists of 20 items comprising 4 subsections corresponding to the amount of the revealed motivation dimensions (attention, appealing to learner's past experience, positive attitude, and satisfaction).

To obtain preliminary results and test the designed survey reliability, it has been conducted in some groups of potential IT-specialists who completed the "Mobile technologies" online course. The acceptable reliability of the scales has been proven. According to the score intervals, four levels of motivation have been distinguished. The results of the survey, according to the levels of students' motivation have been presented and discussed.

The results of the authors' observations according to the monitoring program have been also given and discussed.

It was concluded that the obtained results of the conducted survey and our monitoring program may be used potentially as a basis for holding the comprehensive empirical research for the verification of the impact which made the offered PBL on the level of students' motivation. It is planned to widen respondents' range to generalize the survey results and to expand it by specifying the changes caused by the introduced methods, which makes a prospect of our work.

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