Influence of the low-cost digital contents in improvement of the students' learning experience

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***Abstract* – In the study process, the students have problems understanding parts or of the whole course curriculum. The most frequent reasons for these problems are: the student absence of one or more successive lectures, or the student lack to understand parts of the course curriculum.**

Depending on the structure and dependability of the lessons in the course curriculum, the student can have problems with small part or large number of lessons in the course curriculum. These might lead to complete misunderstanding of the course curriculum.

In order to solve this problem, development and deployment of additional digital content is usually needed, which is both time and budget consuming. The high development and maintaining price are most common arguments which cause resistance against deployment of such systems in the educational institutions.

In this article, we propose a model for broadening of the traditional study process by using low-cost digital content and distance learning. This model is inexpensive for deploying, administering and supporting and is simple to use, while the greatest benefit is increasing the students' learning experience.

In the paper, we will describe the distance education model that was used for content sharing together with the student survey reflecting on the achieved quality of learning experience.

***Keywords* – QoE, Quality of learning experience, E-learning educational systems, Low-cost digital contents.**

1. Introduction

The students' main goal in the study process is to gain the knowledge that can be applied in solving practical problems in their everyday working activities after finishing studies. According to Gagne (1985), there are two distinct types of knowledge: declarative and procedural. Declarative (context) knowledge includes facts, concepts and principles. It is the factual knowledge within a discipline or skill domain. Procedural knowledge is the knowledge exercised in the accomplishment of a task. The courses in traditional study process are divided into lectures and labs. Lectures cover the declarative knowledge. Lab exercises allow students to gain procedural knowledge through problem solving, using declarative knowledge. According to Jonassen (1997), there are two types of problem solvers: novice and expert. Expert problem solvers (teaching staff) have lots of context knowledge and are able to solve the analogous problem in the same domain or problems in similar domains using their context knowledge and problem solving experience. Novices (students) have less context knowledge then experts and have problems in applying the procedural knowledge in problem solving. Teaching assistants use labs to supply students with the procedural knowledge and guide them how to use this knowledge in problem solving through real world practical examples. Many students need more practical examples to gain and implement procedural knowledge. The time dedicated for course labs is not enough for more practical examples. In many courses, materials for lab exercises are interdependent. Procedural knowledge gained from one lab depends on the procedural knowledge gained from one or more previous labs. If the student is absent from one lab, he will have a problem gaining and using the procedural knowledge from this lab, and lack of procedural knowledge from one or more of the next labs. Traditional instructor-led classroom learning cannot solve this problem.

The fast progress of the information and communication technologies allows another type of learning, distance learning. Greenberg (1998) defines contemporary distance learning as "a planned teaching/learning experience that uses a wide spectrum of technologies to reach learners at a distance and is designed to encourage learner interaction and certification of learning". According to Desmond Keegan (1995), distance education and training result from the technological separation of the teacher and the learner which frees the student from the necessity of traveling to "a fixed place, at a fixed time, to meet a fixed person, in order to be trained". KHAN ACADEMY goes step further, promoting new concept of free learner access to the distance learning system which hosts more than 24000 digital contents with short duration (between five and twenty minutes). The main characteristics of this system are: intuitive use, digital contents with minimal creation and deployment cost, Learner path

chosen by the learner, the speed of learning according to the learner abilities.

Although researchers have not found significant difference in learning effectiveness (Johnson at all (2000), Fallah and Ubell (2000), Ben Arbaugh (2000)) between traditional classroom and distance learning, some researchers underline a high rate of students who commence e-learning and not finish them (Dutton and Perry, 2002) and students dissatisfaction with the e-learning experience (Bouhnik and Marcus, 2006).

Blended Learning is a combination of traditional classroom and distance learning. According to Graham (2005) and Graham and Allen (2005), blended learning is a combination of face-to-face instruction with computer-assisted instruction. It is a new way of learning that combines the advantages of both type of learning and eliminates their disadvantages. In order to take the best from both types of learning, the design of blended learning must be done carefully with the optimal balance between online and face-to face instruction (Christensen, 2003). Another important question in designing the blended learning is choosing the appropriate delivery media (Hoffman, 2006).

Teachers that introduce blended learning in their courses are afraid that they do not have sufficient experience for making proper blending. Another problem is the additional time that they must spend in preparing and practicing blended learning. All of this makes teachers to look with skepticism on blended learning.

In our paper we propose a model of using additional digital contents as a preparation step to blended learning. This model is not time consuming as full blended learning. Teaching staff can make additional digital contents, and make them available to the students using distance learning management systems. Teaching staff can monitor the frequency and time that students spend in using of these additional digital contents and the increase of the students learning effectiveness and efficiency. Also they can review the additional digital contents based on students' demands according to students' goals and abilities. All of this will help teaching staff to be prepared to make proper blending and to introduce and practice blended learning in their courses.

Education is one of the most important processes in human being, in which the students gain knowledge and skills from the society knowledge accumulated with centuries and the moral norms developed by generations.

Researches made by Elmore (1996), Chickering and Gamson (1987) and Chickering and Ehrmann (1997) define the components of education, their correlations and the best practices in education development process.

In traditional classroom education, both professor and students are located in the same space (amphitheater, lecture room, laboratory). They communicate according to exact communication rules, accomplishing previously defined functions and have beforehand defined expectation (Gorham (1988), Gorham and Zakahi (1990), Georgakopoulos and Guerrero (2010)). The quality of professor-student interaction has great influence in the quality of the whole education process (Gorham (1988), Gorham and Zakahi (1990), Kelly and Gorham (1988) and Newman at all (1995)).

Moore (1989) identified three kinds of interactivity which affect distance learning: learner – content interaction, learner - instructor interaction and learner – learner interaction. When interacting with the content, learner interacts with the course materials and the concepts and ideas that they present. Learner – instructor interaction includes the way in which instructors teach, guide, correct and support their students. Learner – learner interaction refers to interaction among learners. The overall success of distance learning depends on the success of these three types of interaction.

Learner - learner interaction provides exchange of opinions, discussions and information sharing between learners. It plays important role in distance learning. According to Moore and Kearsley (1996), students' interaction with their classmates in a distance learning environment can contribute to learning. A study by Fredericksen and colleagues (2000) examining asynchronous learning found that students who reported greater interaction with other students in an online course stated higher levels of perceived learning.

Interactions with instructor can help students to gain better understanding of the learning material. In traditional classroom, learning occurs in physical face-to-face meeting. In the distance learning course, this type of interaction is transmitted by electronic means, such as chat discussions or e-mail communications. The role of the instructor in distance learning has changed from that in the traditional classroom learning. In the traditional classroom, the role of instructor is to be a lecturer. In distance learning format, the role of instructor is to be a facilitator (Gutierrez, 2000). Some researchers have indicated that the quality of interactions between students and instructors in the distance learning courses were equal to, or better than, interactions in the traditional courses (Lenhart et al., 2001).

Learner – content interaction is important part of the distance learning process. According to Moore (1989), there is no education without this type of

interaction. The educational process entails the learner's intellectual interaction with content, which results in changes in the learner's understanding, the learner's perspective, or the cognitive structure of the learner's mind. Content delivered in an online course needs to be complete, relevant, and accurate (Siragusa et al., 2007). Brown and Voltz (2005) maintain that "educational materials that have been effectively designed will facilitate the achievement of desired learning outcomes for students".

Many researchers argue that learners' interactions with learning management systems play important part in distance learning (Kedar, Baruch, and Gruvgald (2003), Carswell and Venkatesh (2002)).

From instructor point of view, instructor - content interaction is important part of distance learning process. Many times the instructors have to include up-to day information on the course content. Content "last minute" changing is demanding and frustrating activity. Using the new technologies and carefully dividing the course content in two parts: invariant and changeable, can lighten and speed up the process of content changing. According to Pearson (1999), the course content may be adapted to suit expressed student needs, perhaps indicated by feedback from the students via discussion forums. The instructor can change the learning content to adapt them to learners' goals and abilities. This can motivate the students to be more active, to learn more and to gain additional knowledge.

2. Research Methodology

In order to show the influence of the low-budget digital contents in the increase of the quality of the students' experience, an initial research has been made. During one semester, in the course Object-Oriented and Visual Programming, the students were offered additional digital contents (video contents) in which through examples was elaborated the material and knowledge which is necessary to finish the homework assignments and successfully pass the mid-term exams.

The research is consisted of three parts. In the first part of the research a cost analysis has been made for the creation and setting up the additional digital contents (expressed in working hours). The second part of the research is the initial evaluation of the students' additionally gained experience with use of the additional digital contents. In the third part of the research a comparison has been performed between the students of this group in the performance and outcome of solving the homework assignments and passing the mid-term exams, and, the students from the previous year for the same course when they did not use the additional digital contents.

2.1. Cost analysis of the additional digital contents

For the needs of the course, additional digital contents have been made. These contents are in Adobe Flash (.swf) video format with resolution 800x600. The digital contents are made with use of open source screen and microphone capturing tool. The duration of the additional digital contents (expressed in minutes) in categories is presented in Table 1.

Additional digital contents category	Duration (minutes)
Assignment Working environment preparation	14
Repetition of contents from previous courses implemented in the new working environment	70
Contents for Mid-term 1	136
Contents for Mid-term 2	222
Total	442

Table 1. Detailed summary of the duration of the additional digital contents by category

The total time needed to finish the additional digital contents is calculated as the total duration of the digital contents multiplied by 4, because for each minute of digital contents three additional minutes are necessary for: preparation before producing, saving and converting the digital contents from internal video format into portable video format.

In this manner, the time for making the additional digital contents is 1768 minutes = (442 minutes * 4). In table 2 a summary of the time spent for creation and setup of the additional digital contents is given.

Step	Duration (minutes)
Installation of the tool for creation of the digital contents	30
Training for using the tool	30
Creation of the additional digital contents	1768
Upload of the additional digital contents on a Content Management System	120
Total	1948

Table 2. Detailed summary of the time spent for creation and setup of the additional digital contents

It can be seen from Table 2 that the total duration for creation and setting up of the additional digital contents is 1948 minutes (32 hours and 28 minutes). This is the additional time that one teaching assistant would spent in the frames of one semester.

As the creation and setup of the additional digital contents does not require any additional technical

conditions except microphone, it can be said that those are low cost additional digital contents.

2.2. Initial evaluation of the additionally gained experience of the students with use of additional digital contents

In our research, there were two main reasons for making the additional digital contents: students' demand and teaching staff estimation. Both of two reasons indicate quality and intensive communication between students and teaching staff. When students were asked whether the teaching material and additional digital contents correspond to their level of goals, their answers were positive. Because of that, our first hypothesis is:

H1: The quality of communication with teaching staff influences choosing the proper level of goals for the teaching materials and the additional digital contents.

Because teaching materials and additional digital contents correspond to students' goals, students actively used them and have success with homework assignments and the midterm exams. Our second hypothesis is:

H2: The proper set of goals for the teaching materials and the additional digital contents highly influences the additional knowledge gained from the additional digital contents.

The students were satisfied with their success in the homework assignments and midterm exams. In communication with them they express their overall course satisfaction. Our third hypothesis is:

H3: The additional knowledge gained from the additional digital contents highly influences the quality of learning experience.

2.2.1. Sample and procedures

In this subsection we discuss sample characteristics and procedures of data collection.

Participants

Participants of this initial evaluation are students enrolled in the course Object and Visual Programming (total=25). Five students only enroll in the course but did not take any course activities. All of the other students (n=20) took participation in the student activities and in this initial evaluation.

Information and Data Collection

At the end of the semester, students responded to the written questionnaire. This questionnaire consists of main part and additional part. Main part consists of 7-point Likert scale questions (1=I absolutely disagree, 2=I disagree, 3=Partially disagree, 4=no opinion, 5=partially agree, 6=I agree, 7=I absolutely agree) and open ended questions. The additional part of this questionnaire contains data such as: demographic data, previous experience with use of additional digital contents, previous experience with use of distance learning management systems. Student's personal data and privacy are protected.

Demographic profile of respondents

Table 3 shows the demographics profile of the students. According to the table, male students comprised about 80%, while female students constituted 20% of the sample. Furthermore, 85% of the students use additional digital contents for the first time and 75% of the students use distance learning management system for the first time.

		Frequency	Percentage
Gender			
	Male	16	80
	Female	4	20
Age			
	Between 19 and 25	20	100
Previous experience with use of additional digital contents			
	Using of additional digital contents for the first time in this course	17	85
	Using of additional digital contents in another course	1	5
	Using of additional digital contents in more than two courses	2	10
Previous experience with use of distance learning management systems			
	First time in this course	15	75
	First time in another course	2	10
	Many times in more than two courses	3	15

Table 3. Demographics profile of the sample (n=20)

2.2.2. Information and data analysis

In the last phase of the research, analysis of the main part of the evaluation data was performed. These statistical analyses were done using IBM Statistical Package for Social Sciences software. The results and the findings are presented in this article.

Input variables

By carefully evaluating student responses on different questions, we have chosen the following list of items from questionnaire:

Item name	Item Description
PLA1	The level of the curriculum corresponds to my abilities
PLA2	The level of the additional digital contents corresponds to my abilities
PLG1	The level of the curriculum corresponds to my goals
PLG2	The level of the additional digital contents corresponds to my goals
QCTS1	The professor was timely responding on the questions
QCTS2	The professor answers were with high quality
AQADC1	The additional digital contents helped me understand the curriculum
AQADC2	The additional digital contents helped me apply the knowledge gained through the curriculum in solving practical problems
AQADC3	Mastering this curriculum gave me significant knowledge that I will use in practice after graduation
QOE1	The declared quality of the course is on a high level
QOE2	The established quality of the course is on a high level

Table 4. Input variables

Statistical information regarding input variables is shown on Table 5.

Variable name	Mean	Standard Deviation	Skewness	Kurtosis
PLA1	6,00	0,858	1,109	1,517
PLA2	6,20	0,951	2,069	6,177
PLG1	6,05	1,146	1,273	1,286
PLG2	6,05	1,146	1,273	1,286
QCTS1	6,30	1,218	2,585	7,955
QCTS2	6,45	0,759	1,017	0,371
AQADC1	6,40	0,681	0,712	0,446
AQADC2	6,55	0,686	1,283	0,542
AQADC3	6,10	0,641	0,080	0,250
QOE1	6,00	0,973	1,522	3,705
QOE2	5,90	0,968	1,331	3,101

Table 5. Statistical information regarding input variables

For all of the input variables, the absolute values of skew are less than 3.0 and the absolute values of kurtosis are below 8.0. According to Curran, West and Finch (1997), input variables in Table 5 are normally distributed.

In our proposed structural model, we have constructed five endogenous variables: quality of communication with teaching staff (QCTS), proper level of abilities (PLA), proper level of goals (PLG), additional knowledge gained from the additional digital contents (AQADC) and quality of learning experience (QOE).

Scale reliability

In order to determine the data reliability for the endogenous variables in our research model, we perform reliability analysis. The results of reliability tests are presented in Table 6.

Item	M	SD	CA*	r**
QCTS			0.877	
QCTS1	6.30	1.218		0.871
QCTS2	6.45	0.759		0.871
PLA			0.870	
PLA1	6.00	0.858		0.773
PLA2	6.20	0.951		0.773
PLG			0.889	
PLG1	6.05	1.146		0.800
PLG2	6.05	1.146		0.800
AQADC			0.776	
AQADC1	6.40	0.681		0.667
AQADC2	6.55	0.686		0.635
AQADC3	6.10	0.641		0.539
QOE			0.974	
QOE1	6.00	0.973		0.950
QOE2	5.90	0.968		0.950

CA* - Cronbach alpha

r** - corrected item-total correlation

Table 6. The mean, standard deviation, Cronbach alpha, corrected item-total correlation (from 1 which means "strongly disagree" to 7 which means "strongly agree")

All of the endogenous variables have a Cronbach alpha's value range of 0.776 and 0.974 which are greater than 0.7. According to (Nunnaly and Bernstein, 1994), the measurements of the variables are valid and reliable.

Correlation analysis

The relationship among variables was examined with the correlation analysis. The results are shown in Table 7.

Table 7. Correlation analysis

	QCTS	PLA	PLG	AQADC	QOE
QCTS	1.000				
PLA	0.242	1.000			
PLG	0.663**	0.364	1.000		
AQADC	0.366	0.459*	0.738**	1.000	
QOE	0.308	0.506*	0.520*	0.709**	1.000

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

According to Hair at all (1998), if there is a case such that the correlation coefficient exceeds the 0.90 there is a possibility of multicollinearity and must be explored. We can see from Table 7 that the highest value of correlation coefficient is 0.738. Therefore we can assume that we have no multicollinearity problem in our research study.

Multiple regression analysis

In order to examine our research hypotheses, multiple stepwise regression analyses were conducted. The results are shown on Table 8, Table 9 and Table 10.

Table 8. Stepwise multiple regression for Proper level of goals

	B	Std. error	Beta (β)	t	Sig.
(Constant)	1.252	1.289		0.971	0.345
QCTS	0.753	0.200	0.663	3.761	0.01

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.440; Adj. R^2 = 0.409; F (1, 18) = 14.145; N=20

Table 9. Stepwise multiple regression for additional knowledge gained from the additional digital contents

	B	Std. error	Beta (β)	t	Sig.
(Constant)	4.064	0.500		8.128	0.000
PLG	0.378	0.081	0.738	4.642	0.000

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.545; Adj. R^2 = 0.520; F (1, 18) = 21.549; N=20

Table 10. Stepwise multiple regression for Quality of learning experience

	B	Std. error	Beta (β)	t	Sig.
(Constant)	-1.803	1.825		-0.988	0.336
AQADC	1.221	0.286	0.709	4.265	0.000

Note1: $p<0.01$
Note2: R^2 (coefficient of determination) = 0.503; Adj. R^2 = 0.475; F (1, 18) = 18.189; N=20

2.2.3. Hypotheses testing

H1

As we can see from Table 8, the coefficient of determination (R2) is 0.440 representing that 44% of proper level of goals can be explained by quality of communication with teaching staff. The F(1,18) = 14.145 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the Quality of communication with teaching staff is predictor for the Proper level of goals.

H2

As we can see from Table 9, the coefficient of determination (R2) is 0.545 representing that more than 54% of additional knowledge gained from the additional digital contents can be explained by proper level of goals for teaching materials and additional digital contents. The F(1,18) = 21.549 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the Proper level of goals is predictor for the additional knowledge gained from the additional digital contents.

H3

As we can see from Table 10, the coefficient of determination (R2) is 0.503 representing that more than 50% of Quality of learning experience can be explained by additional knowledge gained from the additional digital contents. The F(1,18) = 18.189 is significant at the 1% level ($p<0.01$). This indicates that regression is reasonable and the additional knowledge gained from the additional digital contents is predictor for the Quality of learning experience.

2.2.4. Conceptual model

Based on our analyses we propose conceptual model that reflects the influence of additional low-cost digital contents in improvement of students' learning experience (Figure 1).

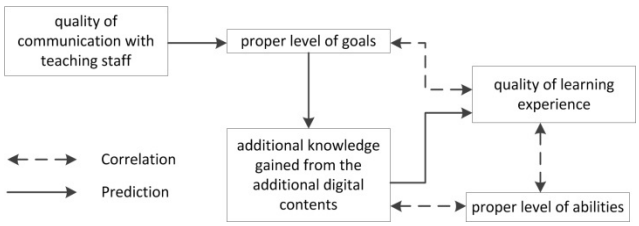

Figure1. Conceptual model of influence of additional low-cost digital contents in improvement of students' learning experience

This model shows the predictive relationships drown from multiple regression analyses (our hypotheses) and the positive correlation between proper level of goals and quality of learning experience and positive correlations between proper level of abilities and additional knowledge gained from the additional digital contents and quality of learning experience.

This model should be tested on larger sample and reviewed if necessary.

2.3. Analysis of the increased success with use of additional digital contents

In this part a comparison has been shown between the students of this group in the performance and outcome in solving the homework assignments and passing the mid-term exams, and, the students from the previous year for the same course, that did not use the additional digital contents.

	Homework assignments success (%)	**Mid-term 1 success (%)**	**Mid-term 2 success(%)**	**Average success of Mid-term 1 and Mid-term 2 (%)**
Group 1 (students who have used additional digital contents)	80,31	60,05	54,75	57,4
Group 2 (students who did not use additional digital contents)	61,22	41,47	22,77	28,7

Table 11. Comparison of the success (homework assignments and mid-term exams)

As it can be seen from Table 11, the students that used the additional digital contents have significantly higher success in the performance of solving the homework assignments and passing the mid-term exams against the students who did not use additional digital contents.

One of the possible reasons for this big discrepancy in the success of the Mid-term 2 is that the Mid-term 1 is eliminatory exam, so the students who did not pass the mid-term 1 did not show up on the mid-term 2, that is, they have 0 points. Anyhow, it does not decrease the obvious discrepancy in the mid-term 2 success.

From the results given in Table 11 it can be concluded that the group of students that used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who did not use additional digital contents. This endorses our statement that using additional digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end.

3. Discussion and future work

According to Sabine Moebs, Jennifer McManis (2008), the universities must see the students as learners, as users and as costumers. As customers, students buy the practical and applied knowledge that they hope to gain with finishing the studies and taking the diploma. Universities supply the students with necessary knowledge through the study process. Students use the study process as a service and learning materials as products in this service. In order to supply a quality service, universities must know the goals and the abilities of the students. This can be done through the intensive and qualitative communication between the teaching staff and the students. The teachers who intensively and qualitatively communicate with their students make learning materials that correspond to students' goals and abilities. The H1 hypothesis from our research shows the same, i.e. the quality of communication with teaching staff influences choosing the proper level of goals for the teaching materials and the additional digital contents.

When the proper levels of goals for the teaching materials do not correspond to students' goals, teaching staff can make changes in the current learning materials or can make additional digital contents that correspond to the students goals. These additional contents can supply the students (as learners) with additional knowledge that helps them being successful in solving the homework assignments and midterm exams and can enforce them in solving practical problems. The H2 hypothesis from our research shows the same, i.e. the proper set of goals for the teaching materials and the additional digital contents highly influences the additional knowledge gained from the additional digital contents.

Students who have shown success in their homework assignments and midterm exams (as learners) and are able to use the additional knowledge in solving practical problems have high level of learning experience (as customers). The H3 hypothesis from our research shows the same, i.e. the additional knowledge gained from the additional digital contents highly influences the quality of learning experience.

The main problem of making additional digital contents is the teachers' opinion that the process of their making is very time consuming. Our cost analysis shows that 1948 minutes (=32 hours and 28 minutes) was necessary for making additional digital contents with duration of 442 minutes. For course with 2 hours lectures and 5 hours exercises weekly, or, 30 hours lectures and 75 hours exercises overall, additional teaching assistants' 33 hours is not a too long additional time. This result is encouraging to convince the teaching staff in making the additional digital contents.

The analysis of the increased success with use of additional digital contents shows that the group of students that used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who did not use the additional digital contents. This endorses our statement that using additional digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end.

The results of our research will encourage teaching staff to use additional digital contents in their courses. Next step is testing the results of this research for more courses with bigger groups of students. The positive results will encourage faculties and universities to use additional digital contents as a supplement to the regular learning materials.

4. Limitation of this study

The research presented in this paper has some limitations in regards to the generalization of research finding. The first limitation is that the research is done for only one course. The second limitation is the small population of participants. The third limitation is that the research does not focus on Learning Management System as a system for supplying learning materials and additional digital contents and managing the student-student and student-teacher communication. Future researches must go beyond these limitations.

5. Conclusion

The students' main goal in the study process is to gain the knowledge that can apply in solving practical problems in their everyday working activities after finishing studies. The courses in traditional study process are divided into lectures and labs. Lectures cover the declarative knowledge. Lab exercises allow students to gain procedural knowledge through problem solving. Many students need more working examples to gain and be able to apply procedural knowledge. In many courses, materials for lab exercises are interdependent. The procedural knowledge gained from one lab depends on the procedural knowledge from one or more previous labs. If student is absent from one lab, he will have the problem with gaining and using the procedural knowledge from this lab, and procedural knowledge from one or more of the next labs. Traditional instructor-led classroom learning cannot solve this problem.

In this study we have researched the model of using low-cost additional digital contents prepared according to students' goals and abilities in order to help students to solve the problem with gaining and applying the procedural knowledge.

In our initial research analysis we show that additional digital contents can be created and supplied to students at low cost. After that we have created and evaluated an initial model of using low-cost additional digital contents. We have proved that using additional low-cost digital contents increases the students' overall knowledge gained in a given course, which on the other hand increases and improves level of experience that the student has at the end. From analysis of the increased success with use of additional digital contents we see that group of students that have used additional digital contents showed significantly better success in solving the homework assignments and passing the mid-term exams than the group of students who have not used additional digital contents.

The results of our initial research will encourage teaching staff to use additional digital contents in their courses.

In the next researches the results of this initial research will be tested for more courses with bigger groups of students. The positive results will encourage faculties and universities to use additional digital contents as a supplement to regular learning materials.

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