World Journal on Educational Technology

Volume 5, Issue 2 (2013) 291-300

Comparison of On-line and F2F Education Methods in Teaching Computer Programming

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Suggested Citation:
Gülseçen, S., Reis, A., Z., Erol, S., Ç., Karataş, K., E., Gezer, M., Şimsek, İ., Asaadi, Y., Derelioğlu, Y., Yıldırım, K., Gürsul, F., Mutlu, D., Şişman, B. & Özen, Z. Comparison of On-line and F2F Education Methods in Teaching Computer Programming. *World Journal on Educational Technology.* 5(2), 291-300.

Received May 07, 2013; revised June 16, 2013; accepted July 26, 2013
Selection and peer review under responsibility of Prof. Dr. Steven M. Ross, John Hopkins University.
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Abstract
Although online education provides opportunities to people who traditionally do not have access to universities, there is a need for more empirical studies to gain better understanding on how to deliver quality online education, especially when the subject of the course is related with IT. Learning to program is a complicated process. This study aims to find out the difference between students' performance in online and face-to-face (F2F) settings during a computer programming course

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in the fall semester of the year 2010. The study was conducted at the Department of Mathematics, Faculty of Science, Istanbul University. This online course is one of the required courses for students majoring in Mathematics. It is delivered in a learning management system developed in house through a project funded by Istanbul University.
The goal is to introduce students with structured programming using the programming language C. Two topics -"Functions in C Programming" and "Loops in C Programming" - were presented to students online and F2F. The total of 62 students formed two groups: the online and F2F groups. The content analysis statistical technique is used, as well as a questionnaire consisting of open-ended questions, which performed as a data collection tool to find out the views of the students in context to the process. While some results concluded that the performance of online students was satisfactory, but that their aggregate final grade was significantly lower than that of students who took an equivalent F2F class, others arrived at a conclusion reporting that there were no significant differences in overall outcomes. In case of making transition from F2F to online mode of teaching, prepossession about a new way of teaching is always an important barrier in students' perceptions. One of the further researches is investigation of strategies for incorporating blended learning opportunities in programming courses.

Keywords: E-learning, Computer Programming, Online learning, Information technology, LMS;

1. Introduction

Our daily habits have been changing in parallel with technologic developments. Advances in information and communication technology have in the meantime enabled information sharing, communication, and co-work of distributed parties (Maintz, 2008). People try to use IT in business to be more effective and make processes more optimized. From this point, employers are looking for qualified employees. Today's workforce is expected to be highly educated and to continually improve skills and acquire new ones by engaging in lifelong learning (Hrastinski, 2008). In addition, most students are using IT successfully and today their expectations are different from that in the past. Furthermore, if they want to improve their education, there is a chance, called e-learning which offers flexibility especially in terms of time and place. Of course universities cannot be stay away from these developments. Changes in both the levels of funding and the profiles of students have led to an increasing emphasis on the use of flexible methods of course delivery in higher education and as part of that trend there is increasing interest in the use of communication and information technologies (CIT) (Curtis & Lawson, 2001).

In traditional university education we have only the choice of F2F education: the students must be in the classrooms. The Web is now causing educators, from pre-school to university level, to re-think the very nature of teaching, learning and schooling. Claims have been made that the Web can free teaching and learning from the physical boundaries of classrooms and time restraints of class schedules. Traditional lectures and demonstrations can become Web based multimedia learning experiences for students (Sharma & Gulsecen, 2008). Online education is serving as a catalyst, forcing faculty to reconceptualize teaching and learning (Daugherty & Funke, 1998; Duffy & Kirkley, 2004; Speck, 2002; Wray, Patrick, Bates & Stevens, 2008) Educators support online learning because of its unique abilities to provide students with enriched learning experiences, to extend learning beyond school day, and to support more successful differentiated learning strategies that personalize students'educational experiences (eduviews). There was also the belief that, 'the use of new technologies for course delivery will, in itself, attract students.' Furthermore many university administrators perceived 'online course delivery as potentially cheaper than traditional F2F and distance education (Bennett, Priest & Macpherson, 1999; Turbill, 2002).

The efficacy of F2F and online learning was compared by Solimeno, Mebane, Tomai & Francescato (2008) (Diaz & Entonado, 2008). Overall, their results showed that asynchronous collaborative learning online can increase professional competences normally acquired only in small F2F educational settings; they report that online learning can be used to provide innovative educational opportunities to fit the particular needs of students who have time management problems in their learning strategies, with low anxiety, high problem solving efficacy (Diaz & Entonado, 2008).

In one study of undergraduate marketing students, Sweeney & Ingram (2001) evaluated learning preferences for tutorials offered in F2F versus the web (asynchronous and synchronous) (Ladyshewsky, 2004). While web based approaches were seen as more innovative and enjoyable, the F2F tutorials were seen as more effective learning environments by the students (Ladyshewsky, 2004).

Hadjerrouit (2007) argued that computer programming is a difficult matter because it is more a skill than a body of knowledge. According to Pollack and Schertz (2003), the most common approach to programming among novice students is that of "bricolage": students develop programs directly on the computer, and tend to skip the phases of analysis and design. They develop their programs gradually by testing them on various examples of input. Novice students practicing "bricolage" are incapable of explaining and justifying their algorithms (Kolikant & Pollack, 2004). One suggested solution to the learning of programming is to use information technologies, e.g. online programming systems, Web-based programming tutors, online learning systems, or similar software, that give appropriate feedback while working on programming assignments.

This study aims to find out the difference between students' performance in, as well as the students' perceptions on online and F2F settings during a computer programming course in Fall semester of the year 2010. The study was conducted at the Department of Mathematics, Faculty of Science, Istanbul University. The subjected course is one of the required courses for students majoring in Mathematics that have no any programming experience. Two lectures were delivered through a Learning Management System (LMS) developed in house within a project funded by Istanbul University.

The next section reviews current literature related to web based online learning and online programming courses. Section two describes the methodology of the study. The methods and tools that were identified and used for collect and analyse the data regarding the students views and opinions are described next. Finally, the paper concludes with a discussion of the lessons learned in the process and opportunities for future work.

1.1. Literature Review

The term "e-learning" will still most likely be utilized to reference out-of-classroom and in-classroom educational experiences via technology, even as advances continue in regard to devices and curriculum. It is essentially the computer and network-enabled transfer of skills and knowledge. E-learning applications and processes include Web-based learning, computer-based learning, virtual education opportunities and digital collaboration. Content is delivered via the Internet, intranet/extranet, audio or video tape, satellite TV, and CD-ROM. It can be self-paced or instructor-led and includes media in the form of text, image, animation, streaming video and audio (Tavangarian, Leypold, Nölting & Röser, 2004). E-learning can be performed simultaneously or asynchronously. In Table 1 the e-learning models are presented together with the differences between them.

Table 1 E-Learning Models (Özmen & Ediz, 2002)

E-learning Models			
Simultaneous Mode		**Asynchronous Mode**	
Interactive	**Passive**	**Interactive**	**Passive**
Real time lecturing and interaction	Real time lecturing but not interaction	Lecture notes are on the web and students can access at any time. They can contact lecturer through e-mail	Lecture notes are on the web and students can access at any time. No e-mail connection

On the other hand, a new concept of e-learning is called blended learning. It is a mix of different traditional and online learning environments. It combines conventional F2F classroom methods with more modern computer-mediated activities.

Currently however, there are few examples of application of online learning and Web technologies within computer programming. Hence, it is not possible to draw general conclusions about the effect of online learning systems and similar software (Clancy, Titterton, Ryan, Slotta & Linn, 2003; Conolly & Standsfield, 2007; Hadjerrouit, 2005; Schwieren, Vossen & Westerkamp, 2006). In addition, most applications focus on technological aspects rather than pedagogical principles based on learning theories, which is not sufficient for helping students acquire programming skills.



Figure 1. Blended Learning Methodology (URL 1).

According to El-Sheikh (2009) some of the literature focuses specifically on the design of online programming courses, including reports of technologies and methods used in such courses, and of their impact on student learning outcomes. For example, Reeves, Baxter & Jordan (2002) described an introductory course in C++ taught online with the WebCT LMS. The course was built around this LMS which contained the syllabus, daily assignments, longer-term programming projects, PowerPoint-based presentations, a textbook, and a programming environment. Students in the online class were encouraged to attend a F2F section of the same course (at least at the start of the term), but only one student took advantage of this opportunity. While the opportunity for synchronous communications was present, it was not available online and largely ignored. Thomas (2000) described an online offering of a C++ programming course. She related that even though the course was geared toward mature students with at least a year of programming experience, F2F meetings with a teaching assistant proved useful. Despite the fact that the course included utilization of standard distance communications, several students reported feeling isolated and wishing for better contact with the instructor. Suggestions included holding F2F exam reviews. Thomas concluded that online courses require mature and motivated students and some compensation for the lack of F2F interactions. Molstad (2001) describes uses of various types of distance educational technology in an online introductory programming course, including the use of two-way audio-video capabilities that were used to allow students to access recordings of lectures. Students could ask questions that arose in the process of viewing the recordings, but no synchronous capability was available. Varying results regarding the quality of outcomes that are achieved in online versus F2F programming courses exist in the literature. Ury (2004) concluded that the performance of online students was satisfactory, but that their aggregate final grade was significantly lower than that of students who took an equivalent F2F class. Kleinman & Entin (2002) arrived at a different conclusion, reporting that there were no significant differences in overall outcomes, corroborating the results of Maki & Maki (2007).

2. Method

In this study, we tried to find out the answers of the following questions regarding a course on computer programming taught at the Fall semester of the year 2010 both in conventional F2F manner and through on line learning to students with no previous computer programming experience. The study was conducted at the Department of Mathematics, Faculty of Science, Istanbul University.

- What are students' approaches to online learning?
- Can students individually understand the course content easily on an online learning environment?
- Is there a significant difference between the traditional education and online learning?
- Does online learning affect student success positively or negatively?

Two lectures in the unit, each of which concerned with a separate well-defined topic ("Loops in C" and "Functions in C"), were chosen to be delivered online with all other deliveries being given for these topics in a traditional F2F manner. The lectures were delivered using a set of PowerPoint slides, handouts and tutorial instruction sheets, with the narrative of the lecturer (based upon written notes) given as a substitute to the written material on the Web site. The questionnaires were handed out in the week following each online lecture by the students of experimental group (students with odd numbers) and that of control group (students with even numbers). Next week, by changing the groups, same experiment was done. For every student, a user account has been created. The experiment has continued two weeks.

2.1. Participants

The total of 62 students formed the sample of the study that covers two groups: the online and F2F groups. The age range of participants was 20-33. The gender of the population was balanced with 63% female and 37% male. Students have shared the similar educational backgrounds – they have had skills on using IT but no previous experience on programming. They were forth year majors in Mathematics.

2.2. Limitations

This research was limited with:

1. Students from Department of Mathematics, Istanbul University.
2. Two subjects of Computer Programming course: "Loops in C" and "Functions in C".
3. Experimental groups have had the opportunity of using computers in the computer laboratory and have access to all e-learning materials.
4. Two weeks of experimentation.

2.3. Instrumentation

The data was collected in two ways: a questionnaire and pre and post tests. In every one of two weeks, experimental group took an online pre test (15 min), access the lecture content (45 min), took the online post test (15min) and finally handed out the questionnaire. Control group took only pre and post tests and follow the lecture in traditional manner. The questionnaire includes both open ended and close ended questions.

2.4. Data Analysis

Data of this research have been collected by means of a questionnaire and pre/post tests. Later, the collected data have been typed into SPSS 18 (Statistical Packages for the Social Sciences) and have been processed. Frequency tables have been obtained through this process. T-test statistical tests are used to prove the research results.

3. Findings

The survey analysis results were given in Table 2. Table 3 and Table 4 include the t-test results on students' perceptions that were measured via a pre-test and a post-test mentioned above.

Table 2 Survey Results

	Yes, absolutely		**Uncertain**		**I don't think so**	
	F	%	f	%	f	%
Students' opinions on online environments in general						
Attending an online learning course is rewarding	7	11,3	23	37,1	20	32,3
The education in Higher Education institutions can be supported by an LMS developed to deliver the lecture notes, streaming video, online discussion tools, bulletin boards, chat sessions, IP TV via Internet	14	22,6	8	12,9	38	61,3
The education in Higher Education institutions can be delivered by computer supported materials (video, e-books, virtual classroom, etc.) remotely	15	24,2	11	17,7	35	56,5
Online materials can support traditional F2F teaching	16	25,8	14	22,6	30	48,4
Online materials can support laboratory teaching	13	21,0	14	22,6	33	53,2
Online education in Higher Education is efficient only if it is supported by applications	10	16,1	9	14,5	41	66,1
The static visual elements (pictures) can be used for online teaching in Higher Education	6	9,7			54	87,1
The animations can be used for online teaching in Higher Education	1	1,6	4	6,5	56	90,3
The audio-visual elements can be used for online teaching in Higher Education	3	4,8	6	9,7	50	80,6
Online teaching provides the opportunity to re-access the materials	4	6,5	3	4,8	53	85,5
Students' opinions on advantages of online environments						
I get instant feedback	20	32,3	12	19,4	29	46,8
I can study where I want to	9	14,5	8	12,9	44	71,0
I can study when I want to	9	14,5	8	12,9	44	71,0
I am under less stress than in the traditional classroom environment	25	40,3	10	16,1	26	41,9
I can study individually in the way I want to	11	17,7	10	16,1	40	64,5
I can access the course material easily	11	17,7	11	17,7	39	62,9
I find the opportunity to repeat subjects of a lecture outside of school	5	8,1	5	8,1	51	82,3
I can use a variety of materials than those in the books	11	17,7	19	30,6	31	50,0
Student's opinions on disadvantages of online environments						
It will be interrupted by technical problems (computer, etc..)	7	11,3	4	6,5	50	80,6
It will be interrupted by internet problems	6	9,7	7	11,3	48	77,4
I think that using e-mail during the lecture is a waste of time	17	27,4	13	21,0	31	50,0
The cost of online learning is higher than the cost of formal education	23	37,1	14	22,6	23	37,1
It is not suitable for every subject/course	10	16,1	9	14,5	42	67,7
Surfing the web, using the chat and similar activities would be time-consuming	5	8,1	4	6,5	52	83,9
It is not possible for everyone to access the technological opportunities	7	11,3	6	9,7	48	77,4

While looking at the Table2, it can be seen that the perceptions of students towards online learning are not completely positive.

Table 3 Independent T-Test – First Week

Group Statistics								
	Group	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
QUIZ 2- pre	First week online	36	58,61	18,385	3,064	-2,383	64	,020
	First week F2F	30	69,00	16,682	3,046	-2,405	63,508	,019
QUIZ 2-post	First week online	36	78,61	11,251	1,875	-4,588	64	,000
	First week F2F	22	92,33	13,047	2,382	-4,526	57,715	,000

Table 4. Independent T-Test – Second Week

Group Statistics								
	Group	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
QUIZ 3-pre	2.Week Distance Ed.	28	65,36	16,439	3,107	1,930	48	,060
	2.Week F2F Ed.	22	56,82	14,272	3,043	1,964	47,476	,055
QUIZ 3-post	2.Week Distance Ed.	28	89,64	14,006	2,647	1,382	48	,173
	2.Week F2F Ed.	22	84,55	11,434	2,438	1,417	47,911	,163

The t-test results presented in Table 3 and Table 4 show that there is an increase in performance of both groups.

As it was stated in previous sections, varying results regarding the quality of outcomes that are achieved in online versus F2F programming courses exist in the literature. While some results concluded that the performance of online students was satisfactory, but that their aggregate final grade was significantly lower than that of students who took an equivalent F2F class, others arrived at a conclusion reporting that there were no significant differences in overall outcomes.

4. Discussion and Conclusion

In this study we aimed to find out the difference between students' performance in and their perceptions on online and F2F settings during a computer programming course taught to mathematics majors in the fall semester of year 2010 by using an LMS developed in house through a project supported by Istanbul University. Frequencies which belong to some questions in our survey and statistical test results has been given. This study has shown that the lecture material delivered online is both feasible and practical. The quantitative results of the study indicated that a majority of students (37%) are uncertain in choosing one of the methods (F2F or online) while the 32% of students prefer traditional F2F lectures and a minority (11%) not caring either-way. In our opinion, in case of making transition from F2F to online mode of teaching, prepossession about a new way of teaching is always an important barrier in students' perceptions. So, the number of online teaching and learning experiences must be increased as well as the more emphasis must be given on online personalized teaching environments. Regarding the results on achievement, there is increase in grades of students

in both settings. So, we can conclude that applying online teaching in a computer programming course is rewarding.

In addition, besides this study with a "tiny" experiment, further research is required to ascertain more clearly the advantages and disadvantages of online learning in a computer programming course. Another promising path for future work is the investigation of strategies for incorporating blended learning opportunities in programming courses.

Acknowledgements

This work was supported by Scientific Research Projects Coordination Unit of Istanbul University. Project Number 2962.

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