

The influence of online mathematics learning on prospective teachers' mathematics achievement: The role of independent and collaborative learning

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Abstract

The aim of this study is to influence of online mathematics learning on prospective teachers mathematics achievement based on the role of independent and collaborative learning. An experimental design model with pre-test and post-test control group was used in the study. The working group constitutes a total of 60 prospective teachers in the 1st and 2nd years of education in the department of elementary teaching and preschool teaching of a private university in 2016–2017 academic year in Northern Cyprus. As means of data collection, mathematics achievement test consisting of 30 questions was administered as pre-test, and after the study, the same success test was administered as a post-test. As a result of the findings, it has been determined that the prospective teachers have a significant increase in their successes due to the teaching practices in online learning environments. At the same time, it has been shown that the mathematical success of the prospective teachers in online learning environments differs statistically significantly compared to the prospective teachers who take lessons in face learning environments and this difference is in favour of online learning environments.

Keywords: Independent learning, intelligence, mathematics achievement, Moodle, online learning environments, teacher candidate

1. Introduction

The internet, which is a rapidly growing communication network that emerges as a result of information access, information sharing, storage and generation processes in the current era, has become a highly needed and increasingly used structure within the scope of education and training with its various communication services (Demirel, 2011). Parallel to today's evolving technologies and changing needs, a number of innovations have been realised in teaching and learning methods. One of these innovations is the use of web-based learning environments in education.

Online or web-supported learning environments are described as educational models, in which education and training activities are managed independently and independently of time and place, and the computer is used as a tool for research, inquiry and communication. In this context, communication activities are carried out over the internet between learners-learners and learners-educators. Interactive pages in the context of web-supported learning environments facilitate the processing of the lesson and improve the quality of the education. These are some tools that enable web-supported learning activities such as discussion lists, network pages, additional software, e-mail, forum, multimedia, virtual classroom applications, teleconferencing and video conferencing (Tezer and Çimşir, 2018).

Web-based distance education model is also included in this scope. In this educational model, nearly, all of the methods or techniques used in the context of distance education based on internets are utilised (Carswell and Venkatesh, 2002). The most important advantages of web-assisted distance education are enabled asynchronous (asynchronous) training, enable learners to access content within the system when they want it and use resources to the extent required to meet their goals. The combination of such flexibility with low-cost advantages gives the opportunity to create ideal learning environments (Carswell and Venkatesh, 2002; Doungwilai and Limmanee, 2017).

2. Literature Review

2.1. Learning management systems (LMSs) and Moodle

LMS is web software which includes web-supported distance education model. LMS in literature and LMS in international context are the most general definitions; are web software designed to perform the management of distance education systems. In addition to these, it is still the main task of the LMS to provide learning material, share the presented materials and perform various functions such as discussion, homework, examinations, feedback on these homeworks and examinations, keeping student, teacher and system records and reporting. The limitations or necessity of having the students and educators in the same physical environment have been completely abolished with all these softwares called LMS, Course Management System and Virtual Learning Environment (Uzunboyly, 2008; Tezer and Ozcan, 2015; Birkollu, Yucesoy, Baglama and Kanbul, 2017). One of the most widely used open-source LMS is Moodle (Önal, Kaya and Draman, 2006; Romero and Rozano, 2016; Uzunboyly, Bicen and Vehapi, 2017). The software works under MySQL and PostgreSQL database systems and in any environment that supports PHP language (Linux, Windows, Mac OS X, etc.). The platform is available in 235 countries, with support for 82 dillies and 50,000 students and thousands of courses. Moodle has functionality in virtually any network learning platform, such as assignments, examinations, forums, discussion boards, newsletters and content management. Moodle, a prestigious open-source course management system, is widely used today in schools, educational institutions and even in commercial schools (Su, Qiu, Wang & Zhao, 2016; Tugun, Uzunboyly and Ozdamli, 2017).

Teachers can use Moodle's educational integration to create rich web-based and supported courses using this platform. At the same time, by categorising lessons, they can make use of the tools that support the group work that will create many activities such as materials, examinations, tests, surveys and projects within these categories (Simsek, 2015). One of Moodle's greatest advantages when viewed in general terms is; in addition to being open source, it requires a single entry for users. Thus, users are only accustomed to a single user interface. Another advantage is user and user data protection. Nowadays, especially in online courses, it is easy to use the Moodle platform with just a simple record and account information created as a result of this registration. In a broader context, platform users can easily access relevant online courses from anywhere in the world at any given time. In this sense, the independence of the platform from time and space brings with it learning environments that support cooperation as well as autonomy learning on the students. In addition, support for Moodle course design and course management, enriched multimedia learning resources, various activities based on communicative and collaborative learning (forums, chat, wiki, etc.), tutorials and communicative contacts and guidance as well as controlled learning through feedback. In this context, Moodle platform was used in the lessons conducted by web-based teaching methods for Mathematics I course in study; the course materials and videos embedded in the platform allowed the prospective teachers to follow the Mathematics I course independently from the time and place (Uzunboylu and Cumhur, 2015; Virtop, 2016; Polat, Yavuz and Ozkarabak, 2017).

When we look at the general content of 'Mathematics I' course, it covers basic mathematics, geometry and analytical geometry subjects and applications. It is a compulsory requirement for teacher candidates for the faculty of education, as well as for the first grade of the course. When looking at the aims of the course, this course aims to improve the ability to identify, understand and solve problems involving numerical data and information. When it comes to basic skills, it is essential to give knowledge and experience to teacher candidates to solve the problems that may be encountered in everyday life. Thus, prospective teachers who transfer the basic knowledge and skills they have acquired in the course of Mathematics I to their daily lives will gain both lifelong learning qualities and the ability to transfer this transfer to their students when they are employed in the profession.

2.2. Purpose

The general purpose of this research was to investigate the effect of web-based learning environments on the success of teacher candidates within the scope of 'Mathematics I' course. The subobjectives set for this purpose are as follows:

Is there a significant difference between the pre-test mathematics achievement scores of the prospective teachers in the experimental group and the prospective teachers in the control group in terms of face-to-face instructional environments with traditional learning approach and web-based learning environments?

Is there a significant difference between the pre-test and post-test mathematics achievement scores of the prospective teachers in the control group who took 'Mathematics I' in the face to face in traditional learning environments?

Is there a significant difference between the pre-test and post-test mathematics achievement scores of the prospective teachers in the experimental group who took 'Mathematics I' in the web-based learning environments?

Is there a significant difference between pre-test and post-test mathematics achievement scores of the experimental and control group teacher candidates who took 'Mathematics 1' course in web-supported and face-to-face learning environments?

3. Materials and Methods

3.1. Research method

Experimental design with pretest-posttest control group was used in the study. The real experimental model is the one with the highest scientific value. Using control groups to provide their advantages, the errors that can be caused by the random selection, assignment and equalisation of the groups are reduced the most (Büyükoztürk, 2017). The reason for preferring this design in this research is the prevention of the error (selection effect) that might come from the groups and the equalisation of the groups. Because the subjects in the control and experimental groups were selected randomly, it was ensured that both the centre orientation effect and the time error were prevented as the research and control groups were tested at the same time. Pre-test was applied for each two group dependent variable (Mathematics achievement test) before the experiment. After the experiment, groups were also subjected to post-test test for the same dependent variable (Mathematics achievement test). The following environments were used in groups:

- Experimental group: Prospective teachers who take 'Mathematics 1' course in web-supported learning environments
- Control group: Prospective teachers who take 'Mathematics 1' in face-to-face instructional environments with traditional learning approach.

The duration of the study was completed in a total of 7 weeks in the experimental and control groups. The course on the experimental group was conducted in web-supported learning environments. The media and materials used in the relevant learning-teaching process are the course book, whiteboard, online videos and forum modules. On the control group, the course was conducted face to face in traditional learning environments. The media and materials that are effective are the whiteboard and the course book.

3.2. Participants

The participants of the study consist of 60 first- and second-grade prospective teachers from primary school teaching department and pre-school teaching department in the first semester of 2016–2017 education year at a private university in Northern Cyprus. The 60 prospective teachers assigned to the two groups (experiment and control) determined within the scope of the research were assigned with an even distribution of the unbiased assignment result (30 participants in each of them).

3.3. Data collection tool

To achieve the overall objective of the study, pre-test, a 30-question test before researching prospective teachers; after the research, the post-test consisting of the same test questions was applied. This test is called 'Mathematics Achievement Test' which is a 5-point Likert-type scale. Achievement test is a widely used measurement tool in modern education systems and applications developed by test technique (Koc, 1982). Validity studies of the achievement test were carried out by

consulting expert opinions. As a result of the item analysis, two of the questions were dropped due to poor evaluation in terms of item discrimination index. The content validity of the questions was developed by researchers and course teachers taking into account the goals and achievements covered in Mathematics I subjects. The Cronbach's alpha reliability of the test was 0.85.

3.4. Analysis of data

The scores of the prospective teachers' achievement test were analysed in the Statistical Package for the Social Sciences-23 program. Separate Kolmogorov–Smirnov tests were applied for pre-test and post-test to determine whether the data showed normal distribution before analysis. Kolmogorov–Smirnov (k-s) tests (Akbulut, 2010) which are used to test whether a randomly obtained sample matches a uniform distribution (uniform, normal or poison). Non-parametric tests were used because the data were not normally distributed in the study ($p > 0.05$).

To test the other subobjectives of the study, non-parametric tests were used; Mann–Whitney U and Wilcoxon signed-rank tests. In addition, descriptive statistical analyses were used.

4. Results

4.1. Findings

The information on each subobjective in the study and the relevant test results are given below:

Table 1. Mann–Whitney U-test results on pre-test scores of the experimental group and the control group

Groups	n	Mean ranks	Sum of ranks	U	p	Significant difference
Control	30	31.57	947	418.0	0.635	p>0.05
Experimental	30					

Table 1 shows the result of the Mann–Whitney U-test for the pre-test scores. The level of significance indicates whether the mathematics achievement test scores of two groups are significantly different from each other. The specified significance level is 0.635, which is above the critical value of 0.05. There was no significant difference between the two groups in the pre-test scores. This result is an indication of unbiased assignment to groups. This result is an indication that the prospective teachers were assigned to the groups in an unbiased manner.

Table 2. Wilcoxon signed-rank test for comparing participants' pre-test and post-test scores for the control group

	n	Mean rank	Sum of ranks	Z	p	Significant difference
Negative ranks	2	7.75	15.50	-4.370	0.000	(p<0.01)
Positive ranks	27	15.54	419.50			
Ties	1					

Total	30
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As shown in Table 2, the mean rank in which the scores from the pre-test are lower than the scores from the post-test for the control group. Z value found is -4.370 and the significance level is below the critical value of 0.01 . That is, there was a significant difference between pre-test scores and post-test scores of the participants for the control group. In the course of the research, it is observed that the prospective teachers who took the course in the face to face in traditional learning environments had higher level mathematics achievement from the post-test than the pre-test at 0.001 significance level. It is possible to say that at the end of the given 7-week training period, the post-test scores of the prospective teachers in the control group went to a significant increase in comparison with the pre-test score.

Table 3. Wilcoxon signed-rank test for comparing participants' pre-test and post-test scores for the experimental group

	n	Mean rank	Sum of ranks	Z	p	Significant difference
Negative ranks	0	0.00	0.00	-4.784	0.000	($p < 0.01$)
Positive ranks	30	15.50	465.00			
Ties	0					
Total	30					

As shown in Table 3, the mean rank in which the scores from the pre-test are lower than the scores from the post-test for the experimental group. Z value found is -4.784 and the significance level is below the critical value 0.01 . That is, there was a significant difference between pre-test scores and post-test scores of the participants for the experimental group. In the course of the research, it is observed that the prospective teachers who took the course in the web-supported learning environments had higher level mathematics achievement from the post-test than the pre-test at 0.001 significance level. It is possible to say that at the end of the given 7-week training period, the post-test scores of the prospective teachers in the experimental group went to a significant increase in comparison with the pre-test score.

Table 4. Mann-Whitney U-test results on post-test scores of the experimental group and the control group

Groups	n	Mean ranks	Sum of ranks	U	p	Significant difference
Control	30	23.98	719			
Experimental	30	37.02	1110	254.5	0.004	$p < 0.05$

Table 4 shows the result of the Mann–Whitney U-test for the post-test scores. The level of significance indicates whether the mathematics achievement test scores of two groups are significantly different from each other. The specified significance level is 0.004, which is below the critical value of 0.05. There was a significant difference between the two groups in the post-test scores, implying that the students in the experimental group showed better mathematics achievement scores than the control group. The $r = z/\sqrt{n}$ is used here for the effect size. This value is 0.1 'low', 0.3 'medium' and 0.5 'high effect size' (Field, 2009). According to this, $r = -2.895/\sqrt{60} = 0.373$ is calculated. According to this, 'medium level effect size' was found between mathematics achievement test scores in terms of learning environments (web supported and face to face). It is possible to say that at the end of the given 7-week training period, the post-test score of the prospective teachers in the experimental group went to a significant increase in comparison with the control group.

5. Discussion and Conclusion

In the study, it was determined that the success of prospective teachers who took 'Mathematics I' course in web-supported learning environments and the success of prospective teachers who took by face to face with traditional learning approach differ significantly. The results of research findings are in favour of 'Web-supported Learning Environments'. These results showed that the web-supported learning environments, which constitute a combination of both face to face and online material, made learning independent from time, independent of learning at any time they wish and at the same time support their collaborative learning proving to be of considerable advantage. In addition, the online learning dimension of web-supported learning is supported by Moodle systems. Prospective teachers' course materials, interactive videos, online courses and forum-questionnaire modules are presented through this system. In this context, when examining the related literature on the subject, in a study (Kisla, Karaoglan, Algin and Candemir, 2015). Moodle system was opened for 13 masters and 3 doctorate courses. The system has been actively made ready for use by 8 faculty members and 98 graduate students. In this context, a qualitative research was conducted on the opinions and suggestions of students and faculty members on the use of Moodle software and contribution to learning, and the results were discussed. As a result, it has been revealed that the courses carried out with web-supported learning environments are very effective on the management and learning-teaching processes of the Moodle system. As a suggestion, it has been pointed out that video courses and interaction tools (online chatting, whiteboard, etc.) should be used more to implement the application more effectively.

Recommendations

Web-based learning environments (Driscoll, 2002) in which different forms of web-supported technologies are combined (virtual classes, LMS, independent learning, collaborative learning, text-audio-video or drawing) the results of the study are influenced by the success of the teacher candidates. On the basis of research findings, it has been shown that the mathematical achievements

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of teacher candidates taking 'Mathematics I' in both Moodle-based online learning and face-to-face learning environments are far superior to mathematical achievements of mathematics achievements of teacher candidates in the face-to-face learning environments.

Based on the relevant learning approaches, this study was carried out within the scope of 'Mathematics I' on teacher candidates at the university level and was supported by research findings that were quite successful at this stage. In future studies, it is possible not only in mathematics lessons but also in the university level, but in different courses and teaching stages, learning process activities can be diversified using the positive aspects of web-supported learning methods and environments, and positive changes can be observed in student/teacher candidate achievements.

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