Project based learning approach in pedagogical agent assisted learning environment

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Abstract

Since many of project based learning (PBL) cases performed in Science & Mathematics fields, the purpose of this study is to specify the contributions of developing computer assisted project for the teaching process in Human Computer Interaction (HCI) course teaching with the support of pedagogical agent assisted learning environment. This study attempts to examine the effects of PBL approach in pedagogical agent assisted learning environment on students' attitudes and achievements in human computer interaction (HCI) course. Project-Based Learning Attitude Scale, Pedagogical Agent Satisfaction Survey and Perception of Course Content Attitude Scale were applied to students in order to determine the students' achievements in and attitudes towards the activities of pedagogical agent assisted PBL approach. Furthermore, review tests were applied twice as pre-test and post-test before and after the pedagogical agent assisted learning. As a result, the paper indicates that pedagogical agent assisted PBL approach affects students' achievements and attitudes in HCI course in a good way.

Keywords: project based learning. pedagogical agent assisted learning environment, human-computer interaction, e-learning

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1. Introduction

Education is an ongoing fact from the lifelong learning perspective. The use of technology in classes enables technology to be more effective and ease to use for teachers and students. Programs having same content are perfectly transferred, thanks to the use of technology, in education and technology, within this context; it helps the provision of equality. Furthermore, a limitless library is made available with the use of technology in education and teachers become more competent.

Project-based instruction is an alternative method to traditional instruction methods. Projects that are prepared by students are in the centre of project-based instruction method. Project, draft or draft development means; imagination and planning. Projects are individual or group studies of students for the solution of a problem regarding acquisition of a concept of a skill [16].

Projects enable students to learn through experience and to gain academic research skills and to use alternative approaches regarding their individual differences, skills or interests [22]. The project-based learning approach was first handled and published by Kilpatrick (1918) and was called the project. For more than 50 years, educationists like John Dewey [24] have emphasized the benefits of studies which directly place students in the centre of learning method. Project-based approaches are supported because they meet new standards that move beyond a focus on simply understanding concepts to understanding the practices of a discipline too [15, 25, 26]. The project-based learning approach aims at encouraging the students to participate actively, includes high-level cognitive activities, social skills and life skills together, does not regard the computer as a target, usually emphasises the use of technology as a tool and underlines appropriate computer-supported educational applications [1]. The use of technology in instructional environments has significant advances as it improves the motivation of students and makes them the centre of the instruction. With the use of technology in instructional environments, the term Computer Assisted Instruction has come about. According to Worthington et al. (1996), computerized study guides can impact and improve students' overall level of mastery. Also, they emphasize that testing may be improved if students complete tests on computer screens and receive immediate feedback about their performance [3].

2. Project Based Learning

Project-based learning approach is based on the principle that students work on real-life problems individually or in small groups to produce concrete outcomes [19]. It encourages individuals to explore and examine a variety of problems and resources to construct personal strategies to handle these problems, as well as negotiate and share the solutions [27, 28]. Project-based learning is a comprehensive perspective focused on teaching by engaging students in investigation [4]. Project-based learning is a pedagogy which is used to solve real world problems with developing theories and applying some skills and techniques [20].

Barab and Luehmann [29] defined the project-based learning approach as a high level of thinking skills and as structuring active learning to a high degree. To support this definition, it is possible to include that the project-based learning approach is a teaching and learning model that regards the teaching system as a whole rather than as presenting the curriculum as a small independent mass of information found in the curriculum [1].

Thomas (2000) defined the issues regarding the positive side effects of project-based learning process for students as the development of positive attitudes toward their learning process, work routines, abilities in problem-solving and self-esteem. Similarly, Green (1998) emphasised that participants in project-based learning learn better and are more actively involved in their learning: instructors take a back seat as students work on their projects [8].

Some essential features of project-based instruction can be summarized as follows [15];

- PBL engages students in investigating an authentic question or problem that drives activities and organizes concepts and principles

- PBL results in students developing a series of artifacts, or products, that address the question/problem
- PBL allows students to engage in investigations
- PBL involves students, teachers, and members of society in a community of inquiry as they collaborate about the problem
- PBL promotes students using cognitive tools

Students process their experiences gained with PBL and implement them in their own lives. PBL is a different way of learning which develops new learning habits. PBL pushes students to think in different ways in order to produce solutions to real-life problems and allows them to use their creative thinking skills to produce different solutions.

In the PBL approach, students to develop feelings of self-esteem can be achieved. With this personal liberty provided by the PBL approach, students form their projects according to their own interests and abilities [18].

The stages of PBL approach can be summarized with the following items [19].

(1) Determination of the goals

(2) Determination of the study or the topic to be dealt with

(3) Formation of the groups

(4) Determination of the features and presentation style of the conclusion report

(5) Development of the study program

(6) Determination of the check points

(7) Determination of assessment criteria and efficiency levels

(8) Collection of the data

(9) Putting the data in order and preparing reports

(10) Presentation of the project

Students will obtain efficiency if they work only in accordance with these steps in a systematic way.

There are some significant differences between traditional instructional model and project-based learning model. While definition of problems, solutions and designs are important in traditional instructional model, more than one solution may be found out in the process of PBL model and the draft is prepared with students. In traditional learning approach teachers have strong authority in class but in PBL approach, there is a teacher model that learns, researches and inquires with students. While students are individuals who learn what their instructors teach and who are generally passive in class; there is a participative class environment in PBL approach, students are the ones who do the activities. In traditional instructional method, outputs are important and in PBL method outputs and process are both important. In long term goals, students participate in traditional instructional model, become individuals who are successful in exams; and students participate in PBL model, become independent, problem-solver individuals who learn throughout their lives.

There are many advantages provided by PBL model. Project studies, promote students with a life-long learning opportunity, enable students to satisfy their curiosity through different aspects of the research field, enable students to obtain first-hand information in related topics with their projects, enable students to think, study and success independently and individually, enable students to develop their creativity, gain scientific study habits, experience success and contributes to their self-esteem.

Bartscher et al (1995) indicated that PBL should be implemented at all levels of learning with a few modifications. The use of cooperative groups along with projects allows students to work

with others on similar projects which in turn may help to give them more confidence in completing their task. Working in groups motivates students because it allows them to share ideas and to receive immediate feedback from their peers.

In a traditional instructional model, teachers settle down and silence students, and move through the curriculum at a rate that bores students (Gump, 1982). Instead, PBL teachers are concerned with making it possible for students to manage classroom tasks, time, resources, group work, as well as learning and assessment, on their own [17].

PBL method can also be applied with the support of computers. There is no difference between Project-Based Teaching (PBT) and Computer Assisted Project-Based Teaching methods in terms of implementation and evaluation processes. The only slightest difference is that computer technology is more dominant in developing project in Computer Assisted Project-Based Teaching.

3. Pedagogical Agent Assisted Learning Environment

Agent technology is used in a variety of areas. The use of agent technology in instructional environment is increasing rapidly. Therefore, the term 'pedagogical agent' has begun to be used. Pedagogical agents can be described as the software tools that are promoting learning process in interaction with students and learning environments and that works in certain tasks.

Pedagogical agents are computer simulated characters. They guides to students during the learning process and provides necessary information and feedback to the learner. Pedagogical agents communicate by using any communication tool and create a social learning environment.

Schroeder and Adesope [23] were investigated 99 different pedagogical agent outcome measures about pedagogical agents' persona, motivation, and cognitive load implications for learners and according to the results of this review, pedagogical agents may be preferable compared to non-agent control conditions.

4. Recent Studies of Project Based Learning

There are very few researches on pedagogical agent assisted PBL in software development field. In this part of the study, research done in different fields within the scope of PBL and computer assisted learning environment are ordered.

Basturk [3] examined the educational advantages of Computer Assisted Instruction. Learning outcomes of students who take the introductory statistics course with CAI was compared with the learning outcomes of students who take the course with traditional learning methods. Midterm and final exam scores of students in computer assisted instruction section were higher than the scores of the students in the traditional learning section. According to the results, learning capacity of the students in the introductory statistics course could be improved when traditional learning methods supported with the computer assisted instruction methods.

Ozdemir (2006) studied the effects of project based learning on the students' attitudes towards and success in geometry. In this study, students' and researchers' observations and teachers' answers to observation scales were examined. According to the result, students' geometry achievements in and attitudes towards geometry were increased with the use of project based learning methods. Also, students who have lack of attention and easily distracted began to focus easier.

Piccinini and Scollo [21] studied on collaborative project-based learning approach in a web based software engineering course. Teachers'' role remains critical even in a self-organized project-based learning approach. Instructors provide an initial orientation to students in order to understand the educational goals. A survey consists of a few questions proposed to that purpose has been applied in a software engineering course. A project setup methodology has been outlined with the findings of this survey, empirical data from the latest seven-year history

of the course has been collected and finally the work presented has been added to the context of current approaches of software engineering education.

Bottino and Robotti [6] investigated the results of a project-based research on a testing field of a course that aims to develop arithmetic problem solving skills of primary school students. This course has been designed to combine the e-learning techniques. In this study, an e-learning technique, ARI@ITALES authoring tool has been used. These tools allow the integration of a set of micro worlds with the courses of constructivist activities based on interaction. In this study, analyzing how the adopted approach and tools could help instructors to design and manage technology based classroom activities and evaluating the effectiveness of ARI@ITALES tools to support the students' to gain mathematics skills were aimed.

Haake and Gulz [11] studied on using the virtual pedagogical visual stereotypes and investigated the potential effects of this in digital learning environments. In this study, the visual stereotype concept has been analyzed and the difficulties and drawbacks of using these stereotypes in traditional media have been discussed. Furthermore, it has been investigated that if there is any innovation on the use of visual stereotypes of virtual pedagogical characters. After the use of visual stereotypes, indeed some new challenges and disadvantages has been emerged. In the conclusion of this study, it has been identified as the knowledge about these matters could be useful both for educational system developers and educators who enables them to strengthen some pedagogical settings and activities.

Bodenheimer, et al. [5] worked on a study that evaluates animation and interface components for an agent-based system that provides decisions, technical approach and learning by teaching. The agent can answer questions about the learned topics and take quizzes. Agent's performance provides feedback and motivation for students to learn and the overall interaction helps students to learn by themselves. The teachable agent uses speaking and animations to communicate with the students and sometimes, the agent expresses emotions with facial expressions. The effects of the animated agent on U.S. public school pupils aged 9-11. According to the results, existence of the animated agent supports positive learning experiences.

Karahoca, et al. [12] examined a Computer Assisted Learning System (CALS) according to several factors that supports the flow where students are fully involved in learning activities in history of civilization course. The designed Computer Assisted Learning System has been supported by cognitive maps and multimedia tools like movies, flash cards and online quiz applications. The research data has been collected by surveys which were applied to 54 students which are randomly selected from the students who enrolled in history of civilization course at Bahcesehir University. According to the results, 53.7% of the selected students who use the CALS could be in flow easily and results showed that the flow has significant predictors in terms of the course enjoyment of students.

Köse [14] studied on a web-based system that developed to support project-based learning activities in a "web design and programming" course given at Information Technologies program of vocational high schools. Project-based learning is a learning approach that runs projects through the students' learning activities. This approach gives students a chance to investigate a valuable issue more detailed and it allows students to learn from experiences and adapt gained knowledge, skills and attitudes in real-life scenarios. This system aims to enable students to learn web site designing and programming.

Demirci [8] investigated a dialog activity for a science lesson that adopts project-based learning approach and get views of researchers about the course. This study was carried out on 6. grade students. Data has been collected by observations, views and artifacts. According to the results, students enjoyed the activities that has been implemented throughout the project and they found these activities different from the others that has been applied so far.

Eskrootchi and Oskrochi [9] thought that combining computer simulation model with project-based learning can be effective, but there should be a careful planning and implementation. It was emphasized that teachers should have pedagogical content knowledge especially about how students learn with technology infused materials. In this study, it has been suggested that

students can learn with the creation of active information which is a combination of interactions with peers and teachers using technology, experiences and interpretation. Simulations don't work on their own. In order to increase the efficiency, interactions of students with simulation need to be structured. Purpose of this study is to measure the efficiency of project-based learning in technology-rich environments. A science project was developed and to provide a better understanding of this project to students, a simulation software package named "Structural Thinking and Experiential Learning Laboratory, with Animation (STELLA)" has been developed. As a result of this study which was carried out with quasi-experimental research design model, the students in the watershed experiment were found to be more successful than others.

Baran and Maskan [2] researched on the effects of project-based learning approach on students' achievement of 2. grade physics students in electrostatic. This research was carried on 40 students, including the control group and the experimental group. An electrostatic concept achievement test has been applied in order to measure the success of students in electrostatic and, oral and written exams has been applied to students in order to obtain their views about the application. The experimental group learned the issue of electrostatic with project-based learning approach while the control group was learning with the traditional learning methods. Significant differences showed in results in favor of the experimental group. As a result of observations and interviews, it was identified that students who learn with project-based learning approach are more active and spend more enjoyable time while learning.

Changa and Tsengb [7] examine the effect of a Web-based portfolio assessment system on students' performances who takes project-based learning (PBL). According to the results, there is no significant effect on students' achievement, but there is a significant effect on self-perceived learning performances.

Kim et al. [13] were conducted an empirical analysis on a Web 2.0 learning environment that supports project-based learning. According to the results, promoting deep learning through group reflection methods is important for team project learning.

Karahoca et al. [12] investigated the effects of robotic training to support science and technology lessons in primary school. The study was conducted with 16 students between the ages of 10 and 15, and students were divided into 4 groups. It was seen that students can learn while they are discussing with their classmates in terms of cooperative learning and project-based learning and they can design circuits when they apply their skills. At the end of the study, it was concluded that project-based robotic education supports students' lives and affects their science performance and their friendships positively.

Gibbes and Carson [10] investigated project-based language learning (PBLL) in a university language programme. Reflections of learners were analysed through activity theory. The analysis of the evaluations of PBLL but it showed that there are some contradictions in the activity system for human interaction.

5. Research Question

How does the PBL approach in a pedagogical agent assisted learning environment affects the students' achievements and attitudes in HCI course in theoretical and practical applications?

6. Methodology

In this section, research model of this study and analysis of the data is given with some details.

7. Research Model

The research was done in order to apply PBL Approach in Pedagogical Agent Assisted HCI course and to determine students' views. The students were asked to design a website for online education on museum studies and to do the analyses in this research which is carried out as a part of HCI course. The students were separated into groups and each group carried out their studies on the module they determined.

In order to determine the students' achievements in and attitudes towards the activities of PBL approach in pedagogical agent assisted learning environment, 'Project-Based Learning Attitude Scale, 'Pedagogical Agent Satisfaction Survey and 'Perception of Course Content Attitude Scale' developed by the researcher were applied. Five level likert scale is used in these questionnaires. Furthermore, chapter review tests were applied twice as pre-test and post-test before and after the pedagogical agent assisted learning in web medium.

8. Subjects

The study was done in the spring semester of 2010-2011 academic years on all students taking the HCI course. The participants consisted of 46 students, 13 females and 33 males, taking the HCI course in Software Engineering in Bahcesehir University, Faculty of Engineering. The participants were separated into 11 groups, each consisting of 2-6 students. The research was done in these 11 groups and each group was given the opportunity to carry out their own studies.

9. Data Analysis

In the statistical analysis of the data, in order to compare the pre-test and post-test success points, paired-samples t-test; to compare the attitudes and views of students according to their genders, independent-samples t-test, to compare the attitudes and views of students when different groups are considered, one-way analysis of variance (ANOVA) was used. Moreover, correlation coefficient was used in order to interpret the relationship between students' attitudes towards PBL and their success in HCI course projects. The statistical analyses were done on SPSS 17.0.

10. Results

In this section, results of this study in terms of the surveys and chapter review tests are provided.

10.1. Results of Project Based Learning Attitude Scale (PBLAS)

There was no significant difference between genders (t_{44}=1.537, p>.05) and different groups ($F_{10,35}$=.97, p>.05) in students' views on PBL approach was observed. Accordingly, we can also say that the relationship between gender and students' attitudes towards PBL is not statistically significant at the level of p<.05. And also, the relationship between different groups and students' attitudes towards PBL approach is not statistically significant between 95% confidence interval.

The final grades of the students were determined after the project presentations. The results of students' attitudes according to the PBLAS and final project grades are compared in order to examine the relationship between students' attitudes towards PBL and success in the course.

When Table 2 is analyzed, it can be seen that there is a positive direct relationship in .01 significance level (r=.440, p>.01) between the attitude average of students towards PBL approach and their final project grades. It can be said that students who receive instruction with PBL approach are pleased with the approach and their success improves with this approach.

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Table 1: Correlation between students' attitudes towards PBL approach and course achievements

		Project Grade	Attitude Mean
Final Project Grade	*Pearson's r*	1	.440[*]
	P	-	.002
	N	46	46
Student's Attitudes Mean Towards PBL Approach	*Pearson' r*	.440[*]	1
	P	.002	-
	N	46	46

Correlation is significant at the .01 level (2-tailed).

10.2. Results of Pedagogical Agent Satisfaction Survey (PASS)

There was no significant difference between genders in students' views on pedagogical agent assisted learning environment was observed (t_{44}=.321, p>.05).

Table 2: ANOVA results according to students' attitudes in PASS from different groups

	Sum Sq.	Std. Dev.	Mean Sq.	F	P
Between Groups	11.298	10	1.130	3.205	.005
Within Groups	12.337	35	.352		
Total	23.635	45			

According to Table 3, a significant difference was observed in students' views on pedagogical agent assisted learning environment when different groups were taken into consideration ($F_{10,35}$=3.205, p<.01). We can say that the relationship between different groups and students' attitudes towards pedagogical agent assisted learning environment is statistically significant between 99% confidence interval.

10.3. Results of Perception of Course Content Attitude Scale (PCCAS)

There was no significant difference between genders (t_{44}=1.210, p>.05) and different groups ($F_{10,35}$=1.284, p>.05) in students' views on perception of course content was observed. Accordingly, we can also say that the relationship between gender and students' attitudes towards perception of course content is not statistically significant at the level of p<.05. And also, the relationship between different groups and students' attitudes on perception of course content is not statistically significant between 95% confidence interval.

Table 3: Correlation between students' attitudes towards perception of course contents and course achievements

		Project	Mean Attitude
Final Project Grade	*Pearson's r*	1	.316[*]
	P	-	,032
	N	46	46
Student's Attitudes' Mean Towards	*Pearson's r*	,316[*]	1

| Perception of Course Contents | P | ,032 | - |
| | N | 46 | 46 |

* Correlation is significant at the .05 level (2-tailed).

The results of students' attitudes according to the perception of course content attitude scale and final project grades are compared in order to examine the relationship between students' attitudes towards perception of course content and success in the course.

When Table 4 is analyzed, it can be seen that there is a positive direct relationship in .05 significance level (r=.316, p>.05) between the attitude average of students towards the perception of course content and final project grades. It can be said that students who receive instruction with pedagogical agent assisted PBL approach are pleased with this approach and it improves their success.

Perception of course content attitude scale was applied to students as pre-test at the beginning of the semester in order to find out if students were aware of the course contents which are about the project steps in human computer interaction course. The same survey was applied to students again after students have finished their projects and have learned the project topics. The purpose was to check to what extent the course contents of project based HCI course was effective.

Table 4: Paired-samples t-test results according to the pre-test and post-test results for the course contents of project-based HCI course

	X	ΔX	N	Std. Dev.	df	t	P
Post-Test	4.2596		46	.45116			
		0.2294			45	2.518	.015
Pre-Test	4.0302		46	.52403			

The results of paired-samples t-tests results for the course contents of project-based HCI course are presented in Table 5 in order to determine whether there is a significant difference between the students' responses for pre-test and post-test results in perception of course content attitude scale.

According to these data, a significant difference between pre-test and post-test evaluations for perception of course content surveys was observed (t_{45}=2.518, p>.05). Therefore, we can say that the difference between pre and post test evaluations of perception of course content surveys is statistically meaningful between 95% confidence interval.

10.4. Results of Chapter Review Tests

Chapter review tests were applied to students as pre-tests before the chapters were covered in order to check the perception of course contents in web medium. The same tests were applied to students in the HCI course again after students covered chapter contents with pedagogical agent assisted online. The purpose was to check to what extent the pedagogical agent assisted instruction in web medium was effective.

Table 5: Paired-samples t-test results according to the pre-test and post-test results of chapter review tests

	X	ΔX	N	Std. Dev.	df	t	P
Post-Test Grade	6.1739		46	1.52300			
		1.13304			45	5.187	.000
Pre-Test Grade	5.0409		46	1.51529			

The results of paired-samples t-tests are presented in Table 6 in order to determine whether there is a significant difference between pre-test and post-test results. According to the data in the table, while the average grade of pre-tests was 5.04, the average grade of post-tests was 6.17; that is, there was an increase about 1.13 points between the tests.

According to these data, a significant difference between pre-test and post-test evaluations of chapter reviews was observed (t_{45}=5.187, p>.01). Therefore, we can say that the difference between pre and posttest evaluations of chapter review tests is statistically meaningful between 99% confidence interval.

11. Conclusions

The effects of PBL approach in pedagogical agent assisted HCI course on students' views and academic success were examined. The conclusions obtained with the help of sub-problems are listed below:

- There was no significant difference according to gender in the attitudes towards PBL approach of HCI students, to whom PBL method in Pedagogical Agent Assisted Learning Environment was applied; however, female students' attitudes towards PBL approach were a little higher than those of males.

- There was no significant difference according to groups in the attitudes towards PBL approach of HCI students, to whom Pedagogical Agent Assisted PBL method was applied.

- This conclusion may be related to the fact that the students was chosen randomly regardless of their academic levels, interests or genders.

- There was a significant positive linear relationship between the attitudes towards PBL approach and their final project grades of HCI students, to whom Pedagogical Agent Assisted PBL method was applied.

- It was observed that the students who were more successful in final projects had given more positive answers In PBL approach questionnaire. According to this result, it can be said that students, to whom PBL method in Pedagogical Agent Assisted Learning Environment was applied, are pleased with this approach; and the approach has positive effects on students' achievements.

- There was no significant difference according to gender in the attitudes towards Pedagogical Agent Assisted Learning environment of HCI students, to whom PBL method in Pedagogical Agent Assisted Learning Environment was applied; however, female students' attitudes towards Pedagogical Agent Assisted Learning Environment were a little higher than those of males.

- Significant differences were observed according to groups in the attitudes towards Pedagogical Agent Assisted Learning approach of HCI students, to whom Pedagogical Agent Assisted PBL Method was applied.

- This conclusion may be due to the fact that the Pedagogical Agent Satisfaction Survey was applied after the whole semester and during the semester students may have influenced each other's ideas in their own groups on Pedagogical Agent Assisted Learning Environment.

- There was no significant difference according to gender in the attitudes towards Perception Of Course Contents of HCI students, to whom PBL method in Pedagogical Agent Assisted Learning Environment was applied; however, female students' attitudes towards Perception Of Course Contents were a little higher than those of males.

- There was no significant difference according to groups in the attitudes towards Perception Of Course Contents of HCI students, to whom Pedagogical Agent Assisted PBL method was applied.

- This conclusion may be related to the fact that the students was chosen randomly regardless of their academic levels, interests or genders.

- There was a significant positive linear relationship between the attitudes towards the perception of course contents and their final project grades of HCI students, to whom Pedagogical Agent Assisted PBL method was applied

- It was observed that the students who were more successful in final projects had given more positive answers in Perception Of Course Contents attitude questionnaire. According to this result, it can be said that students, to whom PBL method in Pedagogical Agent Assisted Learning Environment was applied, are pleased with this approach; and the approach has positive effects on students' success.

- Significant differences were found out in the pre-test and post-tests evaluations for the Perception Of Course Content survey results in HCI course which is taught with Pedagogical Agent Assisted PBL approach.

- According to this result, it can be said that HCI course, in which PBL Approach in Pedagogical Agent Assisted Learning Environment was applied, had positive effects on students' achievements and students' attitudes towards the perception of HCI course's contents; and students were pleased with the approach.

- Significant differences were found out in the pre-test and post-tests evaluations of HCI students, to whom Pedagogical Agent Assisted PBL method was applied.

- According to this result, it can be said that HCI course, in which PBL method in pedagogical agent assisted learning environment was applied, had positive effects on students' achievements; and students were pleased with the approach.

According to this research, it can be said that HCI course in which PBL method in pedagogical agent assisted learning environment was applied, has influence on students' attitudes towards the course and their academic success. That PBL approach covering human-computer interaction in software engineering field may be effective in reaching the goals when used in classroom environment with pedagogical agent assistance is under consideration.

11.1. Recommendations on Future Researches

- This study was applied on a small sample group consisting 46 students. More meaningful results may be obtained with more crowded samples.

- In this study, we used pre-existing pedagogical agents that are already used in different studies. New pedagogical agents may be designed and their appearances may be changed according to the students' ages, genders or level of education.

- In next researches, it may be provided guidance applications by pedagogical agents and competencies of agents on project evaluation process may be developed.

- In this study, not just pedagogical agents was used, but also student-teacher relationship has used when it is necessary. Pedagogical agents' emotional and cognitive skills may be developed as student-agent relationship in classroom environments (Sound, Light, and Motion-Sensitive Pedagogical Agent Designs).

- The effects of project-based learning approach on students' success and attitudes were examined in this study. Project-based learning approach may be also examined in terms of features like logical thinking, permanency, creativity, self-sufficiency, cognitive intelligence, etc.

- The effects of project-based learning on HCI course was examined in this study; and the results promoted the use of project-based learning approach in pedagogical agent assisted learning environment. Within this context, similar studies may be applied in different disciplines and their results can be discussed.

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