



## Investigation of the Effect of Online Problem-Based Learning on Achievement, Attitude, Motivation, and Group Dynamics: A Systematic Literature Review

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### ABSTRACT

The current period is a period in which distance education applications are widely used and the effectiveness of distance education applications is examined in terms of different variables. In this study, various studies in the literature between the years 2015-2021 were examined and the effectiveness of the online problem-based learning approach on achievement, attitude, motivation and group dynamics was examined. A systematic literature review method was used to determine the effects of online PBL approach applications on students' academic achievement, motivation, attitude and group dynamics. Articles were obtained from Taylor & Francis Online, SpringerLink and WileyOnlineLibrary databases and were searched in "SCI", "SCI-E", "SSCI" and "Scopus" indexes. The search terms used within the scope of the research were determined as follows; "problem-based learning", "PBL", "e-PBL", "distance education", "online education", "web-based learning", "technology", "success", "attitude", "motivation". As a result of the systematic literature review, a total of 20 studies were reached in accordance with the criteria determined. The results show that the online problem-based learning approach has a positive effect on group interaction, has a positive effect on student achievement, and students have a positive attitude towards the online problem-based learning approach. In addition, it has been determined that the online problem-based learning approach has a significant effect on students' motivation. It is thought that the research findings can offer meaningful clues about online problem-based learning applications.

**Keywords:** PBL, online learning, achievement, attitude, motivation, group dynamics

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## 1. INTRODUCTION

The current period is a period in which distance education applications are widely used and the effectiveness of distance education applications is examined in terms of different variables. One of the approaches known to contribute to students' meaningful learning in science education is problem-based learning. Problem-based learning (PBL) is a student-centered approach that focuses on combining theory and practice using research, inquiry, and existing knowledge and skills to solve a problem.(Savery, 2015). With the rapid development of educational technologies in recent years, PBL has been applied online in various ways as well as in face-to-face education. In the literature, there are studies in which group studies and discussions are carried out through digital education environments such as Moodle (Yağcı, 2018), and microblogs (Huang et al., 2016), virtual games (Chang et al., 2020; Sancar-Tokmak & Dogusoy, 2020) that are effective in e-learning. According to literature PBL process is carried out online can increase the motivation of students (Chang et al., 2020; Sancar-Tokmak & Dogusoy, 2020; Liu et al., 2020), and positively effects academic achievement of the students (Yağcı, 2018; Sung et al., 2019). With the advances in technology, the interest in the use of technology in education is also increasing (Chan & Blikstein, 2018; Jong, 2019). Considering the place of technology and PBL in education, technology integration into the PBL approach is expected to have an impact on student achievement, motivation, group interaction, and attitude. In this context, within the scope of this study, various researches between the years 2015-2021 were examined and the effectiveness of the online problem-based learning approach on success, attitude, motivation, and group dynamics were examined.

### 1.1. Statement of the Problem

In the problem-based learning approach, the process includes both individual and group work of students (Schmidt, Rotgans, & Yew, 2019). In group work, where the problem is first analyzed, students' prior knowledge is activated. Then, the individual learning process takes place, in which students are responsible for their learning and various researches. After individual studies, students come together again, and this process provides further elaboration of what has been learned (Schmidt, et al.

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2019). Group work in PBL is an important factor in understanding the information about the problems (Schmidt, et al. 2019). An effective problem in PBL leads students to appropriate learning goals, encourages self-learning, develops critical thinking skills, encourages group work, and enables students to construct their knowledge by activating their prior knowledge (Sockalingam, Rotgans & Schmidt, 2010). In addition, teachers' socially compatible behaviors and being experts in the subject area also have an impact on student success (Schmidt, et al., 2019). Problem-based learning also increases student motivation and differences in student motivation can be measured by situational interest (Rotgans & Schmidt, 2012). Situational interest is an individual's immediate emotional response to certain stimuli in the learning environment. An unexpected or unknown problem situation encountered by students in PBL can increase students' curiosity and interest in the subject. Another situation that affects the motivation of students in the PBL process is that they carry out group work with their peers. In addition, when students choose the subjects they want to study and determine their learning goals in PBL, their motivation can be positively affected (Schmidt & Rotgans, 2012).

One of the cornerstones of problem-based learning is small group work. Group work based on socialization increases the output of an activity as it facilitates access to resources, accelerates the flow of information and gives a sense of belonging (Neyişçi & Erçetin, 2020). Students share, elaborate, integrate and apply the acquired knowledge by explaining, discussing and negotiating the subject content within the group (Schmidt, et al., 2011). Small group work also has positive effects on students' socio-emotional status and motivation. Since the problem in PBL is the focus of group work, students are forced to put more effort into completing the task while working with their peers. On the other hand, the acquisition of knowledge and skills in a training group relies heavily on individual learning. Therefore, group discussions in PBL are limited to the competencies of the students who make up the group. High-level students in the group can be an important resource in completing the group's task and may help some group members to perform better, but they can also reduce the motivation of other group members (Rogers & Feller, 2016).

According to Mbuva (2015), especially learning management systems (LMS) have developed online education and this development is an indicator of the effectiveness of these online tools. Therefore, it can be stated that online PBL applications are effective. However, in the use of these systems, difficulties such as accessibility to technology by all students, computer literacy, self-discipline requirements, and minimum social interaction should be considered. Cooperation and active participation of PBL especially support its compatibility with Web 2.0 tools and this can provide an effective infrastructure for ePBL (Buus, 2012). Although Manwa et al. (2014) showed that there was no significant difference between online PBL and routine PBL in terms of student outcomes, they emphasized that the advantages offered by Web 2.0 made online PBL more useful.

## 1.2. Purpose of the Study

Educators should analyze, evaluate and decide on appropriate curriculum and teaching methods to prepare students for real-life situations (Sungur et al., 2006). We need people who can think, solve problems, and make decisions based on evidence and logic. Problem-based learning is a student-centered pedagogical approach that integrates the knowledge that students have with the knowledge they have acquired in the problem-solving process. The advantage of this approach is that students become aware of how to use the knowledge they have acquired. In problem-based learning environments, students are faced with situations that require acting professionally, defining a poorly structured problem, developing hypotheses, accessing and analyzing data from different sources, reviewing the initial hypothesis with the collected data, developing solutions based on evidence and reasoning, and justifying it.

Based on the ease of access and use of technology, educators also want to benefit from technology in student-centered learning practices (Chan & Blikstein, 2018). The traditional method, according to PBL, is limited to papers on which group discussion, material research, and learning outcomes are difficult to collect and record. On the other hand, Means et al. (2009) think that online learning increases the usability of learning experiences for students and that teachers can bring together instructional content more cost-effectively and reach more students. For this reason, the study aims to examine the effects of the problem-based learning approach carried out with distance/online education on students' academic achievement, attitudes and motivations, and group dynamics by examining various studies between the years 2015-2021.

## 1.3. Problem of the Study

Within the scope of this research, it was aimed to examine the online PBL approach in terms of students' achievements, motivations, attitudes, and group dynamics variables, and the research questions were determined as follows; (1) Does the online PBL approach support the motivation of the students? (2) Does the online PBL approach contribute to student success? (3) How are students' attitudes affected online PBL approach? And (4) How is group dynamics in the online PBL approach?

## 2. METHODOLOGY

A systematic literature review method was used to determine the effects of online PBL approach applications on students' academic success, motivation, attitude, and group dynamics. Systematic literature review is the screening of all published studies related to the focus of the research, determining the criteria according to the purpose of the research and filtering the

studies in the literature according to these criteria, and synthesizing the findings that can answer the research problem (Davis, Mengersen, Bennett). & Mazerolle, 2014). This method allows to access a wide variety of studies in the literature related to a research problem and to synthesize them in detail. In this way, it can shed light on future research by revealing gaps in the literature (Kitchenham, 2004). The systematic literature review model defined by Kitchenham (2004) was used in this study. The process carried out by this model is explained below.

## **2.1. Planning**

The effect of the PBL approach on students' affective characteristics such as success, interest, and motivation has been studied and discussed for many years. However, there is very limited research in the literature on the question of whether these affective characteristics of students are similarly affected in cases where the online PBL approach is applied. It is aimed to shed light on future research by presenting a concrete and broad framework regarding the effect of the online PBL approach on students' affective characteristics of the findings to be obtained within the scope of this research.

### **2.1.1. Development of the systematic review protocol**

The search terms used within the scope of the research were determined as follows; "problem-based learning", "PBL", "online PBL", "e-PBL", "distance education", "online education", "web-based learning", "technology", "success", "attitude", "motivation", "group dynamics".

### **2.1.2. Determination of article selection criteria**

The following criteria were considered in the selection of the articles to be included in the research:

- The article should evaluate the effects and consequences of the use of problem-based learning in education.
- The article should focus on the use of online classroom management systems or ICT
- The journal should be published internationally and generally include studies on "educational technologies" and "problem-based learning".
- The article must have been published between 2015-2021,
- Articles must be written in English,
- The article should be accessed using the keywords; "problem-based learning", "PBL", "online PBL", "e-PBL", "distance education", "online education", "web-based learning", "technology", "success", "attitude", "motivation", "group dynamics".

## **2.2. Scanning**

Studies conducted between 2015-2021 in "Taylor & Francis Online", "SpringerLink" and "WileyOnlineLibrary" databases are classified as "problem-based learning", "PBL", "online PBL", "e-PBL", "distance education", "online education", "web-based learning", "technology", "success", "attitude", "motivation", "group dynamics" were searched systematically using the keywords in "SSCI" and "Scopus" indexes.

## **2.2. Reporting**

A four-stage selection process was carried out to determine the publications obtained as a result of the literature review. First of all, studies whose full text could not be reached and those that were not written in English were eliminated. Secondly, studies that did not apply the online problem-based learning approach or focus on the effectiveness of this approach were eliminated. Third, all full-text articles meeting the criteria were read in detail and it was determined whether they answered the research questions determined within the scope of this research. In this context, the method, sample, application processes and analyzes of the selected study were taken into consideration. The articles determined at this stage were labeled according to the research questions. At the last stage, the studies determined for examination were read in detail and crosswise, and those with similar findings were identified and reported. As a result of the systematic literature review, a total of 20 studies were reached in accordance with the criteria determined. Information about these studies is presented in Table 1.

Table 1.

*Selected Studies*

<b>Study</b>	<b>Purpose of the study</b>	<b>Procedures and analyzes</b>
Chang, et al. (2020)	It is to examine students' perceptions with a game-based learning educational software based on a problem-based learning strategy.	The PBGLQ questionnaire was used to gather information about students' perceptions, and paired sample t-tests were conducted to understand the difference between pretest and posttest.
Yağcı (2018)	To investigate students' attitudes towards programming and its impact on their academic achievement in an online problem-based learning environment.	Working Approach Scale, Attitude towards Programming Scale, and Academic Achievement Test were used in the data collection phase. T-test and covariance analysis were performed for statistical analysis.
Smith & Hung (2017)	To investigate the situation of children who have little access to technology outside of school on self-efficacy for PBL.	A pre/post-test was administered using the Self-Efficacy Scale. Data analysis was performed using the Mann-Whitney test and Pearson Goodness of Fit.
Wijnen, et al. (2018)	The aim of this study is to examine the relationship between the student-centered, problem-based learning (PBL) method and the motivation of law students.	An adapted version of the questionnaire and the Job-Related Basic Needs Satisfaction Scale were conducted to measure perceived autonomy, competence, and relationship. To compare both groups, MANOVA was used.
Rehmat (2020)	To investigate the effect of problem-based learning on students' content knowledge and critical thinking towards STEM.	STEM content assessments and a standardized critical thinking test were used for data collection. ANOVA was used for the analyses.
Kwon, et al. (2017)	It determined the types of learning behaviors exhibited by students during PBL activities and examined the relationship between these behaviors in content knowledge and achievements.	The data were collected with the application called MediaCore and screen video recordings. Pre-test and post-test consisting of 23 items were applied. Qualitative content analysis and correlation analysis were used.
Tokmak & Dogusoy (2020)	Explore how students solve a real-world problem by proposing an instructional design model in Second Life.	Data were collected through demographic and open-ended questionnaires, interviews, and students' logs. The data collected by the demographic survey were analyzed by descriptive analysis, and the data collected by the open-ended survey and SL diaries were analyzed by content analysis.
Chen, et al. (2019)	To develop and evaluate a group incentive mechanism in collaborative problem-based learning to improve learning performance, interactive relationships, group effectiveness, and cohesion of student groups.	Data were collected with an 8-item group effectiveness scale and a 13-item group compatibility scale. Independent samples t-test was used to determine whether the previous knowledge levels and learning performances of the control and experimental groups differed significantly.
De Jong, et al. (2017)	To compare the teacher's role in an online and face-to-face problem-based learning (PBL) session.	Data were collected through the baseline questionnaire on student characteristics, the final questionnaire on course content and setting, the teacher intervention profile scale, and the videotape of teacher interviews and group sessions. Frequency, arithmetic mean and standard deviations were calculated for quantitative data. The interviews were analyzed by narrative analysis. Video recordings were analyzed by content analysis by 2 experts.
Foo (2021)	To evaluate the proficiency of students who took PBL courses with the distance education approach during the COVID-19 epidemic and to compare them with the proficiency levels of the students who learned them with the traditional face-to-face education method.	A standard form was applied to assess the proficiency levels of participation, communication, preparation, critical thinking, and group skills, and grades were given by their teachers. Qualitative variables were analyzed with a chi-square test, continuous variables were analyzed with independent samples t-test.
Century, et al. (2020)	To explore the use of problem-based interdisciplinary modules that combine English language, science, and social studies courses with the Code.org "Basics" CS curriculum.	After Time4CS, the module application questionnaire and the attitude questionnaire were combined and administered online using Qualtrics. Correlation analysis was performed to evaluate the explainability of the variance in the dependent variable with the variance among teachers.
De Jong, et al. (2016)	It is to investigate whether the basic principles of PBL (learning should be constructive, self-directed, collaborative and contextual) are applicable in blended learning.	Qualitative data for cases 1 and 3 were collected through focus group interviews. Simple descriptive analyzes (such as frequency) were used for cases 1 and 2. Statistical analysis was used for case 3.
Chen, et al. (2021)	To examine how the integration of VR technology into PBL contexts affects students' motivation in learning English, problem solving and vocabulary acquisition.	For the quantitative data supported by the qualitative interview data, the scoring table, performance test, and motivation questionnaire developed by the researcher were used. Data were analyzed by ANOVA and ANCOVA.
Haruehansawasin & Kiattikomol (2017)	The impact of using scaffolding approaches to support low achievers in a problem-based learning environment is explored.	Data were collected with an evaluation form, worksheet and questionnaire, and variance analysis was used to determine the differences between the pre-test and post-test.
Huang, et al. (2015)	The aim of this study is to examine the effect of microblogging and blogging on the learning of students at different learning achievement levels.	The pretest-posttest differences for the data obtained with the questions prepared by the teachers and the satisfaction questionnaire were examined with the independent sample t-test and ANCOVA.
Martins, et al. (2018)	It describes a teaching approach based on the Problem Based Learning (PBL) methodology	Self-assessment and process evaluation questionnaires filled by students and teachers were examined with parametric tests.

	associated with the development of educational games to guide programming teaching.	
Manwa, et al. (2020)	To evaluate the design and implementation of an online PBL environment and related pedagogical activity for undergraduate speech/language pathology students.	To evaluate the academic performance of the students, their scores for written assignments, a questionnaire to examine their experiences with online PBL were used, and analyzed with parametric tests.
Liu, et al. (2019)	It is to investigate why secondary school teachers choose to implement a technology-enriched PBL program, the challenges they face, and the facilitation strategies they use to address these challenges.	Data were collected from teachers in semi-structured interviews and analyzed by content analysis.
Sung (2017)	To examine the learning effects of a learner-centered interactive e-book with a learning strategy.	Critical thinking disposition measurement, science learning approaches questionnaire, cognitive load questionnaire and, natural sciences learning achievement posttest were applied. Analyzed by ANCOVA and independent sample t-test.
Erickson, et al. (2020)	To compare face-to-face PBL and PBL applications for translation from different perspectives.	A semi-structured focus group interview and an online questionnaire consisting of open-ended questions were used. The data were analyzed by content analysis.

### 3. FINDINGS

#### 3.1 Achievement

Chen, Hung, and Yeh (2021) conducted a problem-based learning study with 2nd year mechanical and electrical engineering students in the compulsory applied English course (EFL). In the study conducted on the effect of virtual reality (VR) use on students' English vocabulary acquisition and problem-solving performance, the experimental group consisting of 42 people and using the VR-assisted PBL approach performed better than the control group students consisting of 42 people using the PBL approach without VR support. As a result, the integration of VR technology into the PBL approach supported the students in the experimental group to learn English vocabulary. In the study of Chang, Chung, and Chang (2020), it is aimed to implement Game-Based Learning (GBL) by using a problem-based strategy in the classroom environment to improve students' computer programming knowledge. Students' post-test scores for comprehension and application tasks are higher than their pre-test scores. This shows that students who learn through games get higher scores compared to the previous system. In the study, it was concluded that the use of GBL together with PBL can increase the performance of students in computer programming. It can be thought that the contribution of PBL and technology integration to students' higher-order thinking skills has a positive effect on student achievement. Another study (Yağcı, 2018) conducted with 41 students from the 2nd year Computer Education Department. In the study an online environment was created that allows group work and discussions over the Moodle platform to implement PBL activities, and results of the study showed that the use of technology in PBL increases the academic success of students.

In the case study of Martins, de Almeida Souza Concilio & de Paiva Guimarães (2018) involving 30 students in a Computer Science course, it was concluded that the use of PBL related to game development led to higher averages in the course and the creation of more complex projects compared to previous years. This supports the conclusion that the use of PBL with technology affects the academic achievement of students positively. Parallel with this finding, in the study of Liu, Shi, Pan, Li, Pan & Lopez (2019), a comprehensive multimedia-enriched PBL program called Alien Rescue (AR) was used and some teachers stated that this program is beneficial for students with special needs who are not normally successful in traditional classrooms. In another study whose sample consisted of elementary school students, Sung, Hwang & Chen (2019) worked with 46 fourth-year students taking the Natural Sciences Course at a primary school in Taipei City to understand the learning effects of a student-centered interactive e-book. In the study, the control group used a traditional interactive e-book, while the experimental group used an interactive e-book with a problem-posing guidance strategy. A significant difference was found between the mean learning achievement score of the two groups. These results showed that the experimental group outperformed the control group, indicating that the use of interactive e-books with a problem-based learning guidance strategy can effectively increase students' learning success.

In addition to studies showing that PBL and technology integration has positive effects on student success, some studies concluded that the use of technology integration PBL does not affect student success. One of the studies was conducted by Century, Ferris & Zuo (2020) with teachers and students investigated the use of problem-based interdisciplinary modules (Time4CS), which combines English Language Arts (ELA), science, and social studies courses with computer science (CS) education. The experimental group used Time4CS modules, while the control group did not use this module. According to analyzes no significant difference was found in the academic achievement results of the experimental group and the control group. In addition, the current study showed that the use of interdisciplinary Time4CS modules in the literacy block did not reduce achievement in ELA or science. In another study (Manwa, Bridges, Law & Whitehill, 2014) online PBL group and a traditional PBL group of 3rd-year undergraduate students from Hong Kong University were selected, and written homework scores were used to evaluate students' academic performance. When the homework scores of the groups were compared, no significant difference was observed between the academic performances of online and traditional PBL students. Parallel with this, Foo, Cheung & Chu (2021) worked with two groups (distance education vs face to face education) of 4th-year medical

students, and the study revealed that the students using distance education performed significantly lower than the students learning with the traditional approach. However, the training for the two groups were held at different times, and the students in the online training group continued their training during the Covid-19 pandemic.

### **3.2 Motivation**

In the study of Chang, Chung, and Chang (2020), game-based learning was implemented using a problem-based strategy in a classroom setting to improve students' computer programming knowledge. According to the statistical results announced, the students liked the game and felt motivated to play. According to another study by Chen, Hung, and Yeh (2021), a total of 84 participants, 42 of whom were electrical and mechanical engineering students in the 2nd year, were included in the compulsory applied English course (EFL) study. The control group used the PBL approach without VR support, while the experimental group used the VR-supported PBL approach. Participants completed the motivation questionnaire in this study. In the VR-assisted PBL approach, students were given opportunities to learn by searching for English words they did not know, and in this way, their English vocabulary related to the engineering field was expanded. This study shows that the visualization capacity of virtual reality improves the capacity to better recognize and remember English vocabulary. It was observed that the experimental group learning with the VR-assisted PBL approach had a higher level of motivation to learn English than the control group learning with the non-VR-assisted PBL approach. Interviews with students showed that students' motivation to learn English was positive, and this finding was also consistent with quantitative data. Two 6th grade computer classes in the mountainous regions of eastern Taiwan participated in the study by Smith and Hung (2017) with 32 students in both groups. The findings of this study reveal that the PBL approach supports students' self-efficacy. In the study, it was observed that the students in the experimental group had higher self-efficacy levels in completing the tasks than the students in the control group. The study by Liu, Shi, Pan, Li, Pan & Lopez (2019) explored the challenges middle school teachers face in technology-enhanced PBL and the facilitation strategies they use to overcome these challenges. Participants were 25 science teachers using a technology-enhanced PBL program designed for grade 6 space sciences. In this study, a 15-hour curriculum unit on 6th grade space science by Alien Rescue (AR) was used. The findings of the study show that in the PBL approach, teachers are motivated as they observe the increasing motivation of their students as they comprehend the content more deeply and apply higher-order thinking skills. Manwa et al. (2014), in their study comparing the online PBL group with the traditional PBL group, showed that based on the data they obtained from their students, online PBL could be as effective as traditional PBL learning. In this study, students who learned simultaneously with online PBL stated that they had fun and were more motivated. In another study, Sung, Hwang and Chen (2017) was designed a quasi-experimental study, and students in 2 branches were divided into control and experimental groups. An interactive e-book providing problem-posing guidance was used in the experimental group, and a traditional interactive e-book was used in the control group. The same learning process and learning content was carried out in both groups of students. The results of the study revealed that compared with the traditional interactive e-book learning mode, the interactive e-book with a problem-based learning guidance strategy can effectively support students' motivation to learn sciences. When we look at these studies, according to the study of Manwa, et al., (2014), the relationship between online PBL and traditional PBL is equivalent.

### **3.3 Attitude**

Chen, Hung, and Yeh (2021) examined how the integration of VR technology with PBL affected students' motivation to learn English, solve problems, and acquire vocabulary. The results of the research showed that the experimental group students had more positive attitudes towards English compared to the control group. Based on the results of this study, the researchers stated that the integration of VR technology into the PBL approach can support students' English learning and help them discover the importance of English in their future careers due to the positive attitude they will develop. In the case study of Huang, Huang, Wu, Chen, and Chang (2016), a micro-blog (Plurk) and PBL on the blog were conducted with four 7th grade students, 2 experimental and 2 control groups, from the center of Taiwan. The results showed that the students had a positive attitude towards the use of blogs in PBL. It has been emphasized that the use of blogs in the PBL process can help increase learning effectiveness. In another study, Smith and Hung (2017) studied a total of 32 students from two 6th grade computer classrooms in eastern Taiwan. In the field of computer education, self-efficacy was applied to investigate how ideas about one's abilities affect learning performance. The results revealed that the students in the experimental group had higher levels of self-efficacy than the students in the control group in sticking to and reaching their goals. This is thought to mean that the students in the experimental group exhibited a higher degree of persistence than the students in the control group in terms of reaching their goals. Chang, Chung, and Chang (2020)'s work, on the other hand, involves the application of Game-Based Learning (GBL) using a problem-based strategy in a classroom setting to improve students' computer programming knowledge. It has been stated that this learning process enables students to understand learning conditions and gaps, set learning goals, and achieve self-learning. 98 4th grade students participated in the study by Rehmat and Hartley (2020) which investigated the effect of problem-based learning on students' content knowledge and critical thinking towards STEM. It was thought that the change in students' content knowledge might be due to the shift in their attitudes towards STEM. The results show that PBL encourages active participation in learning and also encourages them to be reflective and creative. It was concluded that this continuous interaction with the authentic knowledge base and the practice of multiple skills over several weeks encourages students to develop a deeper interest in STEM content. In another study, Sung, Hwang, and Chen (2017) conducted a quasi-experimental study with 46 fourth-grade students in a primary school in Taiwan to understand the learning effects of a student-centered interactive e-book with a learning strategy. The results showed that there were

significant differences in approaches to learning science between the students divided into the experimental and control groups. A total of 30 students from three different classes in Computer Science participated in the study carried out by Martins, Concilio, and Guimaraes (2018). It was observed that students' positive and proactive attitudes during game development with the PBL method were evident, especially for autonomously seeking new information. In addition, an improvement was observed in the programming itself, in more detailed and organized codes. In a study conducted by Kwon, et al. (2017), it was observed that students who were active in discussion displayed more questioning behavior and less productive behaviors at a minimum level. In addition, it was concluded that students who exhibited more cooperative behaviors also exhibited more questioning behaviors but less productive behaviors. Foo, Cheung, and Chu (2021) conducted a research to evaluate the achievement and competence of students who took distance education PBL approach during the COVID-19 and to compare them with the traditional face to face education method. Although it was a difficult process for some, the research showed that students in the distance education group motivated to continue their education during pandemic.

### **3.4 Group Dynamics**

In the study of De Jong, Krumeich & Verstegen (2017), a case study was conducted to investigate whether the basic principles of PBL are applicable in blended learning. In the results of the study, it was found that face-to-face discussions were no different from online discussions, and the findings confirmed that collaboration is possible despite the distance. According to Sancar Tokmak and Dogusoy (2020), technology integration in PBL has positive effects on group interaction. This study aims to examine how novice education designers solve a real-world problem by presenting an instructional design model in a virtual game environment called Second Life (SL). According to the results of the interviews, all group members emphasized that they had the most effective and productive group working process in which they participated, as the group participants contributed equally to the study. The study of Chen, Wang & Zhao (2019) aimed to examine the effect of the group incentive mechanism (GIM) used in collaborative problem-based learning (CPBL) on the online platform on learning performance, interactive relationships, group effectiveness and cohesion of student groups. According to the results of the study, the learning performance of the experimental group was significantly different from that of the control group. GIM is more effective than IIM in improving PBL performance. The reason for this is thought to be because an individual student's having learning partners in a cooperative learning environment significantly affects the interaction and learning performance.

There is also a study in which both positive and negative results of online PBL were obtained in terms of group interaction. The sample of the study by Erickson, Neilson, O'Halloran, Bruce & McLaughlin (2020) consisted of 5 senior students and 3 Occupational Therapy students studying Speech Pathology at a university in Melbourne. According to the collected data, the participants stated that the depth of communication and discussion was negatively affected and that online PBL was negatively affected by group dynamics such as speaking up and was not as fluent as in face-to-face training. In addition, the participants also stated that they missed the social opportunities created by face-to-face meetings and non-verbal communication methods such as reading body language. However, it was stated in the study that the facilitator-student relationship was not adversely affected. Contrary to the negative thoughts in group interaction, the PBL trainer stated that he felt comfortable in an online teaching area and that the online training did not disrupt the dynamics at all. Some participants also stated that they feel confident in communicating and working in this environment. According to De Jong, Verstegen & Könings (2018), the online PBL application has assigned teachers the task of "chatting" as an extra task. In this study, two groups were studied, one face-to-face and the other with online sessions. A web conferencing tool was used for online sessions in the study. They also pointed out that this helped them communicate effectively. In the literature review, besides the studies on the positive effects of PBL and technology integration on group interaction, a study in which group interaction was negatively affected was also found. In the study conducted with 4th-grade medical students by Foo, Cheung & Chu (2021), two groups were studied in the same class. Distance education was used in the experimental group, and face-to-face education was provided in the control group. Instructors used a standard form to determine students' proficiency levels in five key areas: participation, communication, preparation, critical thinking, and group skills. As a result of the research, the performance of the experimental group of students who used the distance education method was lower than the control group of students who received face-to-face education with the traditional approach in evaluations of participation, communication, preparation, critical thinking, and group skills. However, the reason for this is that distance education students continued their education during the Covid-19 pandemic and thought that negative psychological effects may have affected their work performance.

## **4. RESULTS AND DISCUSSION**

Within the scope of the literature review, it was determined that the online problem-based learning approach had a positive effect on group interaction in general. The findings showed that collaboration is possible despite the distance in online PBL (De Jong, et al., 2017). It is possible to say that technology integration into PBL increases the interaction and communication opportunities between groups. In the study of Martins, de Almeida Souza Concilio & de Paiva Guimarães (2018), it is seen that group interaction helps the process to be more effective when virtual games are used together with PBL. To say how online PBL has an effect on group interaction for younger students, sufficient research could not be reached within the scope of this study. More studies need to be examined to comment on the positive or negative effects. In the studies examined as a result of the literature review, it is seen that online problem-based learning mostly has a positive effect on student success. The studies

examined consisted of participants from different age groups and different departments, and the studies showed similar results. In some of the studies examined, it was concluded that the use of technology-integrated PBL did not have a significant effect on student achievement. The fact that the increase in the success in the results of the studies examined the effect of the integration of PBL with technology on student success was also found at different grade levels in primary and undergraduate programs showed that this success was not due to the age group. In the same way, it is possible to deduce that success in different courses such as English lessons, computer programming lessons, science lessons, and natural science lessons may result from the technology-integrated PBL approach, not from the lesson. The results obtained from the literature review show that the participants have a positive attitude towards the online problem-based learning approach. Chen, Hung, and Yeh (2021) showed that by immersing students in realistic PBL contexts through virtual reality technology, they can develop positive attitudes towards learning English for specific purposes. The integration of VR technology into the PBL approach also affected the students' views about their future careers by developing positive attitudes. Similarly, in another study, Sung, Hwang, and Chen (2017) observed that when compared to the traditional interactive e-book, the interactive e-book with a problem-based learning guidance strategy increased students' willingness to science teaching and helped them experience positive learning outcomes.

### Research and Publication Ethics Statement

This study is a systematic literature review examining students' achievement, attitude, motivation and group dynamics of online problem-based learning approach. Data were not collected from students and teachers in any way, only the researches in the literature were accessed and examined comparatively. Therefore, no application was made to the Ethics Commission in this study.

### Contribution Rates of Authors to the Article

This study was carried out by single author.

### Statement of Interest

There is no conflict of interest in this study.

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