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# Effectiveness of Gamification on the Community of Inquiry Development in Online Project-based Programming Courses Conducted on Facebook

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**Abstract.** This study aims to explore how gamification elements influence the development of the Community of Inquiry (CoI) in an online project-based programming course conducted on Facebook. We formed student groups by using a quasi-experimental design from students studying in the computer science department. While both courses were project-based, the experimental group's project development process was enriched with gamification elements. We collected data from the CoI survey, transcript analysis of online discussions, and interviews with students. The results indicated that the use of gamification elements contributed significantly to students' social, cognitive, and teaching presence development. Besides, while a high level of CoI perception was created in both groups in the online project-based learning environment, the design and organization role of the instructor came to the fore in the gamified environment more.

**Keywords:** programming, project-based learning, gamification, community of inquiry, social presence, teaching presence, cognitive presence, asynchronous learning.

## 1. Introduction

Today, in many different parts of the world, programming activities are increasingly emphasized and included in programming curricula (Bocconi *et al.*, 2016; Passey, 2017). Programming is included in many levels of education from kindergarten to university (Lamagna, 2015; Brennan and Resnick, 2012; Kong and Wang, 2020; Weintrop and Wilensky, 2017). With the pandemic (COVID-19) process, programming courses using different teaching approaches such as teacher or student-centered, programming courses focusing on individual practices and courses conducted with groups based on the project began to be given online. The transfer of these courses, which are carried out by using different approaches, to the online environment has brought a number of problems. Besides learning how to program is difficult, time-consuming and boring to students (Aparicio *et al.*, 2018), there are also some differences in teacher-student, student-student and student-content interactions in online environments (Vlachopoulos and Makri, 2019). In online learning environments, students' participation (Stone, 2017), satisfaction (Tratnik *et al.*, 2019) and interaction are less than in face-to-face learning environments (Bali and Liu, 2018). In addition to the difficulties of programming, these limitations experienced in online environments can make learning programming even more difficult. In Turkey, there are application-oriented and project-based programming courses in the curriculum of an associate degree or undergraduate department related to computer science (Higher Education Institution, 2021; Ordu University, 2022). Efforts to use the project-based learning (PBL) approach for programming teaching are seen worldwide too (Huang, 2019; Younis *et al.*, 2021). In these courses, students mostly carry out their projects outside of the school individually or as a group. When there is a problem with the project, the students meet face to face with the instructor. However, during the pandemic process, these courses were moved to online environments and communications were provided synchronously or asynchronously. In courses organized within the framework of PBL, communications and interactions are very important for the execution and realization of projects. PBL having the feature of incorporating many different approaches, offers many advantages such as taking students to the center to be active in the process, being responsible for their own learning, connecting with real-life and learning by doing and living (Jeon *et al.*, 2014). While students take an active role in the process, they also need the active guidance role of the teacher. However, student and teacher roles can be affected by the synchronous or asynchronous communication and interaction factor in online environments (Chakraborty and Nafukho, 2015). Although asynchronous learning environments provide time flexibility for students to achieve learning goals (Simonson *et al.*, 2012) and to develop critical thinking in discussion environments (Stein *et al.*, 2007), there are some difficulties in students' interactions with their instructors, peers and content. In asynchronous learning environments, students' social presence (SP) decreases due to the lack of class participation, communication, compatibility, and intimacy (Shank and Doughty, 2002). SP is about students' communication and interaction with each other in an online environment (Shea and Bidjerano, 2009). When an effective communication environment is not established in online environments, students get bored, their motivation is low, and therefore they have problems in class participation (Kreijns, 2004). These problems also affect students' SP development (Wei *et al.*, 2012). In addition, due to the communication limitations, students receive later feedback from the instructors for the solution of the problems they encounter in the process, and this negatively affects the teaching presence (TP) of the students (Jin, 2005). TP is about students' communication with the instructor and the instructor's role in the course (Garrison *et al.*, 2010). Cognitive presence (CP) of students whose TP and SP developments are not adequately provided, also decreases (Jinks, 2009). CP is about students' constructing knowledge and critical thinking skills (Garrison *et al.*, 2010). CP is considered an important parameter in studies to determine student satisfaction (Alaulamıe, 2014). The development of these three presences plays an important role in the formation of Community of Inquiry (CoI) in online environments (Garrison *et al.*, 1999). These limitations to the formation of a CoI can make the execution and implementation of projects difficult for both teachers and students. Different approaches are recommended to achieve CoI development in online environments (Fiock, 2020). The gamification method in online learning is among the alternative methods recommended in CoI development (Utomo *et al.*, 2014).

Gamification is the use of game design components in non-game environments (Deterding *et al.*, 2011). Gamification elements are used to facilitate learning by encouraging students on difficult-to-learn subjects (Zichermann and Cunningham, 2011) and to encourage their participation in online environments (Muntean, 2011). Basic gamification elements such as leaderboard, badge and score increase learning success (Marczewski, 2015), motivate students (Davis and Singh, 2015), and support student participation (Ibanez *et al.*, 2014). Tunga and İnceoğlu (2016) state that components such as leaderboards and badges used in gamification of online learning environments have features motivating, encouraging to complete activities, and facilitating progress. Factors such as class participation (Furrer and Skinner, 2003), satisfaction (Tratnik *et al.*, 2019), motivation (Gamon, 2001) and communication (Jung *et al.*, 2002) affect learning performance. While the use of the gamification approach in online learning environments contributes to the development of these elements, it is thought that it will play an important role in the formation of CoI. Studies examining the effect of gamification on CoI development by using different environments are quite limited in the literature. These studies are conducted in a blended learning environment by using learning management systems (Mese and Dursun, 2019; Tzelepi *et al.*, 2020) and MOOC (Antonaci *et al.*, 2019).

The problems experienced in the pandemic have deprived students and teachers of real classroom environments. Universities have carried out their online education through different learning management systems. While these systems are considered suitable for sharing course content and live course applications, they may be limited in terms of communication and interaction between students and instructors. With the widespread use of social networks in recent years, applications such as Facebook, Twitter, and WhatsApp have been used for educational purposes to support learning and increase students' communication (Derakhshan *et al.*, 2015; Nazir and Brouwer, 2019; Zaina *et al.*, 2014). Keles (2018) used Facebook within the scope of the community service practices course and examined the students' sharing in the process. Facebook supported the development of the TP of both students and instructors, and Facebook's communication and socialization features directly contributed to the SP of students (Keles, 2018). This study aimed to examine the formation of the students' CoI in the project-based programming course conducted through gamification on Facebook.

In this study, we tried to answer the following questions:

1. What is the effect of gamification on students' perceptions of TP, SP and CP in programming courses conducted asynchronously within the framework of PBL?
2. What is the effect of gamification on students' TP, SP, and CP development in programming courses conducted asynchronously within the framework of PBL?

## 2. Literature Review

### 2.1. *Community of Inquiry Model*

SP, CP and TP development of students is considered as a prerequisite for creating CoI in online environments and realizing effective learning (Garrison *et al.*, 2010). In Fig. 1, there are educational experience components in CoI.

SP refers to the social interactions between individuals and the community atmosphere ensuring the realization of learning and achieving learning goals (Garrison *et al.*, 1999). CP can be considered as a measure of learners. This concept is expressed as the ability of each participant in CoI to construct, interpret and analyze the problems posed during the discussions (Garrison *et al.*, 1999). TP is handled such activities as designing the environment before the beginning of the course, planning the course, creating and managing a discussion environment, giving information (Anderson *et al.*, 2001), providing feedback and evaluating the process more related to the instructor (Ke, 2010). There are sub-components and indicators showing the developments of CoI components (Table 1).

Some suggestions have been presented in the literature for the formation of desired CoI in online courses. Fiock (2020) compiled the recommendations in the literature for designing suitable learning environments and conducting teaching activities. The

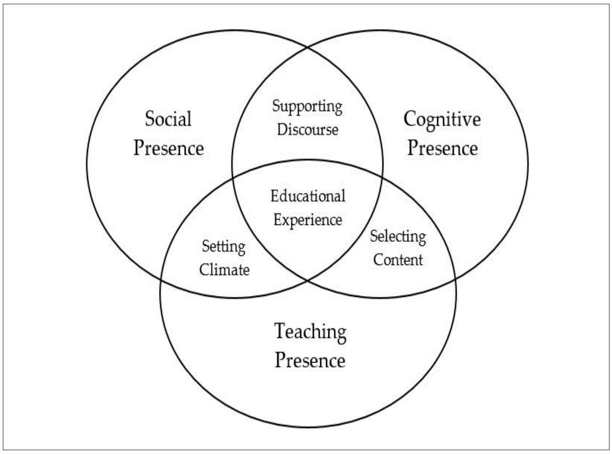



Fig. 1. CoI components (Garrison *et al.*, 1999).

teaching activities in this study were created and carried out within the framework of these suggestions (Table 2).

Table 1

Components of CoI model

| Elements | Category | Indicators |
|---|---|---|
| Cognitive Presence | Triggering event<br>Exploratory<br>Integration<br>Resolution | Sense of puzzlement<br>Information exchange<br>Connecting ideas<br>Apply new ideas |
| Social presence | Affective expression<br>Open communication<br>Group cohesion | Emoticons<br>Risk-free expression<br>Encourage collaboration |
| Teaching presence | Design and organization<br>Facilitating discourse<br>Direct instruction | Setting curriculum and methods<br>Sharing personal meaning<br>Focusing discussion |

Table 2

Appropriate teaching activities for CoI formation

| Suggested teaching Activities | Teaching activities carried out |
|---|---|
| Increasing student-peer interaction (Stewart, 2017)<br>Incorporating social software into course activities (Stephens and Roberts, 2017). | A group was created on Facebook and students were allowed to become members of the group. |
| Quick feedback to emails and messages (Watson *et al.*, 2017) | The instructor gave quick feedback to the students in the posts made via the institution e-mail or Facebook. |
| Creating discussion environments and encouraging students to share their experiences (Watson *et al.*, 2017).<br>Creating opportunities for students to solve their problems (Dunlap and Lowenthal, 2018). | Students were asked to share their projects on Facebook and other group members to express their opinions on these posts. |
| Being active in discussion environments and intervening on the spot (Watson *et al.*, 2017). | First of all, students were expected to produce solutions to each other's problems. Otherwise, suggestions for the solution were presented on time by the instructor. |
| Addressing students by their names (Lowenthal and Parscal, 2008). | The comments of the students were answered tagging by the instructor. |
| Designing collaborative activities and creating project groups (Richardson *et al.*, 2009).<br>Supporting group work or peer-assisted learning experiences (Redmond, 2014). | Students were divided into groups of two. |
| Constructing cooperative learning activities (Lowenthal and Parscal, 2008).<br>Provide a detailed syllabus with deadlines for all assignments (Richardson *et al.*, 2009). | The process and evaluation calendar of the project was established. |
| Creating video and audio lessons (Dunlap *et al.*, 2016)<br>Checking students' presentations (Richardson *et al.*, 2009). | Students presented their projects with audio, video and screen sharing. |

### 2.2. *Project-based Learning*

Based on the constructivist approach, PBL is a learning method in which students take an active role in the process and use different methods to find solutions to the problems encountered in daily life (Brundiers and Wiek, 2013; Krajcik and Shin, 2014). In this method, instead of informing students steadily, instructors ask questions, provide opportunities for thinking, and increase the desire to wonder to facilitate the students' process of realizing the project (Diffily, 2002). PBL encourages active participation in the course and increases success and motivation (Peng *et al.*, 2017). Although there are many opinions about the implementation steps of PBL, these opinions are similar (Katz and Chard, 2000; Moursund, 1999). These stages are:

(1) Determining the subject and groups.
(2) Preparing the project plan.
(3) Implementing the project.
(4) Planning the project display.
(5) Presentation of the project.
(6) Evaluating the projects.

In the literature, there are studies examining the development of CoI in PBL environments, albeit limited. Hsu and Shiue (2017) examined the formations of CoI in interdisciplinary PBL environments through collaborative technologies. The results of the study revealed that students' CP was positively affected by SP and TP. Guo *et al.* (2021) characterized the SP and CP of students in the online PBL environment within the framework of CoI and examined the relationship of these components with academic performance. The results of the research revealed that students used expressions of discovery and affectivity in group discussions intensively. It was also stated that some components of SP and CP were positively related to academic performance.

### 2.3. *Gamification*

Gamification is used to ensure the participation of users and to develop solutions to problems by using game thinking and game mechanics (Zichermann and Cunningham, 2011). Gamification elements consist of point, score, badge, aim and goals, leaderboard, feedback, reward, experience, achievement profile, difficulty, challenge, level, virtual goods and progress bar (Subhash and Cudney, 2018). Leaderboard, badge and score are among the basic gamification elements (Zichermann and Cunningham, 2011). In some studies, the effects of these elements on students' CoI development have been examined. Mese and Dursun (2019) used leaderboard, badge and score gamification elements in blended learning environments and they did not observe a difference in the CoI development of the students between the experimental and control groups. Tzelepi *et al.* (2020) stated that the badge and development indicators affected students' TP in the asynchronous discussion environment. Antonaci *et al.* (2019) gamified the MOOC environment to increase class participation and improve students' sense of community and SP. Research results showed that gamification positively affects students' SP, sense of community and learning performance.

## 3. Method

In this study, a mixed-method enabling the evaluation of both quantitative and qualitative data was used. We collected data using qualitative methods as an alternative to explain and support the data collected by quantitative methods within the framework of explanatory design (Creswell, 2011). The research design was a quasi-experimental design consisting of posttest measurements with a control group. While we were conducting programming activities within the framework of PBL on Facebook with both groups, we used gamification elements in the experimental group.

### 3.1. *Participants*

The research group consisted of 2nd-year associate degree students studying computer sciences at Vocational School. Before the course, we conducted a questionnaire to determine students' demographic characteristics (programming levels, programming languages knowledge, distance education experience). According to the survey results, we divided the students into two groups and randomly assigned the groups to the experimental and control group. We made a match by creating pairs of students within the framework of their demographic knowledge levels and assigned students to the groups randomly (Büyüköztürk *et al.*, 2017). There are 24 students each between the ages of 20–25 in the experimental (Male = 12, Female = 12) and control group (Male = 16, Female = 8). In studies examining the CoI development process, small participant groups are generally preferred to control group discussions and to carry out the process effectively (Akyol *et al.*, 2009; Akyol and Garrison, 2011).

### 3.2. *Data Collection Tools*

We collected the data on students' CoI perceptions with the CoI survey developed by Arbaugh *et al.* (2008) and adapted to Turkish by Öztürk (2012). Cronbach Alpha was calculated as 0.92 for TP, 0.88 for SP, 0.75 for CP, and 0.97 for the whole survey. The survey included 13 items for TP, 9 items for SP and 12 items for CP. We revealed the CoI developments of the students by examining the discussions on Facebook. We collected data from all students with a semi-structured interview form after the course to obtain detailed information about their perceptions towards the CoI. The questions focused on how students perceived their SP, CP and TP development in the course. We received the opinions of the students in writing via e-mail.

### 3.3. *Application Process*

We conducted the system analysis and design course on Facebook. The majority of the students expressed that they were using Facebook actively then, some of them had used it before. Applications carried out with both groups within a 14-week period are detailed in Table 3.

During the process, students shared textual and visual shares about their projects on Facebook. Peers made comments on these posts and feedback was given to both groups by the instructor. While the instructor shared documents about project planning

Table 3
Applications carried out weekly

| Weeks | PBL stages | Applications in the process [Experimental group (EG)/Control group (CG)] |
|---|---|---|
| Week 1 | Informing | Conducting the courses on Facebook was explained. (EG/CG)<br>Brief information on project-based learning and its stages was conveyed. (EG/CG)<br>Information was given on which gamification elements and how to use them. (EG) |
| Week 2 | Determination of subjects and groups<br>Creating individual or double groups<br>Determining the issues in relation to daily life<br>Choosing free project fields such as desktop, web, robotics etc. | Groups shared (EG/CG)<br>Topics shared (EG/CG)<br>Project topics were accepted or rejected by the instructor with their reasons (EG/CG) |
| Week 3 | Preparation of project plan<br>Stating the purpose, subject and justification of the project<br>Creating the project calendar | Sample project outline uploaded to the system (EG/CG)<br>Project plans were prepared and shared (EG/CG)<br>Students made comments and criticized each other's projects (EG/CG)<br>The instructor shared his evaluation of the comments and gave points (EG) |
| Between Week 4 and Week 11 | Implementation of the project<br>Project execution based on individual or group collaboration | The instructor provided feedback to the students (EG/CG)<br>Students shared the problems they encountered in the group (EG/CG)<br>Students offered solutions to problems related to the project (EG/CG)<br>The instructor evaluated the offers and gave points (EG)<br>Based on points, weekly leaderboard and badges received were published (EG) |
| Week 12 | Planning the project demonstration | The Schedule was prepared for project presentation (EG/CG)<br>Project presentations were created (EG/CG) |
| Week 13 and Week 14 | Presentation and evaluation of projects | Projects were presented (EG/CG)<br>Projects were evaluated (EG/CG)<br>CoI survey was applied and students were interviewed (EG/CG) |

and execution, students shared coding interfaces and project reports, especially after the process. The students carried out their projects individually or collaboratively with groups of two.

We used three gamification elements; points, badges and leaderboards in the experimental group. Students contributing to the solution of the problem by evaluating the critique and suggestions made by their peers towards the projects were given 1 point. These scores were added to the final grades of the students. The sample sharings of the students in the experimental group for the project and the evaluation of the instructor are shown in Fig. 2.

We published the leaderboard on a weekly basis according to the points of the students. On the leaderboard, we included the names of all the students who scored and the badges they received. We have offered an example leaderboard that we posted during the course and the types of badges we used in Table 4.

We used 4 different badges to reveal students' development levels. After graduation, vocational school students mostly work in software companies and develop projects for companies. Badge types emphasize the importance of individual programming experience in the project development process, being a part of the project group, and managing the group.

After 14 weeks of work, the experimental group completed 14 projects and the control group completed 16 projects. Students developed projects by using C #, Php, App Inventor, Android studio and Arduino software languages. With C #, projects such as face recognition system, pharmacy, realtor, parking, and market management were

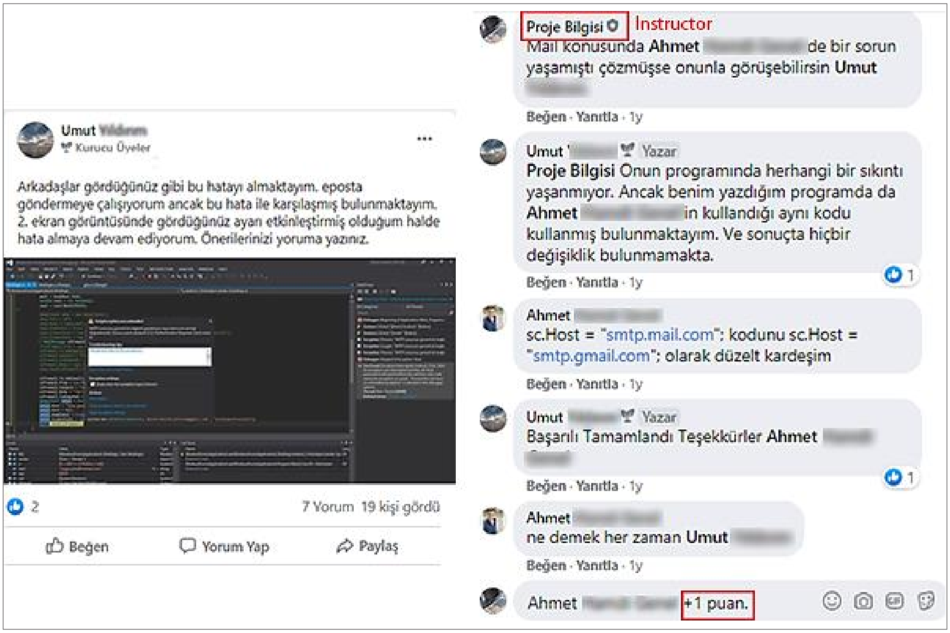



Fig. 2. Giving points to students by considering sharings.

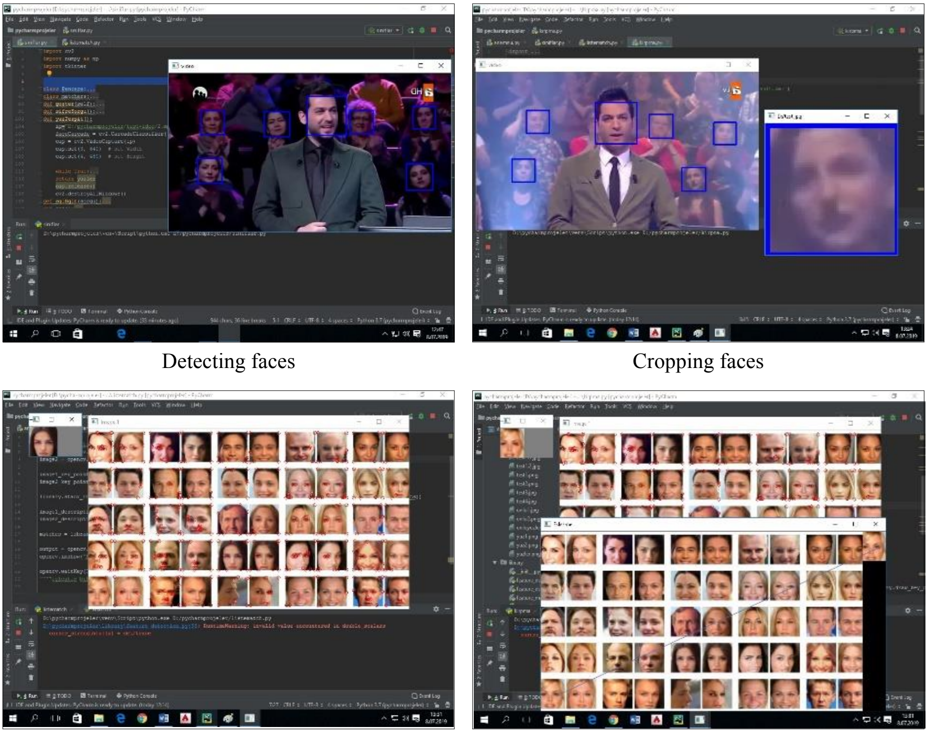
Table 4
Leaderboard and badges

| Rank | Name | Point | Level | Badge |
|---|---|---|---|---|
| 1 | Yasin | 6 | |  |
| 2 | Selçuk | 5 | |  |
| 3 | Zehra | 4 | | - |
| 4 | Umut | 3 | | - |
| 5 | Ahmet | 1 | | - |
| 5 | Neşe | 1 | | - |
| All badges | | | | |
| Beginner programmer | | | 5 points |  |
| Programmer | | | 10 points |  |
| Project developer | | | 15 points |  |
| Project manager | | | 20 points |  |

developed. With the php, projects such as fast taxi calling, car rental and dietician were introduced. With Arduino, projects such as the eyes of the disabled, unobstructed parking, child warning system, traffic lights, CNC drawing and tracking of kindergarten students were produced. Different projects such as balloon popping, ball adventure and educational children's games were developed by using Android Studio and App Inventor software. The face recognition system run by the student named Yakup and İzel is an example project that aims to automatically create a list by detecting the students participating in the course in the classroom (see Fig. 3). The project determines the faces of people individually or collectively with the camera system and compares the data obtained by referring to the distinguishing points on the faces with the database.

## 3.4. *Data Analysis*

By performing descriptive statistical analysis of quantitative data obtained with the CoI survey, SP, CP, and TP perceptions of both experimental and control group students were determined. We performed an independent t-test on normally distributed data to



Detecting faces | Cropping faces

Finding key points | Matching faces

Fig. 3. Steps followed in the face recognition system Project.

determine both the difference of the three presences between groups and the difference between the sub-indicators forming the presences. In addition, since the group size was less than thirty, we performed the Mann-Whitney U test and compared the accuracy of the results (Heumann *et al.*, 2016). Reliability analyzes were performed previously for the compatibility of the items in the questionnaire with the sub-components to which they were related, and it was determined that the reliability indices of the items were at an acceptable level (Kovanović *et al.*, 2019).

We analyzed the transcripts using a consensus-based coding approach with an instructor and using TP, SP, and CP templates (Garrison *et al.*, 1999; Garrison *et al.*, 2006; Anderson *et al.*, 2001). The analysis unit was determined as each message sent by the students and the instructor. During the first two weeks, there was no discussion environment due to information, group formation and determination of project topics and therefore these weeks were not included in the analysis. Among these messages, there were messages that did not fit into the categories in the templates. For example, the sharings of students about the school outside of the class and the posts they made during the project file uploading process at the end of the course were included in the group of uncategorized messages. First of all, two researchers made separate encodings for each of the three presences through Nvivo, and then we compared the codes and discussed the incongruity codes. To determine the agreement between researchers, calculated Cohen's Kappa reliability coefficient was found to be .75 ($p < .05$). We made descriptive analyzes of interviews with students. We presented the factors affecting CoI perceptions with student discourse frequencies. We provided direct quotations from students' discourses to explain some of the factors better.

## 4. Results

### 4.1. *Development of a CoI*

The total number of messages sent by the instructors and students was 320 in the gamified online environment (experimental group) and 182 in the normal online environment (control group). The number of uncategorized messages sent in the experimental group was 66 and 84 in the control group. We have not included the uncategorized message numbers in the sub-components ratios of the presences given in the progress tables. In presenting the findings, Akyol *et al.* (2009) were taken as reference. The developments of presences were shown at three-week intervals (see Table 4, Table 5, Tables 6). Using the three-week sub-category findings for each presence and the total findings of the three presences, we put forward the percentage rates.

By using the frequency values of each presence emerging from the transcript analysis, we created a scatter plot to show how the CoI as a whole developed in each group (Fig. 4).

As can be seen in Fig. 4, each presence in the experimental group improved much more than the control group. To access the data in the chart, we calculated the scores of each subcategory for each presence. Then, we determined the students' SP, CP and TP general development scores by adding the category scores. We also expressed progress points under each presence heading below.

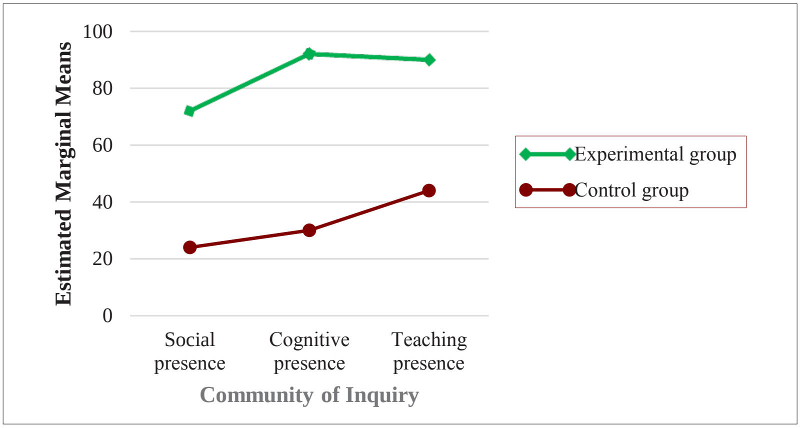



Fig. 4. Development of social, cognitive, and teaching presence in groups.

### 4.1.1. *Teaching Presence*

While the number of messages for TP in the experimental group was 90, it was 44 in the control group. The direct instruction stage in the control group and the design and organization stage in the experimental group were in the most frequently coded message category. In both groups, the messages for the design and organization component were the most intense in the first and last quarter of the course. In both groups, messages regarding the facilitating discourse and direct instruction stage were more intense in the first weeks.

The rates of messages sent according to sub-components of TP are given in Table 5.

We conducted further analysis to determine whether the differences between the two groups were statistically significant. We determined TP components (design and organization, facilitating discourse, direct instruction) as dependent variables and groups as independent variables, and applied an independent sample t-test to the data. While the test results were significant for the design and organization component ( $t(34) = 6.414$, $p = .000$ ) and facilitating discourse component ( $t(33.6) = 4.451$, $p = .000$ ), for the direct instruction component ($p = .331$) was not significant. Due to the small number of students in the groups, we also applied the Mann-Whitney U test to compare the differences. The results were significant for the design and organization component ($p = .000$) and the facilitating discourse category ($p = .002$) similar to t-test results.

### 4.1.2. *Social Presence*

While the number of messages included in SP was 72 in the experimental group, it was 24 in the control group. Affective expression is the most coded social presence component in both groups (49% in the experimental group and 40% in the control group). Most of the messages for SP were coded in the first parts of the course. Table 6 shows the message rates sent according to the sub-components of social presence.

The independent samples t-test results we made; For Affective expression category ( $t(33.4) = 7.199$, $p = .000$ ), for Open communication ( $t(34) = 3.639$, $p = .001$ ), and for Group cohesion category ( $t(34) = 2.491$, $p = .018$ ) indicated that the difference was significant. Mann-Whitney U test results were similar to t-test results (affective expression, $p = .000$, open communication, $p = .004$, group cohesion, $p = .029$).

Table 5

Comparison of coding results for teaching presence between groups

| Teaching presence | Between week 3 and week 5 | | Between week 6 and week 8 | | Between week 9 and week 11 | | Between week 12 and week 14 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CG | EG | CG | EG | CG | EG | CG | EG | CG | EG |
| Design and organization | 24 % | 41 % | 17 % | 35 % | 11 % | 28 % | 50 % | 74 % | 23 % | 42 % |
| Facilitating discourse | 17 % | 27 % | 17 % | 30 % | 22 % | 28 % | 17 % | 13 % | 18 % | 26 % |
| Direct instruction | 59 % | 32 % | 66 % | 35 % | 67 % | 44 % | 33 % | 13 % | 59 % | 32 % |

Table 6
Comparison of coding results for social presence between groups

| Social presence | Between week 3 and week 5 | | Between week 6 and week 8 | | Between week 9 and week 11 | | Between week 12 and week 14 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CG | EG | CG | EG | CG | EG | CG | EG | CG | EG |
| Affective expression | 34 % | 53 % | 42 % | 44 % | 50 % | 46 % | 100 % | 40 % | 40 % | 49 % |
| Open communication | 33 % | 26 % | 29 % | 28 % | 25 % | 36 % | 0 | 20 % | 30 % | 28 % |
| Group cohesion | 33 % | 21 % | 29 % | 28 % | 25 % | 18 % | 0 | 40 % | 30 % | 23 % |

Table 7
Comparison of coding results for cognitive presence between groups

| Cognitive presence | Between week 3 and week 5 | | Between week 6 and week 8 | | Between week 9 and week 11 | | Between week 12 and week 14 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | CG | EG | CG | EG | CG | EG | CG | EG | CG | EG |
| Triggering event | 23 % | 38 % | 23 % | 35 % | 28 % | 44 % | 100 % | 40 % | 27 % | 38 % |
| Exploration | 39 % | 33 % | 33 % | 31 % | 28 % | 31 % | 0 | 40 % | 33 % | 32 % |
| Integration | 23 % | 19 % | 33 % | 26 % | 28 % | 19 % | 0 | 20 % | 27 % | 21 % |
| Resolution | 15 % | 10 % | 11 % | 8 % | 16 % | 6 % | 0 | 0 | 13 % | 9 % |

### 4.1.3. *Cognitive Presence*

While the number of messages included in CP was 92 in the experimental group, it was 30 in the control group. Most of the messages in the experimental group were coded for the Triggering event and exploration components (Triggering event 38%, Exploration 32%). The least message was coded for the resolution component in both groups. In both groups, most of the messages were sent in the first half of the entire course section. Table 7 shows the message rates sent according to CP sub-components.

The independent samples t-test results we made showed that the difference was significant for the triggering event ($t(34) = 3.382$, $p = .002$), exploration ($t(34) = 2.780$, $p = .018$) and integration ($t(34) = 3.799$, $p = .001$) components. For the resolution component, the difference was not significant however ($p = .167$). Mann-Whitney U test results were similar to t-test results (triggering event, $p = .006$, exploration, $p = .020$, ıntegration, $p = .003$, resolution, $p = .265$).

## 4.2. *CoI Perceptions*

In this section, descriptive analysis results of students' SP, CP and TP perceptions (See Table 8) and their indicator scores (See Table 9) are given. In order to determine whether the results were statistically significant, we applied the independent samples t-test to the data.

Table 8

Students' perceptions of CoI components in both groups

| CoI components | Experimental Group (Online + PBL + Gamification) | | | Control Group (Online + PBL) | | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Deviation | N | Mean | Std. Deviation |
| Teaching presence | 24 | 3.35 | .43 | 24 | 3.17 | .56 |
| Social presence | 24 | 2.90 | .43 | 24 | 2.88 | .62 |
| Cognitive presence | 24 | 3.04 | .39 | 24 | 2.93 | .64 |
| CoI | 24 | 3.1 | .32 | 24 | 2.99 | .55 |

Table 9

Descriptive analysis of the sub-components of three CoI presences

| CoI | İndicators | Experimental Group (Online + PBL + Gamification) | | | Control Group (Online + PBL) | | |
|---|---|---|---|---|---|---|---|
| | | N | Mean | Std. Deviation | N | Mean | Std. Deviation |
| Teaching Presence | Design and organization | 24 | 3.61 | .39 | 24 | 3.30 | .60 |
| | Facilitating Discourse | 24 | 3.25 | .54 | 24 | 3.03 | .66 |
| | Direct instruction | 24 | 3.20 | .54 | 24 | 3.21 | .57 |
| Social Presence | Affective expression | 24 | 2.83 | .48 | 24 | 2.92 | .76 |
| | Open Communication | 24 | 2.90 | .42 | 24 | 2.81 | .76 |
| | Group cohesion | 24 | 2.96 | .59 | 24 | 2.93 | .62 |
| Cognitive Presence | Triggering event | 24 | 2.89 | .60 | 24 | 2.71 | .75 |
| | Exploratory | 24 | 3.18 | .55 | 24 | 3.06 | .72 |
| | Integration | 24 | 3.15 | .44 | 24 | 3.06 | .73 |
| | Resolution | 24 | 2.96 | .50 | 24 | 2.89 | .71 |

The descriptive analysis of the questionnaire data indicates that students in both groups have high perceptions of each presence, but students in the experimental group have slightly higher perceptions of all presences than students in the control group. In both groups, it is seen that students' TP is slightly higher than SP and CP; CP than SP. According to the results of the independent t-test applied to investigate whether the differences in perception occurring according to the experimental and control groups are statistically significant or not; there is no significant difference between students' perceptions of TP ( $t(50) = 1.276$, $p = .21$ ), SP ( $t(47.9) = 0.096$, $p = .92$ ) and CP ( $t(45.4) = 0.776$, $p = .44$ ).

All the sub-components of the students in both groups are at a sufficient level. According to the results of the Man-Whitney U test we applied for components score differences, there was a significant difference in favor of the experimental group only between the design and organization indicators ($U = 230.5$, $p = .048$).

After the analysis of the interviews, 80% of the students in the experimental group and 75% of the students in the control group expressed that they participated in the discussions by following all the posts on Facebook. The remaining students stated that they mostly follow the comments made about their own messages. In these interviews, 70% of the students in the experimental group and 60% of the students in the control group expressed that they benefited from the posts of the instructor and all others for the development of the projects. This situation indicates that in both groups, students followed the posts at a similar rate, but the experimental group students could benefit more from these posts. Statement of a student from the experimental group as “The fact that our instructor provided quick feedback to our problems on Facebook and posted frequently helped us to develop the project. I think this type of non-theoretical and applied courses can be conducted through media such as Facebook” emphasizes the contribution of the environment used.

In the interviews with the students, it was seen that the students agreed that the instructor took an active role in the project development process and this situation reflected positively on their TP perceptions. A student in the experimental group said about the instructor’s posts, “I steadily followed the feedback of my instructor about my project and the projects of other friends. These feedbacks helped me find my errors and improve my project in a more orderly manner.” Similarly, the statement of a student from the control group as “The feedback given by the instructor helped me. For example, I saw the deficiencies in my own project and completed them. In the answers given by the instructor to my friends, he was telling my friends’ deficiencies in their projects. In order not to perform these errors, I tried not to perform the same errors by considering what the instructor said to them”. The instructor’s feedback was helpful for correcting errors (5 students in the experimental group, 4 students in the control group).

In both groups, the instructor carried out activities for designing and organizing project-based programming activities. Regarding the instructor, students generally expressed that he provided instant feedback to the questions asked (6 students in the experimental group, 5 students in the control group), went through a planned and systematic process in programming by applying PBL steps (12 students in the experimental group, 10 students in the control group), provided clear statements about the work schedule and rules (8 students in the experimental group, 4 students in the control group). A student in the experimental group said, “The steps I followed gave me advantages in making the project step by step in a planned manner. In another project I will do in the future, I can make my project easier by following these steps” and mentioned the effect of implementing PBL steps. The statement of a student from the control group as “It was good that the instructor shared the information about how the course related to the project should be done and what to do on which dates. The project outline shared as an example gave me information about the titles I needed to create in my project”, demonstrates the instructor’s role in design and organization. Although it was more in the experimental group, there were efforts for communication and cooperation between the students in both groups, which reflected positively on the students’ perceptions of SP. Students following their friends’ posts and participating in the discussion environments expressed that they could increase communication by asking questions to their peers and instructors comfortably (6 students in the experimental group, 4 students in the control group). The statement of a student from the experimental group is “I followed and read all the posts one by one. I made comments on the parts I saw missing in the posts. I added the comments of friends who also commented on my own project, with the approval of the instructor." Students carrying out their projects as a group expressed that they could carry out their projects in cooperation, even from a distance. (7 students in the experimental group, 5 students in the control group). The statement of a student from the control group is: "When we were sometimes disconnected with my friend Kaan, we were able to do the project together from a far. Sometimes we got help from other friends by sharing the situations where both of us had difficulties. " The students reflected their feelings quite often in their posts, occasionally used humor, and called each other by their names.

The students in the experimental group shared more about their projects, and this situation was a trigger for the creation of discussion environments. In the interview with the students, they expressed that more different ideas emerged through discussion and this situation contributed significantly to the development of their projects (8 students in the experimental group, 5 students in the control group). The statement of a student from the experimental group is; "Commenting on shared projects and commenting on my project helped me to get new ideas and solve the problems I encountered during programming." The statement of a student from the control group as "When we had problems in the design and coding parts of the project, solutions from our friends made it very easy to solve these problems" points out that students' perception of CP is developing positively.

## 5. Discussion

Significant differences occurred between two groups in the categories of transcript analysis, design and organization, and facilitating discussion in terms of TP. The instructor took an active role in the process of determining the subjects and groups, and preparing the project plans which are the first stages of PBL. In both groups, more coding of messages to facilitate direct instruction and discussion in the first weeks may be an indicator of this situation. In the studies conducted, it was expressed that they need instructors' presence more in the early days in order to adapt to the environment better (Cleveland-Innes *et al.,* 2007). It is expressed that the role of an instructor in PBL studies is to increase the motivation of passive students by mobilizing them, providing feedback to them individually, finding resources, and acting as a guide for students to structure their knowledge (Frank *et al.,* 2003).

In the gamified environment, the students participating in discussions and contributing to the project development of their peers by commenting on the posts were given points by the instructor, and these students were announced weekly on the leaderboard. In addition, the badge developments of the students according to the points were followed and published. In this process, it can be said that the design and planning role of the instructor in the gamification group came to the fore more. In addition, behaviors such as encouraging students to discuss by components such as points and badges (Utomo *et al.*, 2014), the instructor's supporting of students' participation in the discussion, managing and evaluating discussions in this process are likely to occur more frequently. Tzelepi *et al.* (2020) in their study comparing badges as individual gamification award and development indicators as community gamification award in an online environment, expressed that both types of gamification affect students' TP. In the interviews, the students expressed that the instructor played an active role in carrying out the project development process in a planned and systematic way, detecting errors in student sharing, and managing the discussion environments effectively. Although students 'perceptions of CoI between the two groups did not differ significantly, the more students' discourse in the gamified environment indicates that the TP of the students in the experimental group improved a little more. The survey data revealed that the TP perceptions of the students in both groups developed sufficiently without any significant difference. Mese and Dursun (2019) obtained similar results in the blended learning environments they created by enriching them with gamification elements.

When the sub-components developments of TP within the groups are evaluated, the number of messages encoded in the direct instruction component in the control group is higher than the others. Compared to the experimental group, there was less discussion among the students in the control group and they made fewer comments about each other's posts. Therefore, we can say that the students in the control group need more direct education provided by the instructor. Anderson and Rourke (2002) expressed that peer-led discussions among students are more sensitive, more interesting, and more structured compared to instructor-led discussions. In this way, students undertake more instructional responsibilities (especially in terms of direct instruction) of instructors (Shea *et al.,* 2006).

According to the results of the transcript analysis, the SP of the students in the gamified environment has improved more than the normal environment. Significant differences arose among all SP categories. Although there were efforts for communication and cooperation between students in both groups, we can say that the fact that students shared more in the gamified environment and formed more discussion groups positively affected their social development. As in games (Prensky, 2003), gamification also increases learners' engagement to the environment (Muntean, 2011). As the gamified environment supported student participation (Utomo *et al.*, 2014), they sometimes made humorous discourses towards each other while their feelings were revealed more. While students in the gamified environment participated more in discussion activities (Utomo *et al.* 2014), this was an important factor also for the establishment of social interactions (Hamari, 2017). In the discussion groups, it was observed that students used Facebook's name tagging feature while answering each other. In this way, we can say that group harmony is formed among the students. Particularly in online learning environments, students' commitment to the learning process can be strengthened with gamification and students can interact with other users (Glover, 2013). In the interviews with the students, students in both groups expressed that they could increase their communication by asking questions to their peers and instructors comfortably and that they carried out their projects based on cooperation, even from a distance. The results of the survey indicated that the SP perceptions of the students in both groups were at a sufficient level.

According to the transcript analysis of the online discussions, the CP development of the students differed significantly. The number of messages coded for the CP of the students in the gamified environment was much higher than the other group. In this environment, most of the messages were coded for the Triggering event, Exploration and integration phase. The fact that the students in the experimental group shared more about their projects was a trigger for the problem situation to occur. The students made different suggestions to be taken into consideration for the shared project purpose and contents, and they tried to support their views by brainstorming in cases of conflict. In cases where there was a coherence between the groups in the discussions, the instructor gave extra points to the students who contributed to the discussions and steadily published the leaderboard and badges. In the literature, it is expressed that TP increases SP and CP (Garrison *et al.*, 2010). The active role of the instructor in the gamified environment enabled students to socialize through discussions and reflect their thinking skills to the environment. As in previous studies (Vaughan and Garrison 2005), the resolution phase is in the least coded message category in both groups. Students shared their project aims and contents in the first weeks. Other students examined the projects, made comments, and tried to contribute to the project. Although many ideas were revealed in this process, not much feedback was received at the point of feasibility of solutions during the implementation phase. The students expressed that the emergence of different ideas in the discussion groups contributed significantly to the development of the projects. In both groups, it was thought that conducting most projects with two-person groups through collaborative activities created deeper and more meaningful learning, and contributed to the perception of CP (Garrison and Cleveland-Innes, 2005). 70% of the experimental group and 60% of the control group students sharing and participating in the discussions expressed that the discussions made a significant contribution to the development of the project. Especially the point component was thought to encourage students to discuss and suggest different ideas (Utomo *et al.*, 2014).

In the project-based programming activities carried out on Facebook, students' perception of CoI was sufficient in both groups. Some students expressed that Facebook was an effective environment in project-based studies. Keles (2018) expressed that Facebook supported the TP of students and teachers, and the communication and socialization features of this environment directly contribute to the SP of learning groups. Nazir and Brouwer (2019) expressed that Facebook was an effective environment for students at higher education levels to form a CoI.

### 5.1. *Limitation*

With the pandemic process, all courses were conducted synchronously in online environments. For this reason, students' use of most of their internet quotas in these courses has also limited their duration of participation in Facebook. On the other hand, it is thought that this situation is not effective in the formation of developmental differences between the groups, since there were similar limitations for the students in both groups. Students' opinions about their sense of presence were received via e-mail. The lack of sense of spontaneity that emerges in face-to-face interviews in the data obtained by mail may have limited the obtaining of more descriptive and more detailed data.

## 6. Conclusion

This research aimed to explore the effect of gamification on CoI development of students in a project-based online programming course. According to the data collected by three different collection tools, significant differences occurred between the groups regarding the development of students' teaching, social and cognitive presence. Gamification has highlighted the role of the instructor in design, organization and facilitating discussions. The efforts of instructor to give points, create a leaderboard and badge board were trigger factors in ensuring the participation of students and creating discussion environments. This course process has shown that internet access status and internet quota limitations affect students' active participation in online courses. In the comments received via e-mail, some students stated that Facebook was an effective application in the conduct of application-based courses. It is thought that such applications with widespread usage networks and number of users around the world, will provide some advantages to practitioners in conducting online courses. Besides, based on the effect of gamification in an asynchronous environment, CoI development of students can be retested by using gamification components during the pandemic process, when the courses are mostly conducted synchronously in online environments.

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