Journal of Education and Learning (EduLearn)
Vol. 18, No. 3, August 2024, pp. 976~990
ISSN: 2089-9823 DOI: 10.11591/edulearn.v18i3.21349

Student engagement and academic achievement: the effect of gamification on case and project-based online learning

I Kadek Suartama[1], I Komang Sudarma[1], I Gde Wawan Sudatha[1], Adrianus I Wayan Ilia Yuda Sukmana[1], Ketut Susiani[2]
[1]Department of Educational Technology, Faculty of Educational Science, Universitas Pendidikan Ganesha, Singaraja, Indonesia
[2]Department of Basic Education, Faculty of Educational Science, Universitas Pendidikan Ganesha, Singaraja, Indonesia

Article Info

Article history:

Received Oct 11, 2023
Revised Nov 10, 2023
Accepted Nov 19, 2023

Keywords:

Academic achievement
Case method
Gamification
Online learning
Project-based learning
Student engagement

ABSTRACT

Education is a pivotal pillar in modern society, and technology has brought about major changes in how students learn. Online learning is becoming an increasingly popular form of education, especially since the coronavirus disease (COVID-19) pandemic broke out. However, the challenge of maintaining student engagement and motivation in online learning environments remains a concern for many educators. This is where the concept of gamification erupts as an innovative solution to this problem. This study aimed to examine the effect of case and project-based gamification models on student engagement and academic achievement in online learning in tertiary institutions. Quasi-experimental post-test only non-equivalent control group design was chosen as the method of this research. The subjects of this study were 117 students from Universitas Pendidikan Ganesha. The instrument used to measure student engagement was a questionnaire developed by researchers with reference to the online student engagement (OSE) indicator; meanwhile, an objective test was to assess student academic achievement. The data were analyzed using a one-way multivariate analysis of variance (MANOVA) technique. The study results show significant differences in student engagement and academic achievement between groups of students taught using case and project-based gamification models and direct e-learning models. Case and project-based gamification models used in online learning were effective in increasing student engagement and student academic achievement.

Corresponding Author:

I Kadek Suartama
Department of Educational Technology, Faculty of Educational Science, Universitas Pendidikan Ganesha
Udayana Road No. 11, Singaraja, Bali, Indonesia
Email: ik-suartama@undiksha.ac.id

1. INTRODUCTION

It has been argued that traditional learning approaches are unattractive and ineffective for gen-Z students [1]. They have different ways of processing and understanding information, enjoy the concept of teamwork and collaborative activities in learning, and become skilled, social, and energetic compared to previous generations [2]. Understanding the characteristics of students in this category has encouraged many researchers to design appropriate activities supporting their learning processes [3].

The use of information and communications technology (ICT) in learning, such as online learning, is increasing, especially during the recent coronavirus outbreak that hit the world [4], [5]. Teachers uploaded content and managed learning activities using various learning management system technologies such as Moodle [6], Google Classroom [7], WebQuest [8], Edmodo [9], Schoology [10], and various other non

learning management system (LMS) platforms [11]. However, the factor of teacher unpreparedness in designing and implementing interesting online learning was suspected to be the cause of the emergence of various problems in most parts of the world, including Indonesia [12].

Several problems were identified, such as theoretical, monotonous, and uninteresting learning materials [13], low learning interaction making students passive [14], students' lost interest and focus in learning due to self-study [15], the absence of challenging teamwork activities causing students to be unenthusiastic [16], and inability to achieve learning objectives through online learning [17]. Some of these obstacles can be used as a reference to find an innovative solution that can make online learning more interesting, challenging, fun, and meaningful for students. Learning that is fun and permeates students' daily lives is an important part of the student development [18]. Student engagement refers to the level of involvement, participation, and interest that students have in their learning and educational activities [19]. It is important for several reasons including academic success, motivation, retention, preparation for the future, overall well-being, and societal impact [20]. Pedagogical aspects such as interest, intention, motivation, and attitude are important in the behavior and involvement of students in the online learning [21]. These aspects can be improved through the provision of richer content/teaching materials [22], adaptive and challenging learning strategies or steps [23], and a learning environment that can improve student learning performance [24].

How to motivate and involve students in online learning is one of the biggest challenges in this digital era. Playing digital games is a hobby and routine among today's youth and adults in various regions [25]. Students generally do not like to do their daily learning tasks online for a long time but are willing to spend many hours playing games [26]. Efforts are needed to make delivery of material and learning activities that combine pedagogical principles with games [27]. The utilization of game elements (gamification) can be applied to motivate, entertain, and attract students so that learning objectives are still achieved [28]. Gamification has attracted much attention as a key aspect of underlying pedagogy that can increase student engagement and motivation in the learning [29]. The use of gamification in online learning is developing and increasingly popular [30].

Gamification as an implementation or practice of modern educational theory aims to maximize student satisfaction, motivation, success rate, and ability. This modern theory contains effective learning, which suggests that learning is most effective when it is challenging, fun, active, collaborative, skill-based, and incident/case-based [31]. Several active learning methods can be combined with game elements [32], [33]. Active or student-centered learning methods include the case method [34] and the team-based project learning method [35]. The case method is a constructivist learning approach in which real problems close to students' lives are presented in the learning [36]. Ali *et al*. [37] stated that the case method provides opportunities for students to: i) analyze cases and content, ii) increase exploratory knowledge by independently finding information, data, and literature, iii) improve critical thinking by solving the cases provided, iv) achieve better collaboration by finding answers that are discussed together, and v) increase opportunities to receive feedback through presentations and improvements. Cases presented in learning contain problems related to the environment, conditions, situations, or a picture of students' future [38].

Game elements can also be applied to project-based learning stages [39]. Project-based learning provides opportunities for students to explore, assess, interpret, synthesize, and information to produce various forms of learning outcomes [40]. Through this model, students carry out an in-depth investigation of a topic collaboratively and constructively to deepen learning with a research approach to problems and questions that are weighty, real, and relevant [41]. Collaborative and gamified online learning can generate positive emotions as motivation for students [42].

Designing and implementing gamification methods in the context of active (case-based and project-based) online learning is different from teaching in a (face-to-face) classroom, where lecturers usually easily manage students directly [43]. However, using the LMS technology, gamification in online learning can be developed [29], [44]. Research by Paľová and Vejačka [45] shows the benefits of an LMS that allows lecturers to easily send lesson plans, announcements, and assignments, create learning paths, provide feedback, give badges, distribute quizzes, and make interactions. LMS Moodle can increase student involvement in learning outside the classroom (online) and has a positive influence on student activity, motivation, thinking skills, and innovation [46]–[49].

In addition, after Moodle LMS is configured, it is possible to plan badges or awards that students can win after completing activities in the LMS. Besides, Moodle LMS has more functions that can be optimized in producing gamification in online learning. According to [50], some of the gamification implementations that can be done on the Moodle LMS are: i) giving points to students after accessing learning resources and completing activities/assignments, ii) providing various badges as a reward to students for the achievements obtained, iii) sending certificates and awards after completing all learning, iv) re-certifying at a certain time, v) displaying leaderboards in chart and diagram format, and vi) displaying the entire level to be achieved.

Moodle LMS offers various features that facilitate the gamification process in online learning; however, experience is still required to incorporate these features into existing learning materials and activities. In this regard, researchers have designed, developed, and validated the design of a gamification model in case and project-based online learning [51]. Furthermore, it is necessary to apply this model in experimental research to determine the effectiveness of this model in increasing student engagement and academic achievement. This research provides theoretical contributions in the form of alternative solutions to various problems that have arisen from online learning practices so far through the implementation of online learning model designs by applying game elements in active learning, especially the case method and project-based learning in tertiary institutions. The hypotheses (H1) were formulated for this study: i) there is a significant difference in student engagement between students taught using the case and project-based gamification model and those taught using the direct e-learning model and ii) there is a significant difference in student academic achievement between students taught using the case and project-based gamification model and those taught using the direct e-learning model.

2. METHOD

2.1. Research design

This research is experimental research that examines the effect of independent variables on the dependent variable. The independent variable in this study is the learning model, while the dependent variables are student engagement and academic achievement. Quasi-experimental posttest-only control group design by Shadish and Luellen [52] was used in this study to compare the treatment between the two groups, namely the experimental group and the control group. The experimental group applied special treatment, implementing a case and project-based gamification model. Meanwhile, the control group did not receive special treatment and only used the model that has so far been commonly applied in direct e-learning. The planning of this research can be seen in the Table 1. Where X: treatment (using case and project-based gamification models); -: did not receive treatment (using direct e-learning); 01: posttest of student engagement of the experimental group; 02: posttest of academic achievement of the experimental group; 03: posttest of student engagement of the control group; 04: posttest of academic achievement of the control group.

Table 1. Research design

Group	Treatment	Posttest
Experiment	X	01 02
Control	-	03 04

2.2. Participants

The subjects of this study were students from various educational study programs at the Universitas Pendidikan Ganesha, Indonesia. They are enrolled in the teaching materials development course where this course is a cross-program course in the even semester of the 2022/2023 academic year. A total of 117 students were divided into four classes (two classes were experimental classes, while the other two classes were control classes). The experimental class consisted of 64 students: 23 boys and 41 girls, while the control class consisted of 53 students: 20 boys and 33 girls. The experimental class and the control class were determined using a random class sampling technique, assuming that all subject classes were homogeneous after the class equivalence test was carried out.

2.3. Procedures

The researcher conducted direct research on the class designated as the experimental class and the other class as the control class. In the experimental class, the researcher implemented a case and project-based gamification model; meanwhile, in the control class, the researcher implemented the direct e-learning model. Prior to implementing the learning model, researchers conducted measurements on student engagement and academic achievement for the two research subject groups simultaneously. This enabled the researcher to see how far the level of student engagement and academic achievement was before the experiment. Then the researcher carried out learning activities for the experimental class and the control class.

In the experimental class, the case and project-based gamification model was applied to the course, i.e., the development of teaching materials. In this case, the role of the researcher was only as a facilitator. Students built their activeness, involvement, and knowledge according to the principles and stages of the

model applied. The case and project-based gamification learning in teaching material development courses follows the structure of the designed model as shown in Figure1.

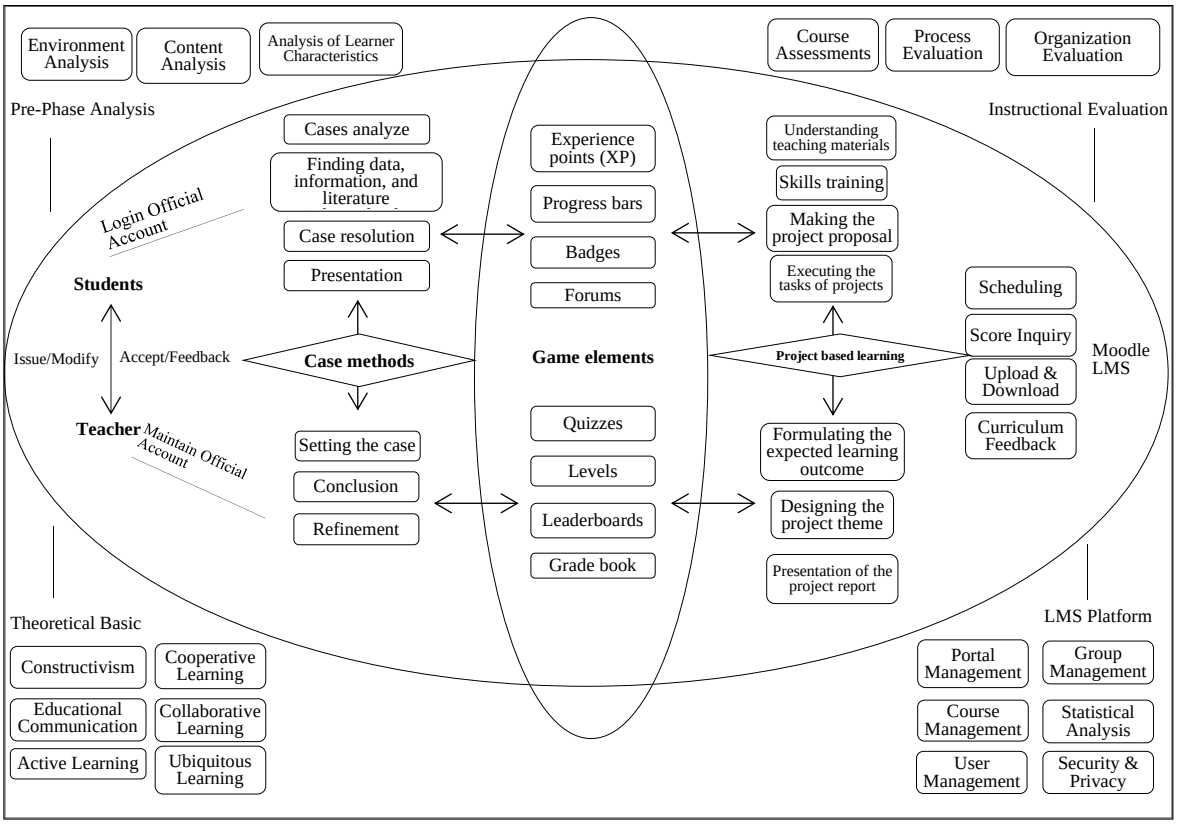

Figure 1. The structure of the case- and project-based gamification model in online learning

Figure 1 shows the structure of the model design that has combined aspects of pedagogy and technology. The gamification strategy was applied to the teaching materials development course, a cross-study course in general education programs for undergraduate degrees. Activities and resources in the e-learning course refer to the stages of the case methods method with the steps: i) defining cases, ii) analyzing cases, iii) independently finding information, data, and literature, iv) determining the completion steps of cases that have been provided, v) making conclusions from the answers discussed together, vi) making presentations, and vii) making improvements. Furthermore, the method of the project based consists of the steps: i) formulating the expected learning outcome, ii) understanding the concept of the teaching materials, iii) conducting skills training, iv) designing the project theme, v) making the project proposal, vi) executing the tasks of the project, and vii) presenting the project report.

Moodle LMS platform was used to build a gamification strategy for all stages of case and project-based learning models by adding game elements. Researchers installed Moodle version 3.2, including the "level up!" block, an additional plug-in for gamification (https://moodle.org/plugins/block_xp), on the web server. Researchers used the basic Moodle activities and resources module for the site to manage courses. Moodle's built-in gamification features and "level up!" blocks were applied to build gamification elements. The built-in and additional features of this system were also implemented to build game elements, such as experience points (XP), levels, badges, leaderboards, and progress bars used at each step of case and project-based learning.

Meanwhile, for the control class, learning activities were carried out using the direct e-learning model. In this learning model, the students obtained main course and enrichment materials, accessed the assignments, and sent answers to lecturers. The learning materials/topics were the same in both classes, focused on developing teaching materials. After all the learning stages were carried out on the two learning models, the researcher gave student engagement questionnaires and learning achievement tests at the end of the lesson to determine the success rate of these models in learning.

2.4. Instruments

To get the right research data, quality instruments were needed to explore what was desired. Activities carried out by researchers to obtain instruments that have good quality are: i) document analysis, ii) manufacture of specifications table (lattice), ii) consultation with experts (materials and media), iv) consultation with colleagues, v) instrument writing, vi) instrument validation, and vii) instrument trial. Student engagement instruments were developed by researchers referring to online student engagement indicators by Dixson [53], including i) skills, ii) emotions, iii) participation, and iv) performance. This instrument consists of 25 questions in a questionnaire prepared using a Likert scale. The student engagement score for each student was calculated by the formula (actual score: ideal score) x 100%. The outline of the student engagement questionnaire is shown in the Table 2.

Table 2. Outline of the student engagement instruments

Skill	Emotion	Participation	Performance
1. Study regularly	1. Put forth effort	1. Have fun in online chats, discussions or via email with the instructor or other students	1. Do well on tests
2. Staying up on reading	2. Find ways to make materials relevant	2. Participate actively in forums	2. Get good grades
3. Look over class notes	3. Apply to my life	3. Help fellow students	
4. Be organized	4. Find ways to make material interesting	4. Engage in online conversations	
5. Listen/read carefully	5. Really desire to learn	5. Post regularly in forum	
6. Take good notes over readings, PPT, Video			

Learning achievement instruments aim to measure factual, conceptual, principle, and procedural mastery/knowledge regarding the conception of teaching materials, steps in developing teaching materials, and the ability to evaluate formative and summative teaching materials. The learning achievement instrument used is an objective test (multiple choice) with one correct answer. The total number of questions is 50 items with 5 options/choices. Score 1 is given if the answer is correct, and score 0 is given if the answer is wrong. The amount of each student's learning achievement score was calculated by the formula (actual score: ideal score) × 100%. The lowest score will get 0, and the highest score will get 100.

Both instruments have gone through expert validation and have been tested on 90 students. From the calculation of the corrected item to the total correlation validity of the items/statements on the student engagement questionnaire, it can be explained that the 25 student engagement instrument items were in the range of 0.261 to 0.676, and the 50 learning achievement instrument items were in the range 0.211 to 0.608. Therefore, they have fulfilled the validity test requirements because each item has a total item correlation value greater than the r table value (0.207). Thus, both instruments could be used in collecting research data.

Furthermore, the level of reliability was tested with the alpha coefficient (alpha Cronbach). The instrument is considered eligible if it has a high level of reliability. The interpretation of the reliability coefficient in this case refers to Allen *et al.* [54], namely: very high (0.80 to 1.00), high (0.60 to 0.79), moderate (0.40 to 0.59), low (0.20 to 0.39), and very low (0.00 to 0.19). From SPSS calculation, the reliability of student engagement instrument with 25 items obtained a Cronbach alpha value of 0.904. Furthermore, the reliability of the learning achievement instrument with 50 items obtained Cronbach's alpha value of 0.907. When referring to the interpretation of the reliability coefficient as mentioned by Allen *et al.* [54], it can be seen that the reliability of the student engagement questionnaire with 25 items and the reliability of the learning outcomes test with 50 valid items are included in the very high category, and this means that the reliability is acceptable for use in research.

2.5. Data analysis

Data analysis techniques are divided into two parts. The first part is data analysis to test the analysis requirements, and the second part is data analysis to test the research hypothesis. Analysis requirements include data normality tests and data homogeneity tests, while hypothesis testing uses multivariate analysis of variance (MANOVA) tests.

2.5.1. Requirements analysis test

To test the analysis requirements, the data normality test and variance homogeneity test were carried out. The data normality test used the Kolmogorov-Smirnov technique, while the variance homogeneity test used the Levene test. The data normality test and variance homogeneity test were used to fulfill all parametric assumptions.

2.5.2. MANOVA test

Analysis to test the research hypothesis was carried out using MANOVA, referring to Kerlinger and Lee [55]. MANOVA is a statistical technique used to calculate the significance test of the mean difference simultaneously between groups for the two dependent variables. This technique is useful for analyzing the dependent variable with interval and ratio scales. In this study, the dependent variable is student engagement and learning achievement. MANOVA analysis technique in this study used SPSS program with a significance level of $\alpha = 0.05$. The decision is determined if the sign value >0.05, then H_0 is accepted; while if the sign value <0.05, then H_0 is rejected.

3. RESULTS

3.1. Description of research results data

3.1.1. Description of data on student engagement and academic achievement measurement results before treatment

The recapitulation of the results of measuring student engagement and academic achievement before treatment is shown in the Table 3. Table 3 shows that students in the experimental class obtained a score of 66.16 with a standard deviation of 4.14 on the average initial student engagement score. Moreover, the test on learning achievement obtained a score of 60.08 with a standard deviation (Std. dev) of 6.82. Meanwhile, students in the control group scored 66.25 on average initial student engagement with a standard deviation of 3.95 and an average learning achievement test score of 60.34 with a standard deviation of 6.53.

Table 3. Student engagement dan academic achievement before treatment

Group	Student engagement		Academic achievement	
	Average	Std. dev	Average	Std. dev
Experimented class	66.16	4.14	60.08	6.82
Controlled class	66.25	3.95	60.34	6.53

Therefore, there is no significant difference shown in student engagement and learning achievement between students in both the experimental and control classes. This illustrates that the ability of the research subjects before the study was not significantly different. The results in Table 3 were then analyzed using an independent sample t-test to understand how significant student engagement and initial learning achievement were before the case and project-based gamification models were implemented in the experimental class and the direct e-learning model in the control class. The results of the analysis of differences in student engagement and student achievement before being taught using the two models are presented in Tables 4 and 5.

Table 4. Result of the t-test of initial student engagement and academic achievement pretest

	Learning model	N	Mean	Std. deviation	Std. error mean
Student engagement	Experimented class	64	66.16	4.141	.518
	Controlled class	53	66.25	3.951	.543
Academic achievement	Experimented class	64	60.08	6.827	.853
	Controlled class	53	60.34	6.531	.897

The SPSS output on group statistics, as presented in Table 4, shows that 64 students obtained an average student engagement score of 66.16 in the experimental class. 53 Students obtained an average of 66.25 in the control class. Furthermore, the average values of academic achievement are 60.08 in the experimental class and 60.34 in the control class. Table 5 shows Sig Levene's Test scores of 0.737 in student engagement and 0.663 in academic achievement. Both significance values are greater than 0.05, meaning there was no difference in the variance of initial student engagement scores and learning achievement (pretest) between the experimental and the control classes. Therefore, the test can be carried out using an independent t-test assuming homogeneous data (assuming variance is the same). The t-test results for the initial student engagement scores between the experimental class and the control class showed a significance value of 0.906 ($p>0.05$, H_0 is accepted), meaning that there was no significant difference in the initial student engagement scores between the two classes. Moreover, the independent t-test for learning achievement scores (pretest) between the experimental class and the control class obtained a significance value of 0.834 ($p>0.05$, H_0 is accepted), meaning that there was no significant difference in learning achievement (pretest) between the two classes. In other words, before treatment with the application of case and project-based gamification models and direct e-learning models, student engagement and student learning achievement in the experimental and control classes were not significantly different or relatively the same.

Table 5. Independent sample test

		Levene's test for equality of variances		T-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Upper	Lower
Student engagement	Equal variances assumed	.113	.737	-.118	115	.906	-.089	.753	-1.581	1.403
	Equal variances not assumed			-.119	112.677	.906	-.089	.750	-1.575	1.397
Academic achievement	Equal variances assumed	.190	.663	-.210	115	.834	-.261	1.243	-2.724	2.201
	Equal variances not assumed			-.211	112.594	.833	-.261	1.238	-2.715	2.192

3.1.2. Description of data on student engagement and academic achievement measurement results after treatment

The results of measuring student engagement and academic achievement show students' scores on the student engagement questionnaires and academic achievement tests after the students taught using case and project-based gamification models and direct e-learning learning models. The student engagement and academic achievement scores after the treatment are presented in the Table 6. Table 6 shows that in the experimental class, the average student engagement score was 90.53 with a standard deviation of 4.313, and academic achievement reached an average of 86.92 with a standard deviation of 4.671. As for the group of students in the control class, the average student engagement score was 79.47 with a standard deviation of 3.603, and academic achievement reached an average of 75.70 with a standard deviation of 5.297. A clearer description of student engagement scores and student academic achievement in teaching material development courses based on the applied learning model (case and project-based gamification model and direct e-learning model) for students is presented in Figures 2 and 3.

Table 6. Student engagement dan academic achievement after treatment

Group	Student engagement		Academic achievement	
	Average	Std. Dev	Average	Std. Dev
Experimented class	90.53	4.313	86.92	4.671
Controlled class	79.47	3.603	75.70	5.297

3.2. Analysis requirements testing

Analysis requirements testing determines parametric feasibility before testing the hypothesis. The analysis requirements testing for the multivariate test consists of a normality test and a homogeneity test. The presentation is preceded by testing requirements analysis or testing assumptions, then followed by hypothesis testing activities.

3.2.1. Data normality test on student engagement and academic achievement based on the learning model

Kolmogorov-Smirnov statistical test at a significance level (α) of 0.05 was used to test the normality of data for each treatment group. This test determines the normality or symmetry of the distribution of scores as a unit of analysis, namely student engagement scores and student academic achievement in teaching material development courses. The null hypothesis (H_0) in the data normality test states that the sample comes from a normally distributed population. If the significance or probability value is less than 0.05, the data distribution is not normal. Meanwhile, if the significance or probability value is more than 0.05, the data distribution is normal. The results of the normality test for student engagement and student academic achievement data in the teaching material development course with the case and project-based gamification model and the direct e-learning model are presented in the Table 7.

Table 7 shows that the student engagement scores in the experimental and control classes obtained a significance value (probability) of 0.066 and 0.067 (>0.05). Likewise, with the value of academic achievement, the output table for statistical test results with SPSS shows that the significance value (probability) was 0.200 (>0.05) for the experimental class and 0.073 (>0.05) for the control class. Therefore, the final grades of student engagement and academic achievement in the experimental and control classes were normally distributed.

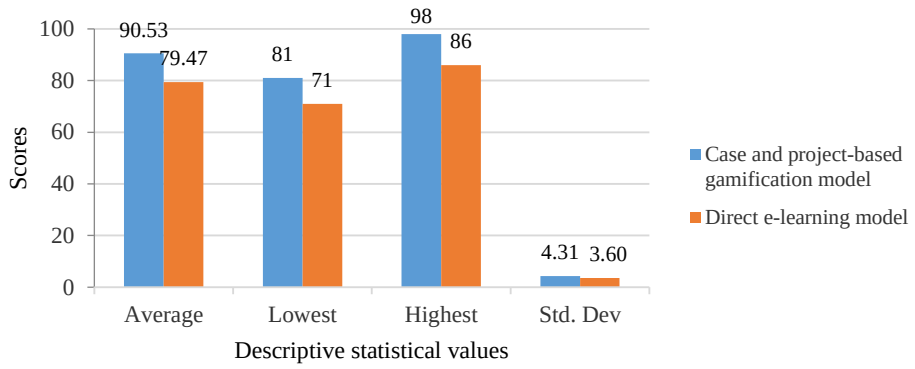

Figure 2. Histogram of student engagement in groups of students taught using the case and project-based gamification models and direct e-learning based on average scores, lowest scores, highest scores, and standard deviation

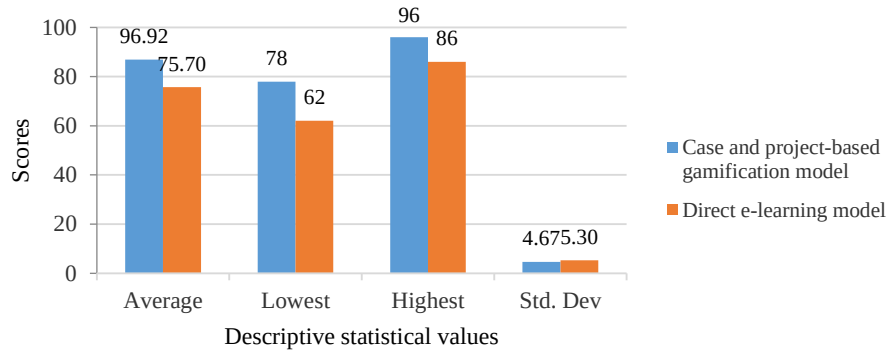

Figure 3. Histogram of academic achievement in groups of students taught using the case and project-based gamification models and direct e-learning based on average scores, lowest scores, highest scores, and standard deviation

Table 7. Data normality test results

	Learning model	Kolmogorov-Smirnov (a)			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Student engagement	Experimented class	.107	64	.066	.971	64	.132
	Controlled class	.117	53	.067	.975	53	.319
Academic achievement	Experimented class	.081	64	.200(*)	.974	64	.190
	Controlled class	.116	53	.073	.965	53	.116

* This is a lower bound of the true significance.
a Lilliefors Significance Correction

In the Shapiro-Wilk test, student engagement scores in the experimental and control classes show a significance value (probability) of 0.132 and 0.319 (>0.05). Likewise, with the value of academic achievement, it indicates that the significance value (probability) was 0.190 (>0.05) for the experimental class and 0.116 (>0.05) for the control class. This means that the final scores for student engagement and academic achievement in the experimental and control classes were normally distributed, and they can proceed to the MANOVA test.

3.2.2. Result of homogeneity test on student engagement and academic achievement

The homogeneity test aims to know whether the variance values in the sample groups are homogeneous. In this study, a homogeneity test was conducted to determine whether the individual student engagement and academic achievement variant values were homogeneous between the treatment groups. To detect the presence or absence of heterogeneity, according to M. E. O'Neill and K. Y. Mathews [56], a test of

similarity of variance or homogeneity of variance-covariance, namely the Levene test (Levene test of homogeneity of variance), is used. Testing the homogeneity of sample variants with Levene's has a significance level 0.05. If the significance is more than 0.05, it can be concluded that H_0 is accepted, meaning the sample is homogeneous. The results of testing the sample variation with the Levene's test using the SPSS program are presented in the Table 8.

Table 8. Data homogeneity test results

Levene's test of equality of error variances (a)				
	F	df1	df2	Sig.
Student engagement	1.825	1	115	.179
Academic achievement	.810	1	115	.370

Tests the null hypothesis that the error variance of the dependent variable is equal across groups
a design: intercept+learning_model

Table 8 shows the significance value of the student engagement data obtained a significance value of 0.179 (p>0.05), so the variance or variance of the student engagement data is considered homogeneous. Likewise, academic achievement data obtained a significance value of 0.370 (p>0.05), so the variance of academic achievement data is homogeneous. In this case, the variance-covariance matrix of the dependent variable, namely the student engagement and academic achievement values, are the same for the existing groups (independent variables). Like ANOVA, MANOVA output can be interpreted properly if the variance-covariance matrix of the dependent variable is relatively the same in each independent group. The results of the normality and homogeneity tests show that the data were normally distributed and homogeneous. Therefore, testing the MANOVA analysis could be carried out because the assumptions of normality and homogeneity of the variety of data had been met.

3.3. Description of the MANOVA analysis results

The results of calculating the MANOVA analysis technique at a significance value of 0.05 are presented in the Table 9. Table 9 shows that the learning model obtained significant value tested by Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root procedures. All procedures showed a significant value of 0.000, which was less than an alpha of 0.05 (p<0.05). Thus, H_0 is rejected, meaning that student engagement and academic achievement had differences in the two learning models. Based on questionnaires and posttest scores, student engagement and academic achievement of students taught using the case and project-based gamification model were proven to have higher scores than student engagement and academic achievement of students taught using the direct e-learning model.

Table 9. Results of multivariate test analysis

Multivariate tests (b)						
Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's trace	.998	29278.546(a)	2.000	114.000	.000
	Wilks' lambda	.002	29278.546(a)	2.000	114.000	.000
	Hotelling's trace	513.659	29278.546(a)	2.000	114.000	.000
	Roy's largest root	513.659	29278.546(a)	2.000	114.000	.000
Learning_model	Pillai's trace	.693	128.402(a)	2.000	114.000	.000
	Wilks' lambda	.307	128.402(a)	2.000	114.000	.000
	Hotelling's trace	2.253	128.402(a)	2.000	114.000	.000
	Roy's largest root	2.253	128.402(a)	2.000	114.000	.000

a Exact statistic
b Design: intercept+learning_model

Therefore, the results of individual tests on the independent and dependent variables (test of between-subject effect MANOVA) using MANOVA are presented in the Table 10. Table 10 shows that student engagement obtained an F value of 220.771 with a significant level of 0.000, which was less than the alpha of 0.05. Thus, H_0 is rejected, meaning that there was a significant difference in student engagement with the use of case and project-based gamification models and direct e-learning models. Furthermore, it can be illustrated that academic achievement obtained an F value of 148.210 with a significant level of 0.000, which was less than the alpha of 0.05. Thus, H_0 is also rejected, meaning that there is a significant difference in academic achievement among students taught using the case and project-based gamification model and the direct e-learning model.

Table 10. Result of tests of between-subjects effects

Source	Dependent variable	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	Student engagement	3,546.052(a)	1	3,546.052	220.771	.000
	Academic achievement	3,652.135(b)	1	3,652.135	148.210	.000
Intercept	Student engagement	837,882.052	1	837,882.052	52,165.062	.000
	Academic achievement	766,686.529	1	766,686.529	31,113.557	.000
Learning_model	Student engagement	3,546.052	1	3,546.052	220.771	.000
	Academic achievement	3,652.135	1	3,652.135	148.210	.000
Error	Student engagement	1,847.145	115	16.062		
	Academic achievement	2,833.779	115	24.642		
Total	Student engagement	861,120.000	117			
	Academic achievement	790,081.000	117			
Corrected total	Student engagement	5,393.197	116			
	Academic achievement	6,485.915	116			

a R squared=.658 (adjusted R squared=.655)
b R squared=.563 (adjusted R squared=.559)

4. DISCUSSION

This study examines the effect of case and project-based gamification models on student engagement and academic achievement in online learning for college students. The study results show a significant difference between student engagement and academic achievement of students taught using the case and project-based gamification and direct e-learning models. Student engagement and academic achievement of students taught using the case and project-based gamification model were better than students taught using the direct e-learning model. The difference in student engagement and academic achievement between the two groups of students shows that student engagement and academic achievement are influenced by the learning model, even though students are given the same subject matter, questions, and facilities.

Student engagement is characterized by student involvement in in-depth learning activities, understanding and self-regulation, positive reactions to the learning environment, peers and teachers, interest and a sense of belonging, persistence, and positive behavior [57]. Students are involved in learning when given an appropriate learning environment according to their learning styles, learning modalities, and learning preferences [58]. In this study, the gamification model was used for case-based learning media courses and online projects. This research combines various learning approaches/methods (cases and projects) with various learning resources or learning media (documents, animations, videos, and multimedia), various activity formats and interactions between teachers and students, and game elements in every step of learning activities.

In the case-based learning process, students are given the opportunity to find the essence of the subject matter independently rather than just listening to the teacher's verbal explanation. Sanjaya *et al.* [59] emphasized that the case-based learning method allows students to solve problems that are relevant to the topics they are studying. Students participate actively in various sources of information into context, and they try to solve cases using their previous knowledge and experience. In this scenario, the steps of the case-based learning method include i) establishing cases, ii) analyzing cases, iii) finding information, data, and literature independently, iv) determining what steps must be taken to resolve the cases provided, v) making conclusions from answers discussed together, vi) making a presentation, and vii) making improvement. Several topics of lecture material, such as the position of teaching materials, selection of teaching materials, and use of teaching materials, were studied by students with the case-based learning method. These topics cover realistic problems and include problems related to the environment, conditions, situations, and pictures of students' futures. The case-based learning method emphasizes the role of students as learning subjects by seeking, finding, connecting, and applying ideas in a representative manner in a low-risk environment [60]. Case-based learning model can increase students' self-confidence, critical thinking skills, problem-solving skills, teamwork, and cultural awareness [61]–[64]. Moreover, case-based learning has many other advantages, such as: i) students can associate what they know with the problems they are currently facing, and ii) students have a chance to consider problems similar to those they face in the real world [65].

Furthermore, other learning topics such as analysis of the needs of teaching materials, design of teaching materials, production of traditional and digital teaching materials, and evaluation of teaching materials were studied using the project-based learning method. The topic of lecture material is very relevant to be studied by students with the team-based project learning method because it can provide hands-on experience in a collaborative manner and present learning that is not limited to mere (cognitive) knowledge. In this scenario, the steps of the project-based learning method include: i) formulating the expected learning outcome, ii) understanding the concept of the teaching materials, iii) conducting skills training, iv) designing the project theme, v) making the project proposal, vi) executing the tasks of the project, and vii) presenting the project report. Guo [66] stated that the project-based learning method gives students more freedom,

engagement, and responsibility for learning. Project-based learning method at each stage improves students' critical thinking skills, starting with the stage of selecting projects that are tailored to students' needs. After the planning stage, which begins by looking at what they already know, such as organizing and asking questions, students can learn more about the activities built into project-based learning strategies. Furthermore, the project-learning method teaches skills in recognizing assumptions, assessing arguments through class discussions, running projects, collecting and analyzing data, and presenting project reports. During the project-based learning stage, students can connect their experiences with the real world and encourage them to think critically when they acquire new information [67]. Collaborative online learning projects can increase student involvement and ability to complete their assignments [16].

Each stage of the case-based and project-based learning methods uses game elements. Various available gamification tools were added to the LMS using a plugin. LMS is a suitable place for gamification for having the ability to automatically record digital statistics of students' results and progress in the gamification-based learning [68]. LMS makes it possible to collect data on how much time students spend viewing and interacting with the material provided. Several settings can be enabled in the LMS to encourage students to participate in discussions, forums and blogs, as well as participate in the development of learning content by creating Wiki pages. Moodle LMS application promotes several advantages, such as: i) being able to choose various formats of available learning activities, such as the weekly format, or also being able to use topic and social formats, ii) being able to be more flexible in determining activities learning, such as communities, journals, quizzes, choice questions, surveys, assignments, and chat, iii) all class members both in forums, journals, quizzes, and assignments can be seen on one page (and can be downloaded as a spreadsheet file), and iv) being able to display various user activities [58]. In e-learning course material development, built-in and additional features of the Moodle LMS are used to create game elements such as XP, levels, badges, leaderboards, and progress bars.

Students receive XP automatically after completing certain tasks and actions in learning, such as logging into the system, posting on forums, and accessing reading material pages. This number of XP can attract, encourage, and increase student engagement and academic productivity [69], [70]. Levels connect student XP related to their activities. This feature notifies students when they level up [71]. The main purpose of using the level up block is to provide incentives for students to follow and complete their learning experiences and motivate them to complete their learning activities [72]. Badges are given to students as a reward for their achievements, including "active", "hard work", and "champion" badges given out for activities that students have completed. In addition, these badges function as social markers because other students can see them in public [73]. This will have an impact on student behavior to always be the best in class [74].

Leaderboards provide a visual representation of students' rankings in the class. Students like this feature because it can help them concentrate on setting personal goals for subsequent learning activities [75]. They also prefer to see their top peers on leaderboards to determine the range of their performance and those of other excellent peers [76]. In addition, progress bars can show how far a student has progressed in their learning. It can also provide feedback to students to improve their efforts to learn. Progress bars are well received and considered a tool for managing individual learning strategies. They allow flexible learning for a wide range of students [77], [78].

An effective online learning environment must be able to encourage student activity in a pleasant atmosphere. The design of case and project-based gamification models in online learning can be an option in current teaching and learning activities. Game techniques and mechanisms implemented in case and project-based learning processes are proven to be able to achieve learning objectives, increase student engagement, and increase student motivation and involvement in a challenging, fun, friendly collaborative learning environment.

5. CONCLUSION

This study examines the effect of case and project-based gamification models on student engagement and academic achievement in online learning for college students. The study results found that the case and project-based gamification models used in online learning had a significant effect on student engagement and academic achievement scores. Thus, case and project-based gamification models in online learning have advantages over direct e-learning models in achieving/increasing student engagement and academic achievement. Case and project-based gamification models in online learning by integrating game elements and techniques in each learning stage have created student activity and strengthened positive learning behavior, maximizing feelings of enjoyment and engagement in the learning process.

6. RECOMMENDATION

Referring to the results of the study and discussion, several recommendations are proposed in this research. Case and project-based gamification models in online learning can be implemented in other tertiary institutions which have students with the same characteristics as the subject of this study. Case and project-based gamification models in online learning can also be implemented in other courses with similar characteristics to the subjects studied in this study. For students taught using this learning model for the first time, the lecturer should provide directions, especially on how to view, access, and utilize LMS features that provide game elements. To be further developed and used by many people, especially related to efforts to involve students in learning and improve their learning achievement, the design of this model can be disseminated through academic seminars, training on the development and use of learning models, collaboration with educational institutions and training, and other forums. It is necessary to pursue further research activities to apply this model to other target characteristics at different levels, pathways, and types of education. In managing learning, lecturers are advised to use a learning model that is more oriented to student characteristics, fun like gamification and active like the case and project-based learning method.

7. LIMITATION

The application of case and project-based gamification models in online learning has several limitations. Implementation of this model requires ICT devices (computer devices or mobile devices), and also requires adequate internet access. Apart from that, the application of this model is only limited to teaching material development. The instrument for measuring student engagement is only limited to measuring primary data in the form of questionnaires. The testing carried out in this research did not reach the long-term impact evaluation stage.

ACKNOWLEDGMENTS

The authors are grateful to the Universitas Pendidikan Ganesha for financially supporting this study through DIPA BLU (List of Entries of Budget Execution Public Service Agency) Number: SP DIPA-023.17.2.677530/2022 Revision 2 dated April 14, 2023, according to the Contract Number: 1037/UN48.16/LT/2023.

REFERENCES

[1] D. Alabasi, "Exploring graduate students' perspectives towards using gamification techniques in online learning," *Turkish Online Journal of Distance Education*, pp. 180–180, Jul. 2017, doi: 10.17718/tojde.328951.

[2] A. Szymkowiak, B. Melović, M. Dabić, K. Jeganathan, and G. S. Kundi, "Information technology and gen Z: the role of teachers, the internet, and technology in the education of young people," *Technology in Society*, vol. 65, no. March, 2021, doi: 10.1016/j.techsoc.2021.101565.

[3] H. Jeong, C. E. Hmelo-Silver, and K. Jo, "Ten years of computer-supported collaborative learning: a meta-analysis of CSCL in STEM education during 2005–2014," *Educational Research Review*, vol. 28, no. June, p. 100284, 2019, doi: 10.1016/j.edurev.2019.100284.

[4] D. J. Lemay, P. Bazelais, and T. Doleck, "Transition to online learning during the COVID-19 pandemic," *Computers in Human Behavior Reports*, vol. 4, p. 100130, 2021, doi: 10.1016/j.chbr.2021.100130.

[5] M. Riad, M. Qbadou, E.-S. Aoula, and S. Gouraguine, "The new e-learning adaptation technique based on learner's learning style and motivation," *Journal of Education and Learning (EduLearn)*, vol. 17, no. 3, pp. 472–482, 2023, doi: 10.11591/edulearn.v17i3.20826.

[6] F. Ettl *et al.*, "A moodle course to substitute resuscitation teaching in a medical curriculum during the COVID-19 pandemic: A prospective pilot study," *Frontiers in Public Health*, vol. 10, 2022, doi: 10.3389/fpubh.2022.991408.

[7] L. R. Octaberlina and A. I. Muslimin, "Efl students perspective towards online learning barriers and alternatives using moodle/google classroom during covid-19 pandemic," *International Journal of Higher Education*, vol. 9, no. 6, pp. 1–9, 2020, doi: 10.5430/ijhe.v9n6p1.

[8] Augustine and S. Eberechukwu, "Webquest for teaching during covid-19: lecturers' awareness, utilization perception, and challenges," *UNIZIK Journal of Educational Research and Policy Studies*, vol. 13, no. 1, pp. 1–16, 2022.

[9] M. Restuati, M. Y. Nasution, A. S. S. Pulungan, N. Pratiwi, and B. Safirah, "Improvement efforts for student learning outcomes and motivation using edmodo during the COVID-19 pandemic," *International Journal of Education in Mathematics, Science and Technology*, vol. 9, no. 4, pp. 614–624, 2021, doi: 10.46328/ijemst.1974.

[10] V. Zulfa and P. Laras, "Schoology and Slido: the perfect platform combination for distance learning during the Covid-19 pandemic," 2020, doi: 10.2991/aer.k.201124.016.

[11] S. L Schneider and M. L. Council, "Distance learning in the era of COVID-19," *Archives of Dermatological Research*, no. 313, pp. 389–390, 2021, doi: 10.1007/s00403-020-02088-9.

[12] M. Churiyah, S. Sholikhan, F. Filianti, and D. A. Sakdiyyah, "Indonesia education readiness conducting distance learning in Covid-19 pandemic situation," *International Journal of Multicultural and Multireligious Understanding*, vol. 7, no. 6, p. 491, Aug. 2020, doi: 10.18415/ijmmu.v7i6.1833.

[13] S. Dhawan, "Online learning: A panacea in the time of COVID-19 crisis," *Journal of Educational Technology Systems*, vol. 49, no. 1, pp. 5–22, Sep. 2020, doi: 10.1177/0047239520934018.

[14] M. Irfan, B. Kusumaningrum, Y. Yulia, and S. A. Widodo, "Challenges during the pandemic: use of e-learning in mathematics

learning in higher education," *Infinity Journal*, vol. 9, no. 2, p. 147, 2020, doi: 10.22460/infinity.v9i2.p147-158.
[15] N. Yusnilita, "The impact of online learning: student's views," *ETERNAL (English Teaching Journal)*, vol. 11, no. 1, May 2020, doi: 10.26877/eternal.v11i1.6069.
[16] M. Yunus, A. Amirullah, I. Safiah, S. Ridha, and I. K. Suartama, "Development of the CPOL design to improve the ability to develop teaching materials," *Cypriot Journal of Educational Sciences*, vol. 17, no. 5, pp. 1655–1670, 2022, doi: 10.18844/cjes.v17i5.7257.
[17] M. Adnan, "Online learning amid the COVID-19 pandemic: students perspectives," *Journal of Pedagogical Sociology and Psychology*, vol. 1, no. 2, pp. 45–51, Jun. 2020, doi: 10.33902/JPSP.2020261309.
[18] D. Kuswandi and M. Fadhli, "The effects of gamification method and cognitive style on children's early reading ability," *Cogent Education*, vol. 9, no. 1, p. 2145809, Dec. 2022, doi: 10.1080/2331186X.2022.2145809.
[19] S. Knox, "Fostering student engagement in virtual entrepreneurship education environments," *International Journal of Management Education*, vol. 20, no. 3, p. 100705, 2022, doi: 10.1016/j.ijme.2022.100705.
[20] R. E. Carpenter, D. Silberman, and J. K. Takemoto, "The student engagement effect of team-based learning on student pharmacists," *American Journal of Pharmaceutical Education*, vol. 86, no. 5, p. 8567, Jun. 2022, doi: 10.5688/ajpe8567.
[21] T. K. F. Chiu, T.-J. Lin, and K. Lonka, "Motivating online learning: the challenges of COVID-19 and beyond," *The Asia-Pacific Education Researcher*, vol. 30, no. 3, pp. 187–190, Jun. 2021, doi: 10.1007/s40299-021-00566-w.
[22] I. K. Sudarma, D. G. A. P. Prabawa, and I. K. Suartama, "The application of information processing theory to design digital content in learning message design course," *International Journal of Information and Education Technology*, vol. 12, no. 10, pp. 1043–1049, 2022, doi: 10.18178/ijiet.2022.12.10.1718.
[23] I. K. Suartama, E. Triwahyuni, and K. Suranata, "Context-aware ubiquitous learning based on case methods and team-based projects: Design and validation," *Education Sciences*, vol. 12, no. 11, p. 802, Nov. 2022, doi: 10.3390/educsci12110802.
[24] S. Hao, V. P. Dennen, and L. Mei, "Influential factors for mobile learning acceptance among Chinese users," *Educational Technology Research and Development*, vol. 65, no. 1, pp. 101–123, Feb. 2017, doi: 10.1007/s11423-016-9465-2.
[25] N. Männikkö, H. Ruotsalainen, A. Tolvanen, and M. Kääriäinen, "Problematic gaming is associated with some health-related behaviors among finnish vocational school students," *International Journal of Mental Health and Addiction*, vol. 18, no. 4, pp. 993–1007, Aug. 2020, doi: 10.1007/s11469-019-00100-6.
[26] R. Mitchell, L. Schuster, and H. S. Jin, "Gamification and the impact of extrinsic motivation on needs satisfaction: Making work fun?," *Journal of Business Research*, vol. 106, pp. 323–330, Jan. 2020, doi: 10.1016/j.jbusres.2018.11.022.
[27] N. Sitthikrai, C. Hemtasin, and T. Thongsuk, "Development of academic achievements using inquiry-based learning together with educational games," *Journal of Education and Learning (EduLearn)*, vol. 17, no. 3, pp. 441–446, Aug. 2023, doi: 10.11591/edulearn.v17i3.20859.
[28] B. Marín, J. Frez, J. Cruz-Lemus, and M. Genero, "An empirical investigation on the benefits of gamification in programming courses," *ACM Transactions on Computing Education*, vol. 19, no. 1, pp. 1–22, Mar. 2019, doi: 10.1145/3231709.
[29] C. Poondej and T. Lerdpornkulrat, "Gamification in E-learning: A moodle implementation and its effect on student engagement and performance," *Interactive Technology and Smart Education*, vol. 17, no. 1, pp. 56–66, 2019, doi: 10.1108/ITSE-06-2019-0030.
[30] A. Antonaci, R. Klemke, and M. Specht, "The effects of gamification in online learning environments: A systematic literature review," *Informatics*, vol. 6, no. 3, p. 32, Aug. 2019, doi: 10.3390/informatics6030032.
[31] L. D. Lapitan, C. E. Tiangco, D. A. G. Sumalinog, N. S. Sabarillo, and J. M. Diaz, "An effective blended online teaching and learning strategy during the COVID-19 pandemic," *Education for Chemical Engineers*, vol. 35, pp. 116–131, Apr. 2021, doi: 10.1016/j.ece.2021.01.012.
[32] P. F. Franco and D. A. DeLuca, "Learning through action: creating and implementing a strategy game to foster innovative thinking in higher education," *Simulation & Gaming*, vol. 50, no. 1, pp. 23–43, Feb. 2019, doi: 10.1177/1046878118820892.
[33] L. R. Murillo-Zamorano, J. Á. López Sánchez, A. L. Godoy-Caballero, and C. Bueno Muñoz, "Gamification and active learning in higher education: Is it possible to match digital society, academia and students' interests?," *International Journal of Educational Technology in Higher Education*, vol. 18, no. 1, p. 15, Mar. 2021, doi: 10.1186/s41239-021-00249-y.
[34] W. Zhao, L. He, W. Deng, J. Zhu, A. Su, and Y. Zhang, "The effectiveness of the combined problem-based learning (PBL) and case-based learning (CBL) teaching method in the clinical practical teaching of thyroid disease," *BMC Medical Education*, vol. 20, no. 1, p. 381, Dec. 2020, doi: 10.1186/s12909-020-02306-y.
[35] J. Park, "Pre-service teachers' project-based tnstruction with mathematics problem-solving," *Education Sciences*, vol. 12, no. 8, p. 526, Aug. 2022, doi: 10.3390/educsci12080526.
[36] S. A. Raza, W. Qazi, and B. Umer, "Examining the impact of case-based learning on student engagement, learning motivation and learning performance among university students," *Journal of Applied Research in Higher Education*, vol. 12, no. 3, pp. 517–533, Oct. 2019, doi: 10.1108/JARHE-05-2019-0105.
[37] M. Ali, S. M. K. Hossain, and T. Ahmed, "Effectiveness of e-learning for university students: evidence from Bangladesh," *Asian Journal of Empirical Research*, vol. 8, no. 10, pp. 352–360, Nov. 2018, doi: 10.18488/journal.1007/2018.8.10/1007.10.352.360.
[38] R. E. Mayer, *The promise of educational psychology volume II: teaching for meaningful learning*. New Jersey: Pearson Education, Inc, 2002.
[39] E. Jääskä and K. Aaltonen, "Teachers' experiences of using game-based learning methods in project management higher education," *Project Leadership and Society*, vol. 3, p. 100041, Dec. 2022, doi: 10.1016/j.plas.2022.100041.
[40] E. V. Soboleva and N. L. Karavaev, "Characteristics of the project-based teamwork in the case of developing a smart application in a digital educational environment," *European Journal of Contemporary Education*, vol. 9, no. 2, Jun. 2020, doi: 10.13187/ejced.2020.2.417.
[41] S. Lam, "Project-based learning," in *Encyclopedia of the Sciences of Learning*, Boston, MA: Springer US, 2012, pp. 2707–2709.
[42] J. Perez-Aranda, S. Medina-Claros, and R. Urrestarazu-Capellán, "Effects of a collaborative and gamified online learning methodology on class and test emotions," *Education and Information Technologies*, vol. 29, no. 2, pp. 1823–1855, Feb. 2024, doi: 10.1007/s10639-023-11879-2.
[43] M. S. Kuo and T. Y. Chuang, "How gamification motivates visits and engagement for online academic dissemination an empirical study," *Computers in Human Behavior*, vol. 55, pp. 16–27, 2016, doi: 10.1016/j.chb.2015.08.025.
[44] C.-C. Chen, "Gamify online courses with tools built into your learning management system (LMS) to enhance self-determined and active learning," *Online Learning*, vol. 22, no. 3, Sep. 2018, doi: 10.24059/olj.v22i3.1466.
[45] D. Paľová and M. Vejačka, "Implementation of gamification principles into higher education," *European Journal of Educational Research*, vol. 11, no. 1, pp. 325–337, 2022.
[46] K. Georgouli, I. Skalkidis, and P. Guerreiro, "A framework for adopting LMS to introduce e-learning in a traditional course,"

Journal of Educational Technology & Society, vol. 11, no. 2, pp. 227–240, 2008.
[47] I. Govender, "The learning context: influence on learning to program," *Computers & Education*, vol. 53, no. 4, pp. 1218–1230, Dec. 2009, doi: 10.1016/j.compedu.2009.06.005.
[48] J. G. Henderson, "Learning through a disciplined curriculum study approach," *Scholar-Practitioner Quarterly*, vol. 4, no. 4, pp. 312–315, 2011.
[49] S. Chootongchai and N. Songkram, "Design and development of SECI and moodle online learning systems to enhance thinking and innovation skills for higher education learners," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 03, p. 154, Mar. 2018, doi: 10.3991/ijet.v13i03.7991.
[50] M. Gachkova and E. Somova, "Game-based approach in e-learning," in *Education and research in the information society*, 2016, no. 26 May, pp. 143–152.
[51] I. K. Suartama, A. H. Simamora, K. Susiani, K. Suranata, M. Yunus, and G. D. Tisna MS, "Designing gamification for case and project-based online learning: a study in higher education," *Journal of Education and e-Learning Research*, vol. 10, no. 2, pp. 86–98, Jan. 2023, doi: 10.20448/jeelr.v10i2.4432.
[52] W. R. Shadish and J. K. Luellen, "Quasi-experimental design," in *Handbook of complementary methods in education research*, Routledge, 2012, pp. 539–550.
[53] M. D. Dixson, "Measuring student engagement in the online course: the online student engagement scale (OSE)," *Online Learning Journal (OLJ)*, vol. 19, no. 4, p. 143, 2015.
[54] K. Allen, T. Reed-Rhoads, R. A. Terry, T. J. Murphy, and A. D. Stone, "Coefficient alpha: an engineer's interpretation of test reliability," *Journal of Engineering Education*, vol. 97, no. 1, pp. 87–94, 2008.
[55] F. Kelinger and H. Lee, *Foundation of behavioral research (fourth edition)*. USA: Holt: Winston, Inc, 2000.
[56] M. E. O'Neill and K. Mathews, "Theory and methods: a weighted least squares approach to levene's test of homogeneity of variance," *Australian & New Zealand Journal of Statistics*, vol. 42, no. 1, pp. 81–100, Mar. 2000, doi: 10.1111/1467-842X.00109.
[57] M. Bond and S. Bedenlier, "Facilitating student engagement through educational technology: towards a conceptual framework," *Journal of Interactive Media in Education*, no. 1, pp. 1–14, 2019.
[58] I. K. Suartama, P. Setyosari, S. Sulthoni, and S. Ulfa, "Development of ubiquitous learning environment based on moodle learning management system," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 14, no. 14, p. 182, Aug. 2020, doi: 10.3991/ijim.v14i14.11775.
[59] D. B. Sanjaya, I. K. Suartama, I. N. Suastika, and S. Sukadi, "The effect of the conflict resolution learning model and portfolio assessment on the students' learning outcomes of civic education," *International Journal of Instruction*, vol. 15, no. 1, pp. 473–488, Jan. 2022, doi: 10.29333/iji.2022.15127a.
[60] P. A. Ertmer and A. A. Koehler, "Online case-based discussions: examining coverage of the afforded problem space," *Educational Technology Research and Development*, vol. 62, no. 5, pp. 617–636, Oct. 2014, doi: 10.1007/s11423-014-9350-9.
[61] A. A. Koehler, P. A. Ertmer, and T. J. Newby, "Developing preservice teachers' instructional design skills through case-based instruction: Examining the impact of discussion format," *Journal of Teacher Education*, vol. 70, no. 4, pp. 319–334, Sep. 2019, doi: 10.1177/0022487118755701.
[62] A. A. Tawfik, J. L. Kolodner, A. A. Tawfik, N. Illinois, J. L. Kolodner, and T. Concord, "Systematizing scaffolding for problem-based learning : A view from case-based reasoning," *Interdisciplinary Journal of Problem-Based Learning*, vol. 10, no. 1, pp. 5–6, 2016.
[63] A. Yadav, C. Bozic, S. Gretter, and E. Nauman, "Benefits and challenges of implementing case-based instruction: A student perspective," *International Journal of Engineering Education*, vol. 31, no. 6, pp. 1554–1563, 2015.
[64] S. Bada, Steve Olusegun Olusegun, "Constructivism learning theory: a paradigm for teaching and learning," *Journal of Research & Method in Education*, vol. 5, no. 6, pp. 66–70, 2015.
[65] A. A. Koehler, Z. Cheng, H. Fiock, S. Janakiraman, and H. Wang, "Asynchronous online discussions during case-based learning: A problem-solving process," *Online Learning*, vol. 24, no. 4, Dec. 2020, doi: 10.24059/olj.v24i4.2332.
[66] P. Guo, N. Saab, L. S. Post, and W. Admiraal, "A review of project-based learning in higher education: Student outcomes and measures," *International Journal of Educational Research*, vol. 102, p. 101586, 2020, doi: 10.1016/j.ijer.2020.101586.
[67] H. B. Issa and A. Khataibeh, "The effect of using project based learning on improving the critical thinking among upper basic students from teachers' perspectives," *Pegem Journal of Education and Instruction*, vol. 11, no. 2, pp. 52–57, 2021.
[68] J. Dias, "Teaching operations research to undergraduate management students: The role of gamification," *The International Journal of Management Education*, vol. 15, no. 1, pp. 98–111, Mar. 2017, doi: 10.1016/j.ijme.2017.01.002.
[69] C. Baah, I. Govender, and P. R. Subramaniam, "Exploring the role of gamification in motivating students to learn," *Cogent Education*, vol. 10, no. 1, Dec. 2023, doi: 10.1080/2331186X.2023.2210045.
[70] R. Văidăhăzan, I. Julean, and A. Moholea, "Online university teaching system, with 7 modules, quantified with experience points (XP), in computer-assisted training, psychopedagogical training module," *Studia Universitatis Babeş-Bolyai Educatio Artis Gymnasticae*, vol. 67, no. 2, pp. 87–96, Aug. 2022, doi: 10.24193/subbeag.67(2).15.
[71] M. Gachkova, E. Somova, and S. Gaftandzhieva, "Gamification of courses in the e-learning environment," *IOP Conference Series: Materials Science and Engineering*, vol. 878, no. 1, p. 012035, Jun. 2020, doi: 10.1088/1757-899X/878/1/012035.
[72] H. F. Hasan, M. Nat, and V. Z. Vanduhe, "Gamified collaborative environment in Moodle," *IEEE Access*, vol. 7, pp. 89833–89844, 2019, doi: 10.1109/ACCESS.2019.2926622.
[73] J. Hamari, "Do badges increase user activity? A field experiment on the effects of gamification," *Computers in Human Behavior*, vol. 71, pp. 469–478, Jun. 2017, doi: 10.1016/j.chb.2015.03.036.
[74] S. Aljraiwi, "Effectiveness of gamification of web-based learning in improving academic achievement and creative thinking among primary school students," *International Journal of Education and Practice*, vol. 7, no. 3, pp. 242–257, 2019, doi: 10.18488/journal.61.2019.73.242.257.
[75] M. Ortiz-Rojas, K. Chiluiza, and M. Valcke, "Gamification through leaderboards: an empirical study in engineering education," *Computer Applications in Engineering Education*, vol. 27, no. 4, pp. 777–788, Jul. 2019, doi: 10.1002/cae.12116.
[76] S. Bai, K. F. Hew, and D. E. Gonda, "Examining effects of different leaderboards on students' learning performance, intrinsic motivation, and perception in gamified online learning setting," in *2021 IEEE International Conference on Educational Technology (ICET)*, Jun. 2021, pp. 36–41, doi: 10.1109/ICET52293.2021.9563130.
[77] K. Bovermann, J. Weidlich, and T. Bastiaens, "Online learning readiness and attitudes towards gaming in gamified online learning – a mixed methods case study," *International Journal of Educational Technology in Higher Education*, vol. 15, no. 1, p. 27, Dec. 2018, doi: 10.1186/s41239-018-0107-0.
[78] T.-L. Chou and S. Chen, "The effects of progress bars on diverse learning styles in web-based learning," in *2015 IEEE 15th International Conference on Advanced Learning Technologies*, Jul. 2015, pp. 493–494, doi: 10.1109/ICALT.2015.141.

BIOGRAPHIES OF AUTHORS

I Kadek Suartama is a doctor in the field of educational technology. He currently teaches at Universitas Pendidikan Ganesha, Singaraja, Indonesia. His research interests are learning design and learning media including e-learning, multimedia learning and mobile learning. He can be contacted at email: ik-suartama@undiksha.ac.id.

I Komang Sudarma is a doctor in the field of educational technology. He currently teaches at Universitas Pendidikan Ganesha, Singaraja, Indonesia. His research interests are instrutional media, development of teaching materials. He can be contacted at email: ik-sudarma@undiksha.ac.id.

I Gde Wawan Sudatha is a doctor in the field of educational technology. He currently teaches at Universitas Pendidikan Ganesha, Singaraja, Indonesia. His research interests are multimedia learning and visualitation learning. He can be contacted at email: igdewawans@undiksha.ac.id.

Adrianus I Wayan Ilia Yuda Sukmana is a doctor in the field of educational technology. He currently teaches at Universitas Pendidikan Ganesha, Singaraja, Indonesia. His research interests are game based learning and gamification. He can be contacted at email: aiwiy-sukmana@undiksha.ac.id.

Ketut Susiani is a doctor canditate in the field of basic education. He currently teaches at Universitas Pendidikan Ganesha, Singaraja, Indonesia. His research interests are instructional media, literate, and education science. She can be contacted at email: ketut.susiani@undiksha.ac.id.