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Gamification Effect of Team Games Tournament in Game-Based Learning on Student Motivation

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Abstract

This study examines the impact of gamification elements, specifically the duration of use and level of collaboration, on student motivation in online learning environments. Using the Team Games Tournament model, which combines elements of both competition and collaboration, a web-based Game-Based Learning application was developed to enhance student motivation. The study employed a motivation survey based on the model Attention, Relevance, Confidence, Satisfaction, which was administered to participants before and after using the application. In addition to the survey, interaction data, such as the duration of application use, frequency of participation, points earned, and the level of collaboration, were collected to assess the relationship between these factors and student motivation. The study involved 20 fifth-semester students (12 male, 8 female) enrolled in a digital games course, many of whom had prior gaming experience, which could influence their response to the gamified learning experience. The data collected was analyzed using Decision Tree algorithms, Pearson correlation, and simple linear regression to understand the impact of various gamification elements on motivation. The results showed that both the duration of application use and the level of collaboration were significant factors in increasing student motivation. Specifically, motivation increased by an average of 0.72 points for every 10 minutes of application use, as measured by the difference between pre-test and post-test survey scores. These findings underscore the importance of balancing competitive and collaborative elements within game-based learning environments. By incorporating features that promote collaboration and encouraging sustained application use, educators can significantly enhance student engagement and motivation. The study provides valuable insights for the development of future game-based learning applications, highlighting the need for optimal design in terms of collaboration and duration to create an effective and engaging digital learning experience.

Keywords: GBL, TGT, Motivation, Learning, Cooperative, Game

1. Introduction

Online learning is still being implemented by several educational institutions even though the Covid-19 pandemic has been declared over [1]. Distance learning is considered to be able to support the teaching and learning process effectively by using innovative technology [2]. One of the approaches used in online learning is cooperative learning model with the Team Games Tournament (TGT). It coumbines the elements of tournament-based competition in order to increase student motivation [3]. However, inappropriate management possibly create competition which increases the tension and reduces collaboration between students. It is contrary to the goals of cooperative learning [4]. In addition, the implementation of TGT for a long period of time can cause boredom and a decrease in student learning motivation due to the lack of variation in learning [5]. Lack of understanding of the material are also seen as the one of the problems that may arise because students focuses more on competition than collaboration and in-depth understanding of the material [6]. Proposing the alternatives to these problems, this study attempts to balance the combination between competition and collaboration in TGT cooperative learning so that motivation decrease and the lack of understanding could be prevented and solved by using Game-Based Learning (GBL) application. Duration for collaborative learning in one group is suggested to be implemented for 30 to 60 minutes. This range of time is considered sufficient for productive interaction [7]. Meanwhile, each group of learning ideally consists of four to six

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students. This number is recommended to ensure that each member can contribute actively and interact with each other effectively so that the educator can be easier to control the activity [8]. By providing clear tasks and roles for each member in a team, the negative impact of competition can be minimized. Moreover, the variety of GBL elements is expectedly can reduce boredom and maintain student engagement during learning.

The developed web-based GBL application that integrates the TGT cooperative learning model in this study is expected to be able to maintain the competitive elements that encourage student motivation, while overcoming the problems that arise in the implementation of conventional TGT. This study will use the Decision Tree method to evaluate the effect of game elements in the GBL application on student motivation. The elements include the duration of application use, frequency of participation, number of points obtained, and level of collaboration in the game.

Applications such as Scratch, Kahoot, and Minecraft have been proven to be able to create an interesting learning environment by involving aspects of student participation, interaction, and motivation [9], [10]. However, this study will explore the different approaches and features in the proposed GBL application, focusing on how the integration of cooperative game elements can effectively increase student motivation and engagement. The Decision Tree method will be used to identify the game elements that have the most influence on student motivation, which will be visualized in the form of a decision tree. This allows researchers to understand more deeply how each element contributes to student motivation in the learning process.

This research is in line with recommendations from previous studies that suggest further exploration of the potential integration of Game-Based Learning into various learning models, particularly to improve critical thinking, collaboration, and decision-making skills [11], [12]. With this data-driven approach, it is expected that the developed GBL application can effectively increase student motivation, engagement, and learning outcomes, while providing new insights into how education can be delivered in the digital era. The research steps include the process of creating, revising, and evaluating the GBL application, with direct feedback from students and educators. The results of this study are expected to provide an overview of the effectiveness of the TGT-based GBL application in increasing student motivation and engagement through the Decision Tree-based evaluation method.

2. Literature Review

2.1. Cooperative Learning Theory

Cooperative Learning Theory has been the subject of intensive research and development in the last decade, offering important insights into how student collaboration in a learning environment can improve learning outcomes. Explored the use of Bruner's theory-based cooperative learning tools, revealing significant improvements in the quality of mathematics learning [13]. The constructivist approach to cooperative learning, shows how the Jigsaw method facilitates students in finding and transforming information, supporting activeness and better learning outcomes [14]. Further strengthens this idea by examining the Jigsaw type cooperative learning model in the context of science education, emphasizing the development of students' social and cognitive skills [15]. Highlighted the effectiveness of Paired Storytelling cooperative learning model in language learning context, where students' knowledge construction can be strengthened through shared stories [16]. Another researcher, applied the principle of constructivism through the Jigsaw method, using Engine Stand media in the learning of vocational students, showing a deep understanding of the theoretical basis and practical application of cooperative learning [17]. These references provide a solid theoretical foundation and examples of practical applications of cooperative learning theory in a variety of educational contexts. It offers insights for educational researchers and practitioners.

2.2. Game-Based Learning (GBL)

GBL is an innovative learning strategy that integrates game elements into an educational context to improve student engagement and learning outcomes. This approach has been accepted as an effective method to facilitate a more dynamic and interactive learning process. The literature review of the benefits and challenges in implementing GBL is presented below.

GBL can increase student engagement through a more interactive and fun learning experience, thus it motivates students to be more active in the learning process [18]. A study found that GBL has the potential to improve student

learning outcomes by enriching the learning experience through game elements that support the educational process. [19]. GBL allows students to construct their own knowledge in a supportive and fun environment so that it facilitates student-centered learning [20].

The main challenges in implementing GBL is designing effective learning experiences that are in line with the learning objectives set [21]. Highlighted the difficulties in using existing GBL frameworks, which are often difficult to apply in concrete learning design practices [22]. Challenges in aligning GBL with existing curricula is ensuring that the use of GBL is relevant and supports learning objectives. It includes the need for sufficient training and understanding of educators to integrate GBL into the learning process effectively [23], [24]. By understanding the benefits and challenges of GBL, educators can design and implement learning experiences that are not only effective but also engaging and motivating for students.

2.3. Design and Development of Web-Based Learning Games

Several studies have made important contributions to the understanding and development of web-based learning game design. The importance of developing web-based learning media to improve students' skills in basic web programming courses [25]. Their approach underlines how web-based media can facilitate more interactive and engaging learning for students, which becomes a critical aspect in developing learning games.

The use of the ADDIE model has been explored in the development of web-based learning media for software engineering courses [26]. This study provides valuable insights into the systematic steps in the design and development of learning media, including needs analysis, design, development, implementation, and evaluation, which are relevant in the context of creating learning games. Perspective on the development of web-based learning media for curriculum and teaching courses in the informatics engineering education department [27]. This study emphasizes the importance of relevant content and effective delivery methods in the development of web-based learning media that can be adapted into learning game designs to create a more immersive and enjoyable learning experience for students.

Overall, this literature review reveals that the design and development of web-based learning games requires a deep understanding of learning theories, instructional development models, and effective game design techniques and tools. By integrating principles from these studies, developers can create learning games that are not only educational but also engaging and motivating for students to learn.

3. Methodology

The implementation stages are designed to ensure that the application development process, data collection, and analysis are carried out systematically, accurately, and responsibly . In accordance with the objectives of this study, a structured approach is applied through 5 steps.

Stage 1: The analysis stage is carried out to understand user needs and problems that arise in online learning using the GBL TGT model. At this stage, literature studies are used to support understanding of the positive and negative impacts of TGT in online learning, as well as the challenges in implementing GBL. The studies conducted show that gamification has proven effective in increasing student motivation and engagement in online learning [28]. Based on this study, the GBL application will be designed with key features such as a tournament system, team collaboration, and point giving designed to increase student engagement. The design of this application also considers previous research that emphasizes the importance of gamification design to support healthy student participation and competition [29]. This analysis stage aims to understand the need for GBL application development to overcome problems such as boredom, competitive pressure, and student learning motivation.

Stage 2: A web-based GBL application was designed to integrate game elements that support cooperative learning through TGT. The design includes a tournament system, point awarding, team collaboration, and leaderboards to create a competitive yet collaborative learning environment. The application was designed in such a way that teachers can monitor student performance and provide immediate feedback, while students are encouraged to collaborate in teams while remaining healthy competitors.

Stage 3: The development stage includes the creation of a GBL application based on the design that has been created. Features such as tournament systems, points, and team collaboration are developed using web-based technology. This

development process involves iteration. Each stage is developed, tested, and revised based on initial feedback. Application development also pays attention to the user experience (UX) aspect so that students feel comfortable using the application in online learning.

Stage 4: The implementation stage is carried out in a real environment. Students are invited to use the GBL application in learning activities. This is a method for collecting data on user interactions. The data collected includes the duration of application use, frequency of participation, number of points earned, and level of team collaboration. A motivational survey was also conducted before and after the application implementation using the ARCS model to measure changes in student motivation.

Stage 5: The evaluation stage involves analyzing data from the use of the GBL application and student motivation surveys. The Decision Tree algorithm is used to evaluate the influence of game elements on student motivation, by considering the user interaction and the result of motivation survey. Algorithm The Decision Tree algorithm was chosen because its capability in handling the complex and non-linear relationships between variables [30]. Decision Tree provides an intuitive visualization of how gaming elements such as duration of application use, frequency of participation, and level of collaboration affect student motivation. This method also allows researchers to effectively identify the factors that most influence motivation, which is important in the context of evaluating gamification elements in GBL. The Decision Tree model will produce a decision tree that helps researchers identify the game elements that most influence student motivation, as well as providing insights for further development of the GBL application.

This study integrates the TGT model into a web-based GBL application. To evaluate the effect of game elements on student motivation, this study uses the Decision Tree algorithm as the main analysis method. The data is collected from two sources: student motivation surveys and user interaction data from the GBL application. The motivation survey was conducted using the ARCS (Attention, Relevance, Confidence, Satisfaction) model that consists of four main dimensions to measure student motivation. The motivation survey was conducted before and after using the application, based on the ARCS model used to measure student motivation levels [31]. User interaction data such as duration of application use, frequency of participation, and number of points obtained in the game were collected from 20 students in the 5th semester who take a digital game course. It consists of 12 male students and 8 female students. The selection of participants considers the students' experience with digital game design. Experienced students are expected to provide better respond to gamification elements in learning [32]. Each dimension is measured using five survey items so that there will be 20 items for the survey.

Table 1. Item and Aspects Assessed for Each Dimension

Aspects	Criteria	Item	Rating Scale
Attention	The appeal of learning content	5	1 (Strongly disagree) - 5 (strongly agree)
Relevance	Suitability of content to learning materials	5	1 (Strongly disagree) - 5 (strongly agree)
Confidence	Feeling about being able to learn the content	5	1 (Strongly disagree) - 5 (strongly agree)
Satisfaction	Feeling of joy toward the lesson	5	1 (Strongly disagree) - 5 (strongly agree)

The survey is conducted before and after the use of GBL application to measure changes in student motivation as shown in table 1. The survey results were then analyzed using the Decision Three algorithm to evaluate the influence of game elements, that is the duration of application use and the level of collaboration on student motivation.

User interaction data is collected from the application logs, which include Duration of Use, Frequency of Participation, Number of Points Earned, and Level of Team Collaboration. The data is processed in the cleaning and normalization stage to ensure the integrity and uniformity of the dataset before being used as input for the Decision Tree model. Figure 1 shows how the Decision Tree algorithm will be applied to evaluate the influence of game elements on student motivation, with input variables in the form of student interaction data and output variables in the form of student motivation levels. The Decision Tree model will be trained using the Classification and Regression Tree (CART) algorithm. There are 80% of the data set for training and 20% for testing [33].

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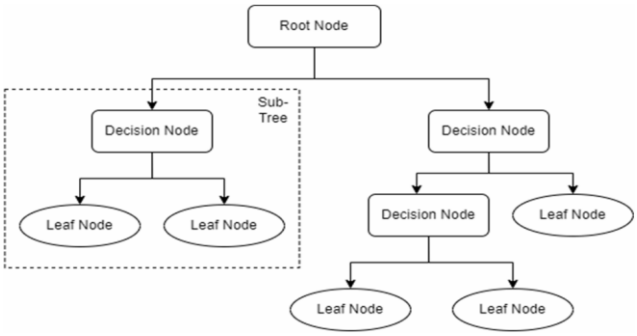

Figure 1. Decision Tree Model [34]

The k-fold cross-validation method will be applied to ensure that the model does not overfit to the training data. Model performance will be evaluated using several metrics, such as accuracy, precision, recall, and MAE and RMSE to measure prediction errors. Visualization of the results in the form of a decision tree will provide insight into the elements of the game that most influence student motivation, so that further development steps can be taken based on the results of the analysis.

In the final stage, this study will compile conclusions that explain the effectiveness of game elements in increasing student motivation, as well as provide recommendations for further development of GBL applications. The findings from the Decision Tree model are expected to provide new insights into how gamification elements, such as collaboration and competition systems, can be optimized to support more effective and engaging learning for students.

4. Results and Discussion

This study involved 20 students as application users, a sample size considered adequate for exploratory research, as smaller samples can provide valuable insights when the goal is to assess students' understanding of motivation [35], [36]. Data were collected from student interactions with the application, such as duration of use, frequency of participation, number of points obtained, and the results of student motivation surveys conducted before and after application implementation. These data were then analyzed using the Decision Tree algorithm to evaluate the effect of game elements on student motivation.

4.1. Student Motivation Survey

Before students used the GBL app, they were asked to fill out an ARCS model-based motivation survey. This survey was conducted to measure students' motivation level in four dimensions: Attention, Relevance, Confidence, and Satisfaction. The results of this survey will be used as initial or baseline data to compare with the survey results after using the application. After students have finished using the app, they again fill out the same motivation survey. This survey aims to measure changes in motivation that occur after the use of the GBL application. Scores from the post-test survey were compared with the pre-test to see the difference in motivation levels in students. Table 2 shows the results of the comparison before and after using the application.

Table 2. Result of Student Motivation Survey

Students	Pre-test Attention	Pre-test Relevance	Pre-test Confidence	Pre-test Satisfaction	Post-test Attention	Post-test Relevance	Post-test Confidence	Post-test Satisfaction
1	3	4	3	3	4	5	4	4
2	4	3	3	4	5	4	4	5
3	3	3	2	3	4	4	3	4
4	2	4	3	3	3	5	4	4
5	3	4	3	4	4	5	4	5
6	4	3	4	4	5	4	5	5
7	3	3	3	3	4	4	4	4
8	3	2	3	2	3	3	3	3

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9	2	4	2	3	3	4	3	4
10	4	3	4	4	5	5	5	5
11	3	4	3	3	4	5	4	4
12	4	4	4	4	5	5	5	5
13	3	3	2	3	4	4	4	4
14	2	4	3	3	3	5	3	4
15	3	3	3	4	4	4	4	5
16	4	4	4	4	5	5	5	5
17	3	3	3	3	4	4	4	4
18	2	4	2	3	3	5	3	4
19	3	3	3	3	4	4	4	4
20	4	4	4	4	5	5	5	5

The biggest increase occurred in the Relevance and Attention dimensions. Students felt that the learning material was more relevant and interesting when delivered through game elements in this application. Confidence also increased significantly. This shows that students become more confident in their understanding of the material after participating in game-based learning.

4.2. User Data Interaction

Students used the GBL application for online learning during a specified period. During the use of the application, various user interaction data were collected. This data helped researchers identify the factors that were most influential in increasing student motivation. User interaction data from the application included duration of use (DU) in minutes, frequency of participation (FP), number of points earned (PE), and level of collaboration (LC) with a range of 0 = Low, 1 = Medium, 2 = High. The data is shown in table 3.

Table 3. User Data Interaction

Students	DU	FP	PE	LC
1	120	5	100	2
2	90	4	80	1
3	75	3	60	0
4	130	5	110	2
5	95	4	85	1
6	100	5	90	2
7	110	5	95	2
8	80	3	70	0
9	85	4	85	1
10	140	5	120	2
12	65	3	50	0
13	70	2	55	0
14	125	5	105	2
15	135	4	115	1
16	105	4	100	2
17	115	5	105	2
18	90	3	75	1
19	85	4	85	1
20	75	3	60	0

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The average duration of application usage was 105 minutes, with an average frequency of participation of 4 times per student. Students who participated more often and used the application longer tended to have higher levels of collaboration, as well as earning more points.

4.3. Data Normalization

Before data normalization, researchers ensure the quality of data from survey results or application usage. Several steps are taken, such as identifying missing data and dealing with imputation or deletion, checking for anomalies or outliers to ensure accuracy, and normalizing the data so that the variables have a uniform scale. In addition, the data is checked for consistency, so that information such as frequency of participation and duration of app use can be said to be appropriate. If inconsistencies or errors were found, the data was further examined and corrected to maintain the integrity of the analysis. The results of the data cleaning conducted are shown in table 4.

Table 4. Data Normalization

Students	DU	FP	PE	LC	Post-test Attention	Post-test Relevance	Post-test Confidence	Post-test Satisfaction	DU (Normalized)	PE (Normalized)
1	120	5	100	2	4	5	4	4	73	71
2	90	4	80	1	5	4	4	5	33	43
3	75	3	60	0	4	4	3	4	13	14
4	130	5	110	2	3	5	4	4	87	86
5	95	4	85	1	4	5	4	5	40	50
6	100	5	90	2	5	4	5	5	47	57
7	110	5	95	2	4	4	4	4	60	64
8	80	3	70	0	3	3	3	3	20	29
9	85	4	85	1	3	4	3	4	27	50
11	120	5	110	2	5	5	5	5	100	100
10	140	5	120	2	4	5	4	4	0	0
12	65	3	50	0	5	5	5	5	67	71
13	70	2	55	0	4	4	4	4	80	79
14	125	5	105	2	3	5	3	4	93	93
15	135	4	115	1	4	4	4	5	53	71
16	105	4	100	2	5	5	5	5	67	79
17	115	5	105	2	4	4	4	4	67	79
18	90	3	75	1	3	5	3	4	33	36
19	85	4	85	1	4	4	4	4	27	50
20	75	3	60	0	5	5	5	5	13	14

The data in table 4 has been cleaned and normalized to ensure quality and uniformity. No missing data was detected. As a result, there is no additional handling was required. Anomalies or outliers in the Duration of Use and Points Earned columns were identified using the Interquartile Range (IQR) method. Although some outliers were found, the data was not deleted as it was still considered valid based on the research context. Furthermore, both columns were normalized to a scale of 1-100 to facilitate comparative analysis between variables, so that the final results were ready for further analysis.

4.4. Analysis Result by using Decision Tree

The Decision Tree model generated from the interaction data shows that the level of collaboration and duration of application use are the two main factors that influence student motivation. Students with high levels of collaboration and duration of use above 100 minutes tend to have higher motivation. In figure 3, there is a visualization of the decision tree that shows how game elements affect students' motivation levels.

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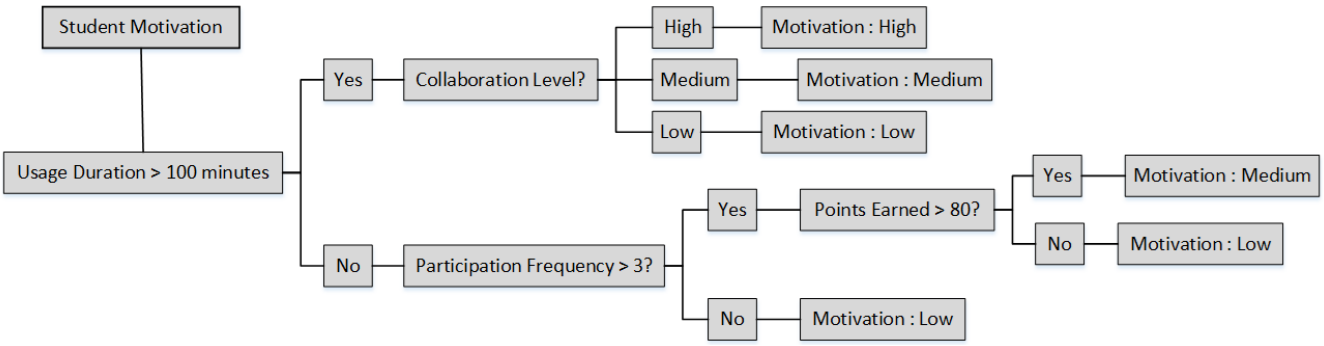

Figure 3. Decision Trees for Predicting Student Motivation

From the decision tree in figure 3, it can be seen that students with high collaboration and usage duration of more than 100 minutes tend to have high motivation. Variables such as frequency of participation and points earned also affect motivation, although not as strongly as the two main variables.

4.5. Analysis of Collaboration Elements and Duration

The main focus of this analysis is to evaluate the effect of app usage duration and collaboration level on student motivation in game-based learning. However, there are several confounding variables that could potentially affect the results, such as students' knowledge of the material delivered through the app, gaming experience, and other external factors such as learning environment, family support, and students' psychological condition. Further understanding of the influence of collaboration elements and duration of application use on student motivation can be obtained through simple correlation and regression analysis [37]. Person correlation is used to measure the strength of the relationship between these variables and student motivation. The product moment correlation, denoted by (r), has the largest positive correlation coefficient value = 1 and the largest negative corrrelation coefficient = -1, while the smallest = 0 [38]. The general interpretation of the correlation coefficient value can be seen in table 5.

Table 5. Interpretation of Coefficient Correlation

Correlation Value	Interpretation
0.00 - 0.19	Very weak or almost no relationship
0.20 - 0.39	Weak relationship
0.40 - 0.59	Moderate relationship
0.60 - 0.79	Strong relationship
0.80 - 1.00	Very strong relationship

Based on the results of the Pearson correlation calculation. a significant and strong relationship was found between Collaboration Level (CL) and Student Motivation. The Pearson correlation value of 0.85 indicates a strong positive correlation between these two variables. In addition. the p-value of 5.57e-29. which is well below the significance threshold of 0.05. indicates that this relationship is highly statistically significant. This confirms that the higher the students' level of collaboration in using the app. the higher their perceived motivation. Simple regression calculations were performed to predict motivation based on duration of use and level of collaboration. Pearson correlation was used to calculate how strong the relationship is between two variables. The Pearson correlation formula is as follows:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2 \sum(Y_i - \bar{Y})^2}} \quad (1)$$

Table 6 shows the results of the Pearson correlation calculation. It was found that there is a strong and significant relationship between Duration of Application Use and Student Motivation with a correlation value of r = 0.72. This result indicates that the longer students use the game-based learning app. the higher their motivation. The p-value of 0.0001 indicates that this result is highly statistically significant with a 95% confidence interval between 0.45 to 0.87. which does not include zero. This indicates that the relationship between duration of app use and student motivation is

consistent across the sample. In addition. Collaboration Level and Student Motivation also showed a moderately strong correlation with r = 0.68. The p-value of 0.0012 indicates that this relationship is statistically significant with a 95% confidence interval between 0.38 to 0.84. which also does not include zero. Thus. these results suggest that collaboration between students in the use of the app positively contributes to their increased motivation in learning.

Table 6. Table of Pearson Correlation Result with p-values and Confidence Intervals

Pair Variables	Pearson Correlation(r)	p-value	Confidence Interval 95%
Duration and Motivation	0.72	0.0001	(0.45. 0.87)
Collaboration and Motivation	0.68	0.0012	(0.38. 0.84)

4.6. Discussion

The results of the motivation survey showed a significant increase after using the TGT-based GBL application. Confidence and Attention dimensions experienced the greatest increase. These findings support previous research. related to gamification elements can increase student engagement by providing an interesting learning experience [28]. The increase in the Relevance and Satisfaction dimensions is also notable as it indicates that students feel more connected to the learning material and more satisfied with using the app. This suggests that game-based learning methods can help bridge the gap between student motivation and effective learning needs.

Analysis of the user interaction data shows that the level of collaboration and duration of app use are key factors in increasing student motivation. Based on the correlation and linear regression results. it can be concluded that the duration of app use and the level of collaboration have a positive and strong relationship with student motivation. The correlation of 0.72 between duration and motivation indicates that the longer students use the app. the higher their motivation. In addition. the linear regression shows that every 10-minute increase in the duration of app use can significantly increase student motivation. Likewise. the collaboration level has a correlation of 0.68 with student motivation. The linear regression model showed that each increase in collaboration level contributed significantly to the increase in student motivation.

Decision Tree does excel in simple and easy-to-understand interpretation of results [36], [37]. However. to improve prediction accuracy and handle more complex data. methods such as Random Forest or Support Vector Machine (SVM) is considerable to use [38], [39]. Although the analysis with Decision Tree shows that collaboration level and duration of app usage have the most significant influence on student motivation. it is important to consider other analysis methods that might provide a more in-depth perspective on the relationship between variables.

This study confirms the findings of previous research that the use of GBL application based on TGT model can increase student motivation. However. further studies need to be conducted regarding the long-term impact of using the application. A longitudinal approach can provide greater insight into changes in students' motivation and academic performance over time. thus revealing whether the increase in motivation is temporary or sustained and the extent to which increased motivation correlates with academic achievement. While high motivation is one of the main objectives. it is important to maintain a balance between competition and collaboration in the design of the app to ensure that the competitive aspect does not adversely affect students' well-being. Thus. consideration of these long-term dimensions and potential negative effects will stengthen the effectiveness and sustainability of GBL apps in supporting optimal and healthy learning experiences for students.

Further research is recommended to use more comprehensive methods. such as experimental designs with control groups or analysis of covariance (ANCOVA) to control the confounding variables such as prior knowledge. gaming experience and other external factors. Teh use of a more in-depth baseline survei can also help measure factors such as family support and students' psychological state. These measures will increase the validity of the research results and ensure that the findings regarding the influence of gamification elements in game-based learning are more accurate and generalizable to a wider population.

5. Conclusion

Based on the results of the analysis of 20 students who used the TGT-based GBL application. this study shows that the application of game elements in online learning can significantly increase student motivation. There are two important findings from this study. First. the student motivation survey measured by the ARCS model showed a significant increase in all dimensions of motivation after students used the GBL application. Second. the Confidence Dimension experienced the largest increase (36.67%). followed by Satisfaction (34.38%). which indicates that students feel more confident and satisfied with the use of the application.

Analysis using the Decision Tree algorithm revealed that the level of collaboration and duration of application use were the two factors that most influenced students' motivation. Students who worked collaboratively and used the application for more than 100 minutes tended to have higher motivation. This finding supports the importance of collaborative elements in the TGT model to motivate students more effectively. Although competitive elements such as frequency of participation and number of points earned also influenced motivation. their influence was not as great as the collaboration element and duration of use. It shows that competition can motivate students. but a balance between collaboration and competition is essential to maintain high motivation and reduce stress on students.

Based on the result of study. GBL applicatiton in the future should emphasis more on stronger collaborative features and provide activities designed to increase student engagement within an optimal duration (around 90 to 120 minutes). The duration of each session could be shorten with some breaks to prevent fatigue. For example. 30 to 60 minutes for each session with automatic reminders for breaks. In addition. More specific collaborative features. such as assigning toles within a team (e.g. leader. moderator. or note-taker). and the use of real-time collaboration tools such as group discussion rooms. can increase interaction and cooperation among students. Point and reward systems should integrate aspects of team collaboration. rather than individual competitiion. by providing rewards based on overall group performance to maintain a healthy balance between cooperation and competition. This study makes a significant contribution to the understanding of how gamification elements in the TGT model can be applied in game-based learning to increase student motivation. With the right balance between collaboration and competition elements. GBL applications can be an effective solution to increase student engagement and motivation in the digital era.

6. Declarations

6.1. Author Contributions

Conceptualization: A.B.W.. F.N.. S.B.Z.Z.. S.. F.N.A.. and Z.R.; Methodology: S.; Software: A.B.W.; Validation: A.B.W.. S.. and Z.R.; Formal Analysis: A.B.W.. S.. and Z.R.; Investigation: A.B.W.; Resources: S.; Data Curation: S.; Writing Original Draft Preparation: A.B.W.. S.. and Z.R.; Writing Review and Editing: S.. A.B.W.. and Z.R.; Visualization: A.B.W. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

The authors received no financial support for the research. authorship. and/or publication of this article.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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