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Sustainable Mathematics Learning Using Digital Game-Based Learning: The Impact on Student's Self-efficacy and Mathematics Achievement

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Abstract
The digital game-based learning (GBL) had potential to improve the quality of the Mathematics teaching and learning process. Previous studies have shown that GBL has many advantages in education to solve the challenges in learning Mathematics due to the difficulty and often tedious nature of the subject. However, few focuses on the mechanisms behind promoting inquiry motivation, such as the effect of GBL on learners' self-efficacy and mathematics achievement. This study developed Mathematics digital game-based learning application based on the constructivism theory. A quasi-experimental study method was used, and 64 primary school students aged 9 were randomly assigned to experimental and control group. After a 10-week intervention, it was found that digital GBL application helps to increase students' self-efficacy and Mathematics achievement. The findings of the study show that digital GBL application has succeeded in improving students' self-efficacy and the achievement of mathematics. Further research and practice must be consider about students motivation to increase students self-efficasy and Mathematics achievement.
Keywords: Mathematics Achievement, Game-Based Learning, Self-Efficacy, 21st Century Abilities, Technology

Introduction

Nowaday, the process of teaching and learning Mathematics is challenging. This is because learning mathematics is seen as an uninteresting, difficult and boring learning (Dele-Ajayi et al., 2019; Lai & Hwang, 2016; Tshewang et al., 2017). As a result, these negative perceptions cause students to be less effective on mathematical learning and affect student mathematical achievement (Deringöl, 2020; Power et al., 2020). Research suggests that GBL holds the potential to improve student performance and confidence, foster creativity and positive motivation, increase student engagement in learning and form critical and creative thinking (Byun & Joung, 2018; Hulse et al., 2019; Lo & Hew, 2018; Mera et al., 2019; Tokac et al., 2019).

The impact of the application of GBL in mathematics learning forms a positive self-efficacy in students. This is because well-designed GBL is able to engage students in meaningful learning environment activities and enable students to build knowledge on their

own (Giannakas et al., 2018). The interactive and technology-based learning process in GBL will make students enjoy playing while learning (Lim & Yunus, 2021) and thus can form a positive self-efficacy of students towards Mathematics. Although the use of textbooks benefits students (Ham & Heinze, 2018), but the change of time and the rapid development of technology has changed the way students learn.

Most studies in recent years have paid attention to the impact of GBL to students' thinking skill, motivation, and mathematics achievement (see Table 1). The results of this literature review show that there are still few studies that look at the impact of GBL on students' self-efficacy in Mathematics. Therefore, this research aimed to understand how GBL impact the students' self-efficacy and mathematics achievement.

Table 1. Impact of GBL in the teaching and learning of Mathematics

Impact of GBL	**Researcher (Year)**
Formation of thinking skills (n = 5)	Tokac et al (2019); Hwa (2018); Lo & Hew (2018); Hsu et al (2018); Hsu & Wang (2018)
Improving Mathematics achievement (n = 14)	Hulse et al (2019); Denham (2019); Brezovszky et al (2019); Ke (2019); Al Khateeb (2019); Moeller et al (2018); Hartanto et al (2018); Denham (2018); Yang et al (2018); Pérez et al (2018); Aljojo (2018); Ahmad et al (2018); Fokides (2018); Wang et al (2018)
Increase motivation in Mathematics (n = 10)	Gil-Doménech & Berbegal-Mirabent (2019); Dele-Ajayi et al (2019); Mera et al (2019); Beserra et al (2019); Kiili, Ojansuu, et al (2018); García & Cano (2018); Maloku et al (2018); Buteau & Muller (2018); Hanghøj et al (2018); Hwa (2018)

In this study, the application of GBL is based on the constructivism theory (Piaget, 1980). The theory of constructivism (Piaget, 1980) is a theory that encourage students to build their own knowledge. This is because the learning process not only occurs in the minds of students, but it is also closely related to the learning environment and issues of student learning environment. For this reason, constructivism theory is important in helping teachers plan and develop an effective learning material that meets the needs of students and over time. Therefore, the application of technologies such as GBL allows the principles of the theory of constructivism where most of the learning design encourages the construction of self-knowledge in students with a modern and up-to-date learning environment (Gaeta et al., 2019).

Mathematics learning and Self-efficacy

Self-efficacy is the individual's confidence in one's ability to organize and perform the actions necessary to complete a task (Bandura, 1997). Pupils with high self-efficacy values have a high level of self-confidence in completing all learning activities. This is because self-efficacy forms students' self-confidence in facing learning situations and prevents students from giving up (Fraile et al., 2017).

Self-efficacy in students is influenced by several factors and affects students. The findings of a study by Bandura (1997) report that the factors that influence self-efficacy are the current performance of students, learning experiences, social support, and psychological level of students. These factors if properly controlled have an impact on motivation, learning, self-confidence, and student achievement in learning. However, the biggest impact in the formation of self-efficacy is on student achievement in learning. This is because students with high levels of self-efficacy are more likely towards success than students with low self-efficacy (Kathryn & David, 2016). This statement is also supported by Schunk and Pajares (2009) where students who believe that they can succeed will form positive self-efficacy and motivation and on the other hand low self-confidence and self-efficacy will drive students towards failure. In the other hand, those students with higher self-efficacy would perform better in the high-level learning of critical conceptions in mathematics (Cai et al., 2019) and the student achievement performance were highly related to their motivation and self-efficacy (Hsia et al., 2016).

In the teaching and learning of Mathematics, students who have low self-efficacy are not able to show dexterity in making Mathematical calculations and are not able to solve difficult Mathematical problems. The findings of May (2009) study show that low level of self-efficacy causes students to feel scared while learning Mathematics. Fear in students results in they are not being prepared in the teaching and learning process and thus causes students to lack self-confidence to learn. Self-efficacy in Mathematics is defined as an individual's belief or perception of his or her abilities in Mathematics (Bandura, 1997). In other words, self-efficacy in Mathematics is his belief in solving various tasks, from understanding the concept of Mathematics to solving problems in Mathematics.

Although the development of self-efficacy cannot be fully understood, but according to Bandura (1997) there are four factors that influence self-efficacy namely mastery of learning experiences, vicarious experiences, social persuasion, and physiological conditions. However, in a study related to the self-efficacy of student Mathematics, Usher and Pajares (2009) found that the mastery factor of learning experience is a source that influences students' strong Mathematical skills. This is because students who feel they have mastered the skills and succeeded in challenging assignments in the learning experience an increase in self-efficacy beliefs.

In addition, the findings of previous studies by Bandura (1986); Pajares (1996) and Deringol (2020) show that the level of self-efficacy influences student achievement in mathematics. This is because self-efficacy is a determinant of student involvement in learning. Low self-efficacy will cause students to be unsure of the learning they are going through and cause students not to engage in learning. This is evidenced by the findings of the Deringol (2020) which showed low self-efficacy caused students to be less interested in mathematics and influenced student achievement in mathematics. According to Bandura (1994), student self-efficacy is influenced by the effect of learning experience where the success obtained will increase student self-efficacy. Meaningful learning experiences will make students' level of

effectiveness more realistic. This high level of effectiveness will form an awareness in students about the abilities they have compared to other peers. Therefore, teachers need to play an important role in applying teaching and learning approaches that can increase confidence and self-efficacy among students.

The findings of a study by Bandura (1997) show that the learning environment influences students' self-efficacy in learning. Students who feel the importance of a learning will be actively involved and build a learning environment to learn for themselves. However, not all students can build their own learning environment. Therefore, it is the responsibility of teachers to provide an environment that can attract students' interest and involvement to learn. This is because student self-efficacy will be built when students know clear learning goals and support a good learning environment such as positive feedback from teachers and stimuli from peers (Kathryn & David, 2016; Vattøy, 2020). Besides, good feedback will develop students thinking and learning (Guo et al., 2019).

Game-based Learning and Self-efficacy

The application of GBL approach is appropriate to apply because it can increase students involvement in learning mathematics (Beserra et al., 2019; Kiili et al., 2018). High student engagement is driven by student self-confidence built from students' interest in the learning process (Gil-Doménech & Berbegal-Mirabent, 2019). This is because the application of an interesting and interactive GBL approach will attract students and make students more focused on learning. Students' level of confidence and interest in learning will affect the self-efficacy of students where students are more confident and dare to try in solving learning problems. The factors of self-efficacy were obtained are organization, help-seeking, and achievement (Beatson et al., 2018).

The application of GBL based on technology is an important teaching approach among teachers today. The positive effects of GBL in the process of teaching and learning mathematics encourage students to learn a mathematical concept without realizing it and form good basic mathematical skills (Okur & Aygenc, 2018). As a result, students' self-efficacy can be formed and encourage students to work hard in solving mathematical problems. High self-efficacy of students with the application of GBL enables the process of learning mathematics to take place inside and outside the classroom only because students are motivated and enjoy doing revision and doing mathematics exercises (Skaalvik et al., 2015). High student confidence and involvement in the process of learning mathematics will help improve students' mathematical understanding and at the same time improve student mathematical achievement (Beserra et al., 2019; Kiili et al., 2018). This is because students' self-efficacy has been consistently linked to positive outcomes such as increased engagement and performance (Power et al., 2020) and students with higher self-efficacy would perform better in the high-level learning of critical conceptions in mathematics (Cai et al., 2019). The directive feedback from teacher to students nowadays has more negative correlations with the low achieving students (Guo et al., 2019).

Optimal student engagement in learning reflects high student self-efficacy in achieving learning goals or objectives (Ramli et al., 2020). This is due to the potential in the GBL that responds quickly to student learning and makes students not afraid to make mistakes. A recent study carried out by Hulse et al (2019) show that the application of GBL has successfully improved the algebra achievement among students. From the analysis that has been done, it is shown that the application of GBL creates a significant relationship between new knowledge and existing knowledge of students. This allows students to apply all available

knowledge at the same time to solve any given problem. This will encourage student engagement in learning and thus improve their mathematics achievement (Denham, 2019).

Moreover, the findings of a previous study by Brezovszky et al (2019) shows that the GBL approach has successfully increased the grade of mathematics achievement among pupils. According to Brezovszky et al (2019) one of the games that apply GBL is Number Navigation Game (NNG) and it demonstrates the enhancement of students' arithmetic skills and knowledge while providing teachers with flexible and practical teaching tools over time. This proves that the application of GBL in teaching and learning mathematics helps to improve the teaching quality of teachers and thus impact student achievement. In addition, the GBL approach is a combination of four aspects namely curriculum knowledge practices, pedagogical knowledge practices, scenario-based knowledge practices and daily knowledge practices (Steinmaurer et al., 2020). The application of GBL in teaching and learning mathematics will enable students to carry out their own learning in a free and safe learning environment. This allows students to learn freely without the fear of making mistakes as the GBL provides instant feedback (Steinmaurer et al., 2020). Thus, create a high degree of confidence and self-efficacy in the students to strive for success in mathematics learning.

The purpose of this research was to identify on how digital GBL application could affect students self-efficacy and their mathematical achievement. The aims of this study were to answer the following question:

1. Is there a difference in students self-efficasy based on the group of students using digital GBL application with the group of students using conventional methods?
2. Is there a difference in mathematics achievement between groups of students using digital GBL application with groups of students using conventional methods?

Method

A quasi-experimental study was conducted to see the impact of the use of digital GBL applications in improving self-efficacy and mathematics achievement.

The sample consists of 64 students in two primary schools in rural area in Miri, Sarawak. Students in the experimental group received treatment with learning mathematics by digital game-based learning apps. The treatment lasted for two hours each week for ten weeks. Participants in the control group attend classes as normal class learning with the use of resources such as mathematics textbooks, through the conventional approach.

The instruments were used in this study is the mathematics achievement test and self-efficacy scale. The mathematics achievement test consists of 16 items. Besides, self-efficacy was measured using an adapted version of scale created by May (2009) involves two constructs, general mathematical self-efficacy, and mathematical task self-efficacy.

Results

Results are presented relevant to students' self-efficacy and mathematics achievement.

Students Self-efficacy

Descriptive statistics of pre-test and post-test for mathematics achievement test were implemented based on the group of students using digital GBL application with the group of students using conventional methods. The measurement of pre-test and post-test to assess the level of self-efficacy of students in mathematics is as in Table 2. Findings show that the mean score of the mean score of students' self-efficacy on mathematics for the experimental

group was at a high level (mean = 4.706) on the post-test compared to the pre-test (mean = 3.547) (see Table 2). The mean score values and standard deviations obtained are interpreted using the mean score interpretation presented by Nunnally and Bernstein (1994) which is 1.00 to 2.00 (low), 2.01 to 3.00 (medium low), 3.01 to 4.00 (medium high) and 4.01 to 5.00 (high).

Table 2. Mean scores and standard deviations for students' self-efficacy on mathematics

Variables	**Pre-Test**		**Post Test**	
	Control	**Experiment**	**Control**	**Experiment**
Self-efficacy				
Mean	3.363	3.333	3.547	4.706
Standard deviations	0.644	0.870	0.633	0.230

Next, the findings for the students' self-efficacy variables on mathematics according to the contract are as in Table 3. Based on Table 3, the mean score of students' self-efficacy on mathematics according to the construct for the experimental group is at a high level, namely general mathematics constructs (mean = 4.650) and constructs. mathematics assignment (mean = 4762) on post-test compared to pre-test. The mean scores of students' self-efficacy on mathematics for the control group were at a moderate level, namely general mathematics constructs (mean = 3.482) and mathematics task constructs (mean = 3.244) on pre-test while on post-general tests on general mathematics constructs (mean = 3.424) and mathematical task construct (min = 3.670).

Table 3. Descriptive statistical analysis of students' self-efficacy on mathematics by construct

Self-Efficacy Construct	**Pre-Test**		**Post Test**	
	Control	**Experiment**	**Control**	**Experiment**
General Mathematics	3.482	3.394	3.424	4.650
Mathematical Assignments	3.244	3.272	3.670	4.762

Next, an independent t-test was performed to see the difference in the mean score of students self-efficasy based on the group of students using digital GBL application with the group of students using conventional methods (see Table 4). There was a significant difference in the mathematics achievement of the group using digital GBL application (mean = 4.7063, s.d.=0.230) and the group using conventional method (mean = 3.5466, s.d.=0.633); (t=-9.743, p=0.000).

Table 4. Mean scores of students' self-efficacy on mathematics based on groups

Self-efficacy	Group	N	Mean	Standard deviation	T-value	Sig.
	Control	32	3.5466	0.633	-9.743	0.000
	Experiment	32	4.7063	0.230		

Next, the eta-squared value is calculated to see the strength of the mean difference in the students self-efficasy score based on the group of students using digital GBL application with the group of students using conventional methods. The strength of the difference in the magnitude of the mean students self-efficasy score based on the group of students using digital GBL application with the group of students using conventional methods is large at 60.5%.

Mathematics Achievement

Descriptive statistics of pre-test and post-test for mathematics achievement test were implemented based on the group of students using digital GBL application with the group of students using conventional methods (see Table 5). For the group of students using digital GBL application, the pre-test mean was 25.606 and increased to 87.513 on the post-test. The mean pre-test for the group of students using conventional methods was 25.225 and increased to 52.356 on the post-test.

Table 5. Descriptive statistical analysis results of pre-test and post-test

Variables	Pre-Test		Post Test	
	Control	Experiment	Control	Experiment
Achievement Test				
Mean	25.225	25.606	52.356	87.513
Standard deviation	17.502	18.681	21.524	13.097

Next, an independent t-test was performed to see the difference in the mean score of mathematics achievement based on the group of students using digital GBL application with the group of students using conventional methods (see Table 6). There was a significant difference in the mathematics achievement of the group using digital GBL application (mean = 87.5125, s.d. = 13.097) and the group using conventional method (mean = 52.3562, s.d. = 21.524); ($t = -7.893$, $p = 0.000$).

Next, the eta-squared value is calculated to see the strength of the mean difference in the mathematical achievement score based on the group of students using digital GBL application with the group of students using conventional methods. The strength of the difference in the magnitude of the mean mathematics achievement score based on the group of students using digital GBL application with the group of students using conventional methods is large at 50.1%.

Next, the relationship between mathematics achievement and self-efficacy of group students using digital GBL application was analyzed using Pearson correlation coefficient

values. Table 6 shows that there is a positive and strong relationship between mathematics achievement with the self-efficacy of group students using digital GBL application ($r = 0.680$, $N = 32$, $p < 0.05$). According to Alias Baba (1992), the value of r indicates the existence of a strong positive correlation between the achievement of Mathematics with the self-efficacy of group students using digital GBL application.

Table 6. Pearson correlation between Mathematical achievement with self-efficacy

		Self-efficacy
Mathematical Achievement	Pearson coefficient (r)	0.680**
	Significant	0.000
	N	32

Discussion

Interpretation of Students Self-efficacy Findings

The findings of the study show that digital GBL application has succeeded in improving students' self-efficacy in learning mathematics. Findings show that students' self-efficacy is at a high level after using GBL application in learning mathematics. These findings are in line with previous studies by Beserra et al. (2019) and Kiili et al. (2018) where the use of learning materials with the application of GBL approach increases student involvement in learning. High student involvement is driven by student self-confidence built from students' interest in the learning process. According to Bandura (1997), individual confidence in one's ability to organize and perform the actions required to complete a task is a form of self-efficacy.

Self-efficacy in mathematics is his belief in a variety of tasks, from understanding the concepts of mathematics to solving problems in mathematics. High self-efficacy with the use of GBL in mathematics learning influences students' actions to achieve the goals of mathematics learning. Learning experience is a factor that influences the mastery of mathematical skills among good students driven by student self-efficacy (Usher & Pajares, 2009). An interesting and enjoyable learning experience with the use of GBL boosts students' self-efficacy. The level of self-efficacy of students will continue to increase as the learning experience they go through affects the achievement achieved by students (Yin et al., 2020). This is because students who feel they have mastered the skills and succeeded in challenging assignments in the learning experience experience an increase in self-efficacy beliefs.

In addition, the learning experience using digital GBL application provides a new and fresh learning experience to students. Exciting and fun learning experiences contribute to form positive self-efficacy in students. This is because the effects of learning experiences that help students 'success in learning increase students' self-efficacy (Mundia & Metussin, 2019). Meaningful learning experiences make students' level of effectiveness more realistic where this high level of effectiveness will form awareness in students about the abilities they have compared to other peers. This is also supported by Kathryn and David (2016) who stated that the formation of self-efficacy of students is built when students are supported with a good learning environment and students know clear learning goals.

Learning responses available from digital GBL application can be a reasonable explanation for the findings of this study. This is because in this study GBL application digital is set with the function of immediate feedback on student learning actions. Immediate feedback provided by this digital GBL application can form a positive self-efficacy of students

and encourage students to strive to the next level. This immediate non-response setting allows students to know the mistakes that have been made and immediately receive learning information to correct the mistakes that have been made.

This allows students to learn freely without fear of making mistakes and always knowing their learning progress. This forms the high self-efficacy of students with digital GBL application. This is because digital GBL application in the learning process encourages students to implement self-learning while playing, do frequent question and answer activities and receive a display of learning developments and reinforcement of positive comments throughout learning. Frequent positive feedback reinforcement responses throughout learning form students 'self-confidence and thus increase students' self-efficacy. This is in line with the view of Bandura (1994) who stated that the praise and stimulus words received by students directly or indirectly will encourage students to continue to strive to succeed despite facing challenging tasks and thus become a factor in improving students' self-efficacy. GBL application digital capabilities that provide a fun learning experience with learning response support are seen to be able to form a positive emotional structure of students and reduce students' anxiety in learning. This in turn helps to increase the self-efficacy of students in the process of teaching and learning mathematics.

In general, digital GBL application is an ideal learning material to help the teaching process of teachers and the learning process of mathematics students. The GBL application digital approach that encourages students to learn while playing has created an active and fun learning environment. The freedom to use digital GBL application helps to encourage self-directed learning among students with teachers acting as mentors. This self-study gives satisfaction and motivation to students to explore digital GBL application to their heart's content without any obstacles. This indirectly helps to change the perception of students who think that learning mathematics is difficult and boring.

Therefore, the application of constructivism theory (Piaget, 1980) is appropriate because this theory allows digital GBL application to provide self-contained learning features that provide a meaningful learning experience to students and motivate students to continue learning. This constructivist approach encourages students to form the basic concepts and skills of their own mathematics to the extent that it allows students to learn a mathematical concept without realizing it. As a result, students' competencies and self-motivation can be improved (Wu et al., 2014) thus helping to improve student achievement in mathematics.

Interpretation of Mathematic achievement findings

The findings of the study show that the use of digital GBL application has successfully improved the achievement of mathematics. This can be seen through the comparison of mathematics achievement based on the group of students using digital GBL application with the group of students using conventional method where the group of students using digital GBL application showed a significant improvement on post-test. This proves that the application of digital GBL application based on GBL approach successfully meets the learning needs of students in this era. The use of digital GBL application makes learning more active where teachers can diversify teaching and learning approaches. This successfully forms a more meaningful understanding of student learning and makes the teaching and learning process more effective. This is also supported by Steinmaurer et al. (2020) which is a GBL-based learning approach and technology helps build mastery of a learning concept easier to understand.

A reasonable explanation of the digital impact of GBL application in helping to improve student mathematics achievement is the potential of digital GBL application to encourage students to do more mathematics practice than conventional approach. If students are usually only able to complete six to eight mathematics training questions in mathematics teaching and learning time, but digital GBL application allows students to complete more than thirty mathematics practice questions in one Mathematics teaching and learning time. The integration of mathematics learning with digital GBL application allows students to learn directly or indirectly. This is because the GBL approach is able to encourage students to solve problems and self-learning (Saudelli & Ciampa, 2016) thus enabling students to learn a concept of mathematics without realizing it. As a result, students' self-competence and abilities can be improved (Wu et al., 2014) thus helping to improve student achievement in mathematics.

In addition, the digital success of GBL applications in helping to improve students' mathematical achievement may be closely related to the application of cognitive load theory Sweller et al (1998) during the construction of digital GBL application. The application of this theory allows researchers to take into account the cognitive load factor of students in developing digital GBL application. This is because a good and effective learning process occurs when the learning materials used are on par with the cognitive design of students (van Merriënboer & Sweller, 2005). The cognitive load theory also contributes to digital GBL application quality as well as student learning (Caskurlu et al., 2020). The application of this theory allows the digital GBL application to provide the arrangement of learning information according to the cognitive needs of students. The use of digital GBL application allows students to do progressive learning from easy to difficult. This helps the GBL application digital users to obtain a structured learning scheme through a learning process that is appropriate to the student's conceptual developmental stage. The implication is that the digital use of GBL application has succeeded in improving the achievement of mathematics.

The findings of the study also show that there is a relationship between self-efficacy and mathematics achievement of group students who use digital GBL application. The results of this study are consistent with Bandura (2006) who found that students' motivation in learning influences the students' self-efficacy where students who believe in their own abilities are more motivated to engage in learning and subsequently improve student achievement. This shows the self-efficacy of students moving in tandem in helping students take action and provide feedback in learning. This finding is in line with the views of Schunk and Pajares (2009) where students who believe that they can succeed will form positive self-efficacy and motivation and on the other hand low self-confidence and self-efficacy will drive students towards failure. The role-play simulations by GBL will help student decision-making foster self-efficacy beliefs (Duchatelet et al., 2021).

The relationship between self-efficacy and achievement in mathematics affects student involvement in learning. These findings prove that self-efficacy is an interrelated aspect of student mathematics achievement and influences student learning activities in determining actions in achieving learning objectives. This is because self-efficacy forms students' self-confidence in dealing with learning situations and forms student motivation (Ghufron et al., 2016). Learning experiences using digital GBL application provide an environment throughout the teaching and learning process that can be a factor in improving students' self-efficacy. This is because the stimuli, desires and confidence received by students while using digital GBL application encourage students to achieve the desired learning objectives. A good and effective teaching and learning process will be the main driver

to keep students in the learning process and thus improve students' mastery and achievement in learning.

Limitation and future work

The findings of this study show that digital GBL application has succeeded in improving students' self-efficasy and mathematics achievement. However, Bandura (2006) shows that self-efficasy are correlated to students learning motivation and impact to the students achivement. This give us information that students motivation is an importand factor that must be consider to increase students self-efficasy. The high motivation among student will influence their engagement in learning (Yu et al., 2019). In mathematics learning, students self-efficacy plays a crucial role for students motivation and directly affect their achievement. So, future word should be made on the students motivation and self-efficacy. This is because previous studies have also found that student motivation influences students' self-efficacy in that students who believe in their own abilities are more motivated to engage in learning (Bandura, 2006). This indicates that low levels of student motivation result in lower student self-efficacy in mathematics.

Previous studies shown that the application of GBL has helped to increase students' instructional motivation in mathematics learning (Beserra et al., 2019; Kiili et al., 2018; Wang et al., 2018). This is because GBL approaches make the learning process more interactive and engaging. This is in line with the needs and learning needs of students of this age who are often exposed to sophisticated technology devices in everyday life. Learning needs that are in line with student needs will encourage student engagement in learning. Therefore, the application of attractive and appropriate learning approaches to pupils will create positive pupils needs and thus enhance students' motivation to learn. Moreover, the application of learning approaches such as GBL will encourage students to feel the need to complete the play activities and thus influence their motivation and self-efficacy for the goals they want to achieve.

Conclusions

The results of this study have proven that the digital application of GBL in the process of teaching and learning mathematics has successfully improved the students' self-efficacy and their mathematics achievement. The case shows that digital GBL application can provide useful impact to students and mathematics learning. It is important to teachers and educational stakeholders to know that students in this century want new teaching and learning style by fully embracing and utilizing technology. Good teacher should have high performance goals relate to better student mathematics achievement (Ritzema, Deunk, Bosker, & van Kuijk, 2016). The rapid development of technology has influenced the development of student self-esteem and the implementation of the teaching and learning process of mathematics. These changes have led to the setting of the UNESCO Declaration of Incheon which requires teachers to develop effective learning environments to achieve the goals of education 2030 through quality education leading to relevant and effective learning outcomes. An interactive and technology-based learning process will make puppies fun while learning and thus develop the motivation and positive self-efficacy of students towards mathematics.

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