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Gamification Framework for Engagement Design Using Pls-Sem

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Abstract: The study's goal is to look into the gamification framework. This research focuses on gamification in e-learning, particularly in early childhood education; the 'what' and 'how' gamification can promote e-learning. Gamification has become popular in the past few years of research in education and business marketing. Early childhood is when brain formation can set the foundation for learning later. The most common scenes are the need to develop a complete and generic framework from a new perspective and its application to different environments in areas such as education and training, business, government, health, and life-day. However, the developed gamification for the business process has suggested more work needs to be done in the gamification area. Even their design framework is yet to be tested and aimed to act as a foundation for future research. Thus, this study aims to develop a gamified framework for children’s engagement design. PLS-SEM was used to analyse the proposed framework. Results show that the framework demonstrates that emotional and social factors substantially link children's engagement. Among the emotions noticed in this research are enjoyment, amusement, and satisfaction. Further research is valuable to explore more possibilities in increasing sustainability and the long-term effects of one gamification learning tool.

Keywords: *E-learning, education, children, emotion, social*

1. Introduction

Ludwig Wittgenstein, an Austrian philosopher, was among the first to attempt to formalise and make systematic gamification - Philosophical Investigation 1958. He was famous for utilising games to demonstrate the insufficiency of language for articulating abstract notions. Following this, other research projects in the subject of gamification were initiated, resulting in a much more progressive learning process (Wittgenstein 2010).

Past studies have noted that one size does not fit all in gamification application contexts. This means that individual differences must be considered (Nacke and Deterding 2017). Furthermore, Arnab et al. (2015) stated that we are still learning about which gamification design components and methodologies best map into which application domains.

Landers and Armstrong (2017) evaluated how satisfied, enjoyable, or relevant participants expected to be before utilising a gamified application by testing them on materials with PowerPoint versus gamified instructions. The findings indicate that the impacts are related to the participant's attitude and experience. Gamification benefits participants with game experience and a positive attitude more than traditional instruction benefits participants with less experience and a bad attitude.

Another classic example of how gamification is affecting education is Nacke and Deterding's research (2017). The study developed a gamified logbook application to track driving hours for driving school pupils. The study found that using gamification in a traditional scenario makes the tedious chore of logging driving hours more interesting and pleasurable than a manual log book without affecting the students' behaviour (Nacke and Deterding 2017).

Much literature indicates that gamification is fundamentally about learning (Nacke and Deterding 2017), which prompts greater research into the impact of gamification on education. However, determining how effective gamification is in learning strategy is a difficult task. This is owing to a dearth of long-term research that rigorously investigate and evaluate the impact of gamification treatments on student learning ability.

According to Granic (2014), it is proven that children is able to demonstrate their creativity through games. Games have also been shown to excite the mind while offering the education that is desired. As a result, it is not surprising that youngsters at an early age are familiar with any medium of gaming (Vittrup et al. 2016).

Early childhood is when the brain develops, laying the groundwork for subsequent learning. Neuroscientist and Harvard Center on the Developing Child director Jack Shonkoff has written extensively about how brain development in the

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early years is critical for later results (Gelsomini et al. 2020). Mora et al. (2015) stated that the needs for developing a complete and generic framework from a new perspective and its application to different environments in areas such as education and training, business, government, health, and life-day are the most common scenes. In addition, Dichev and Dicheva (2017), who had developed gamification for the business process, suggested more work needs to be done in the gamification area, even though their design framework is yet to be tested and aimed to act as a foundation for future research. In agreement with this, Li and Chu (2020) indicated that additional research is necessary to investigate more opportunities for boosting sustainability and the long-term impacts of gamification learning platform/tool/system.

While assessing learning at all levels of education is critical for tracking progress towards an education institution target, measuring children's development and learning at the start of school is especially important for equity (Unterhalter 2014). Sitorus et al. (2017) defined gamification as already widely used in cutting-edge technology, showing that the current approaches having gamification are the right way but do not take into account some necessary keys to get a more effective gamified process for success. Also, Dichev and Dicheva (2017) stated that gamification had successfully implemented in various subject matters and age groups. However, studies examining gamification and second language acquisition were not as prevalent.

According to Zainuddin et al. (2020), another limitation is the lack of adequate scientific research based on longitudinal evaluation and gamified learning perceptions. He urges that future studies go beyond short-term interventions to develop quality research output that can evaluate the efficacy of gamified interventions on student learning by systematically analyse the influence of gamification on students' learning.

In his book, Simoes (2015) lists four reasons why people play games: to learn, to relieve stress, to have fun, and to socialise. Fun can then be divided into four different categories.

- Easy fun is when players are merely concentrating on discovering;
- Hard fun is when a player is competitive and wanting to beat the competition;
- An altered state of fun alters how the player feels; and
- Social fun involves the player in interaction with other players.

The MDA framework, developed in 2001 by LeBlanc, Hunicke, and Zabek, is a popular gamification framework. This paradigm categorises how the game is used into three categories: Rules, System, and Fun. This makes up the mechanics, dynamics, and aesthetics of its design counterparts. This combination results in a gamified experience (Hunicke et al. 2004).

According to Dominguez et al. (2013), gamification education developers need to concentrate on the core factors that make video games appealing to players in order to create a system that can enhance student motivation. Because they affect players' cognitive, emotional, and social interaction, games are motivating (Lee & Hammer 2011).

The MDE framework, which Robson et al. (2016) modified from the MDA framework, was introduced in 2016. The final game design elements were simply altered by the MDE framework. This is due to the fact that feelings more closely mimic a gamified environment with emotional or engagement outcomes from the person.

Emotions are seen as the result of a gamified experience's mechanics and dynamics. The primary emotion elicited by a game designer, according to Sweetser and Wyeth (2005), is "joy." There are many different ways to have fun, including being surprised, amazed, and excited. It's significant to remember that the MDE Framework outlines three interconnected principles. Changes to one principle will have an impact on the other two, and they may even change the experience altogether. A game designer should always start from the players' perspective rather than the other way around, claim Robson et al. (2016).

Mohamad et al. (2018) have summarised that the five most popular gamification have been used in earlier studies. There are six common game elements used and defined. The definition are:

1. Leaderboard: A chart that displays individual progress. Show the student's rank and score. It added peer pressure to allow healthy competition among users of the application. To prevent demotivation among low-level ranking in the leaderboard, normally, a leaderboard will only display 5-10 top learners.

2. Badge: Given after a complete task, a completed milestone learning, a token of appreciation. According to O'Dononvan et al. (2013), the badge is an important element of gamification to motivate the student, engage them in subsequent learning tasks, and ensure that students are involved in the learning process.

3. Points: The scoring system is given upon completion of the module/ task. There are ways to implement point systems such as redeemable points, experience points, karma points and reputation points. Similar or used as a reward, a form of investment for further development. Points can also be considered a credit in an academic environment (Kumar et al. 2012)

4. Level: Inter-related with points. For example, reach a new level if points reach a certain amount. A ranking system gives the student a sense of development or achievement. A lower level is usually easier to achieve, while the advanced level requires more effort and competencies in the game.

5. Avatar: A virtual representation of oneself. A character in the system according to the students 'choice.

Award/Trading and Gifting: These can be physical rewards or in-system rewards (stickers, trophies). Turn points into physical inexpensive physical rewards. In the application itself, the reward can also be an avatar upgrade (Raymer 2011). It makes use of pride emotion in the student to display their progress in character (avatar).

This paper presents a gamification framework for children's engagement in community learning applications. The study is conducted in Sabah, Malaysia.

2. Related Works

According to Niittylahti et al. (2021), student engagement manifests itself in various ways and acts on numerous levels (cognitive, affective, and behavioral). Student involvement is the product of a collaborative effort that should result in positive consequences for students and schools (Scager et al. 2016). The more involved and empowered students are within their learning community, the more likely they will channel that energy back into their studies (Bond et al. 2020). Student engagement increases student satisfaction, boosts student motivation to learn, diminishes the feeling of isolation, and enhances student achievement (Martin and Bolliger 2018). For learning engagement to be present during class or other school activities, there must be student engagement.

Learning engagement is influenced by the teacher in addition to student engagement. A teacher who is enthusiastic about teaching can significantly increase pupils' interest and motivation to learn more (Cecilio-Fernandes et al. 2020). Furthermore, teacher enthusiasm is a motivating characteristic that can affect most students (Rianti et al. 2020). Teacher enthusiasm in the classroom involves various behaviours and practises, including (1) varying speed and tone of voice, (2) maintaining eye contact, (3) employing demonstrative gestures, (4) body movement, (5) displaying a lively facial expression, (6) employing illustrative words, and (8) maintaining vitality (Bellibaş et al. 2022). Positive relationships between teachers and students, and increased positivity in the classroom, reduce negative emotions and create a more engaging learning environment (Li and Dewaele 2021).

For this study, the learning engagement of preschool children is studied. Students, particularly preschoolers, tend to have a shorter attention span, making it difficult to interest them in the learning process. Moreover, in our technologically advanced era, traditional learning methods are less successful than in the past. Therefore, simple adjustments to the learning environment can raise children's interest in learning.

Preschool-aged children like playing. Children can improve motor skills in a stimulating and secure setting through play (Nijhof et al. 2018). Using game aspects in the learning environment helps boost students' motivation to study. Gamification of education is a strategy for increasing involvement in a learning environment by incorporating gaming elements (Dichev and Dicheva 2017). Young children are eager to learn about engaging, relevant, and life-enhancing issues (Bransford et al. 2000). Implementing gaming aspects into school-taught subjects is a fantastic way to interest students in their learning.

3. Methodology

The data gathered is then statistically analyses using the PLS-SEM technique using SmartPLS 3.3.3 software. There are two steps taken for the analysis of the data. Measurement model assessment is the first step, and structural model analysis is the second step.

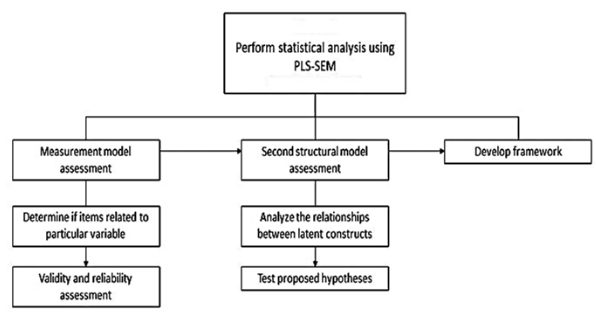

Fig. 1: Methods

The first step is determining if the items are related to a particular variable representing the variable and involves validity and reliability assessment. As for the second step, the relationships between the latent constructs are analyses. The testing of proposed hypotheses is also conducted in order. Finally, a framework is developed.

3.1 Expert Review

An expert review was gained from **23 experts** from the Information Technology education and industry field with more than ten years of experience. The review was done with two objectives: a) To get their opinion on the importance of gamification in education, b) To seek validation on the final instruments that were developed and suitable for use.

Table 1: Percentage of experts who approved and validated the instruments

No	Questions	Approve d (%)
1	Format suitable for data collection	91.3
2	The meaning of each item is clearly defined	69.6
3	The language used is easy to understand	78.3
4	Size and legible writing appropriate	87
5	The instructions given are clear	82.6
6	Distance writing is appropriate	87
7	Option meets answer questions	78.3
8	There is no spelling mistakes	82.6
9	Number of items used is appropriate	69.6
10	Questions to achieve the objectives of the overall study	91.3

Table 2 shows the content analysis for the experts' evaluation; most of them, over 70%, agreed on the contents of the instruments. Only minor corrections were improved from their further suggestions and comments.

3.2 Pilot Test

A pilot test was conducted with ten students from the Faculty of Computing and Informatics to see if they understood the instruments developed and to provide opinions on what constructs are suitable for children and what are constructs suitable for teachers/parents. The final instruments, 40 questions for children and 55 for teachers/parents, were developed as the final questionnaires.

4. Result and Discussion

The research model was analysed through the PLS-SEM technique (PLS-SEM) using SmartPLS 3.3.3 software (Hair et al. 2017). According to Thien (2020). there were two steps of PLS-SEM analysis: measurement model assessment and structural model assessment.

In the model assessment, the items are evaluated to determine if they correspond to a certain variable and accurately reflect that variable. It also includes assessments of validity and reliability. Only 24 components with loadings of at least 0.60 are retained for the entire model. The AVE values ranged from 0.542 to 0.764, indicating the achievement of convergent validity. Regarding the structural model assessment, the results indicate that emotions, socials, and mechanics are significant to children's engagement, but dynamics and mechanics are not. H3 and H4 are supported, but neither H1 nor H2 is. This component accounted for 0.241% of the variance in children's engagement. According to Owston and York (2018). standards for impact size, a value of 0.35 (considered large), 0.15 (considered medium), and 0.02 (considered small) is deemed large. This investigation identified only one medium effect (Socials f2 = 0.158) and three small effects.

4.1 Measurement Model Assessment

The first step in PLS-SEM analysis is the measurement model to determine if the items are related to a particular variable, represent the variable itself, and involve validity (Convergent and discriminant) and reliability assessment (Hair et al. 2020). Convergent validity will evaluate Composite Reliability (CR), Average Variance Extracted (Ave) and loading (Purwanto & Sudargini, 2021). Figure 1 and Figure 2 show the measurement full model assessment.

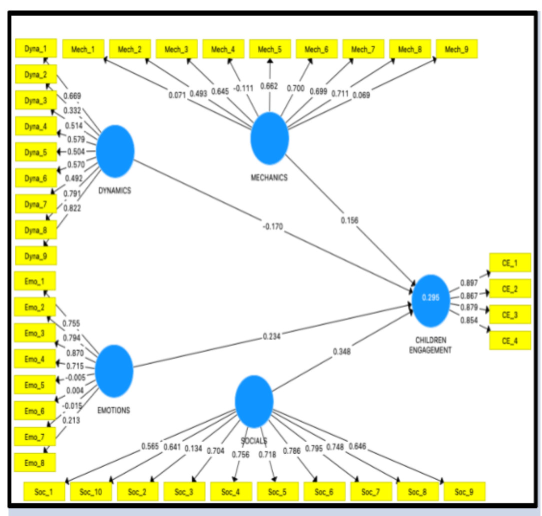

Fig. 2: Measurement Model (FULL MODEL)

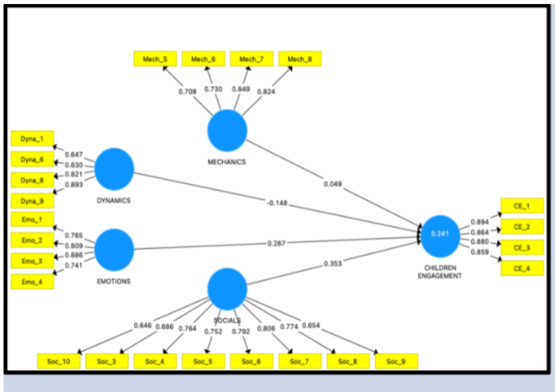

Fig. 3: Measurement Model

As shown in Table 3, the CR coefficient value for each of the latent constructs ranges from the lower value of 0.839 up to which exceeded the minimum acceptable level of 0.60 (Bakhsh et al. 2017).

For the loading, sixteen items (EMO_5, EMO_6, EMO_7, EMO_8, MECH_1, MECH_2, MECH_3, MECH_4, MECH_9, SOC_1, SOC_2, DYNA_2, DYNA_3, DYNA_4, DYNA_5 and DYNA_7) were deleted out of a total of 40 items as these items possessed loadings below the threshold of 0.60. In the end, only 24 items were retained for the entire model as they had loadings of at least 0.60 (Refer to Table 3).

The AVE values ranged from the lower value of 0.542 up to 0.764, which suggested that convergent validity has been achieved as the values are larger than the cutoff value of 0.50 as recommended (Kueh et al. 2017) (Refer to Table 2). Therefore, the convergent validity of the measurement model is acceptable.

Table 2: Amount of Loadings, Average Variance Extracted (AVE) and Composite Reliability (CR) Extracted

Construct	Measurement Item	Loadings	AVE	CR
Children Engagement	CE_1	0.894	0.764	0.928
	CE_2	0.864		
	CE_3	0.880		
	CE_4	0.859		
Mechanics	Mech_5	0.708	0.609	0.861
	Mech_6	0.730		
	Mech_7	0.849		
	Mech_8	0.824		
Dynamics	Dyna_1	0.647	0.572	0.839
	Dyna_6	0.630		
	Dyna_8	0.821		
	Dyna_9	0.893		
Emotions	Emo_1	0.765	0.643	0.878
	Emo_2	0.809		
	Emo_3	0.886		
	Emo_4	0.741		
Socials	Soc_3	0.686	0.542	0.904
	Soc_4	0.764		
	Soc_5	0.752		
	Soc_6	0.792		
	Soc_7	0.806		
	Soc_8	0.774		
	Soc_9	0.654		
	Soc_10	0.646		

For the discriminant validity, this study uses the Fornell-Lacker criterion and HTMT approach to assess the discriminant validity of the construct (Ab Hamid et al. 2017). Table 3 shows the Fornell-Lacker criterion in which the square of the AVE for each construct is higher than their respective correlation with other constructs. Table 4 shows the HTMT which none of the HTMT values for any constructs are higher than 0.9, which indicates that discriminant validity has been established. Table 5 shows the VIF value ranged from the lower value of 1.009 up to 1.746.

Table 3: Fornell-lacker

	CHILDREN ENGAGEMENT	DYNAMICS	EMOTIONS	MECHANICS	SOCIALS
CHILDREN ENGAGEMENT	0.874				
DYNAMICS	-0.192	0.756			
EMOTIONS	0.282	-0.049	0.802		
MECHANICS	0.258	-0.048	0.640	0.780	
SOCIALS	0.351	-0.079	-0.067	0.088	0.736

Table 4: HTMT Ratio

	CHILDREN ENGAGEMENT	DYNAMICS	EMOTIONS	MECHANICS	SOCIALS
CHILDREN ENGAGEMENT					
DYNAMICS	0.210				
EMOTIONS	0.294	0.136			
MECHANICS	0.296	0.161	0.812		
SOCIALS	0.363	0.208	0.180	0.181	

Table 5: VIF Value

VARIABLES	VIF VALUE
DYNAMICS	1.009
EMOTIONS	1.743
MECHANICS	1.746
SOCIALS	1.041

4.2 Structural Model Analysis

The second step to be performed for data analysis in PLS-SEM is assessing the structural model by analysing the relationships between the latent constructs and testing of proposed hypotheses (Sarstedt & Cheah 2019).

Figure 3 and Table 6 show and summarise the structural model analysis (hypotheses testing). The result shows that emotions (t-value = 2.288, $p < 0.023$) and socials (t-value= 3.002, $p < 0.003$) were significant to children engagement while mechanics (t-value = 0.465, $p > 0.642$) and dynamics (t-value = 1.229, $p > 0.220$) were not significantly to children engagement. Thus H3 and H4 were supported, while H1 and H2 were not supported. Altogether, this factor explained 0.241% of the variance in children's engagement.

Table 7 also shows the effect size (f2). This study follows Cohen (1988) guidelines for effect size that a value of 0.35 (large), 0.15 (medium) and 0.02 (small) (Osteen & Bright, 2010). Thus, based on table 5, only one medium effect (Socials f2 = 0.158) and three small effect (Mechanics f2 = 0.002, Dynamics f2 = 0.029, and emotions f2 = 0.054).

In addition, this study also uses blindfolding (Q2) to evaluate model predictive relevance. Based on Table 7, the predictive relevance (Q2) value is 0.147, indicating the large predictive relevance of this research model.

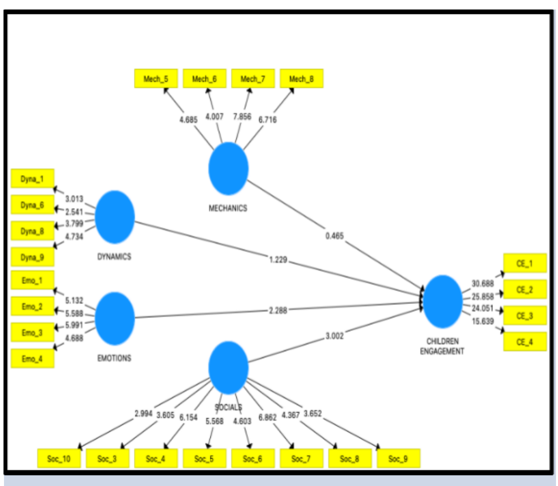

Fig. 3: Structural Model (Full model)

The primary objective of this project is to investigate the gamification framework for designing community learning applications for children. Using PLS-SEM, a gamified framework is constructed based on the findings. Before the development of the framework, EEG and an instrument consisting of a questionnaire produced by the authors were used to evaluate preschoolers from two separate preschools.

The EEG evaluation of children's involvement revealed that 67.45% are engaged with the gamified app. After the EEG test, the students are evaluated with the equipment (questionnaire). Based on the questionnaire results, the children's involvement with the app was high, with a mean of 3.68 for mechanics, dynamics, emotions, and socials.

The variable with the highest mean based on the results of preschool pupils is mechanics (mean score = 3.8). The item with the highest score (4.58 out of 5) in the mechanics is "Playing this game provides me with a meaningful experience." Students also report feeling more positively different ("I feel different (more courageous, less shy, etc.)," mean score = 4.33), focused ("I feel focused while using the app. ", mean score = 4.21) and happy when they see their peers happy ("When others are happy, I am happy too. ", mean score = 4.14). According to Poondej and Lerdpornkulrat, (2019), gamification substantially impacted student engagement, such that they participated in more learning activities offered by the community learning app. The majority of children are more motivated to learn in a gamified setting.

Emotions and social interactions had the most significant effect on children's participation. When youngsters are engaged with the application, their desire to learn intensifies as they attempt to win points or awards for learning accomplishments. Consequently, children become more competitive with their peers and will pay less attention to their environment. For instance, leaderboards encourage students 'goal-directed participation in an activity (Leung et al., 2022).

5. Conclusion

The framework demonstrates that emotional and social factors substantially link children's engagement. Among the emotions noticed in this research are enjoyment, amusement, and satisfaction. When youngsters exhibit tremendous feelings during the learning process, they are very engaged with the medium on which they concentrate, in this case, the community learning application. Engaging in an activity may reduce or increase your concentration on social interaction. Typically, a mobile app for community learning would provide exercises to be completed independently or in groups. If students were required to complete the activities independently, they would have less engagement with other app users and their environment. The kids will interact more with the application's users if the activity involves group participation. The study provides insight into what characteristics a mobile application for community learning should have to get high student engagement.

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Table 6: Results of the Structural Model (Hypotheses Testing)

Hypothesis	Relationship	Std. Beta	Std. Error	t-value	P value	Decision	f^2	Q^2	R^2
H1	Mechanics > Children Engagement	0.049	0.079	0.465	0.642	NOT SUPPORTED	0.002	0.147	0.241
H2	Dynamics > Children Engagement	- 0.148	- 0.166	1.229	0.220	NOT SUPPORTED	0.029		
H3	Emotions > Children Engagement	0.267	0.259	2.288*	0.023	SUPPORTED	0.054		
H4	Socials > Children Engagement	0.353	0.378	3.002	0.003	SUPPORTED	0.158		

Note: t-value > 1.65* (p<0.05); t-value>2.33** (p<0.01)