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Framework of Gamification Towards Art and Design Students' Problem-Solving Skills in Malaysia Higher Education

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Abstract: *In recent years, some of the debates regarding to the Malaysia education system ability to produce competitive graduates have arisen among researchers. Specifically, in Art and Design education, there are researcher emphasizing on the employment gaps results in the different expectation between education and industry. Transformation of teaching method needed to be implemented as the conventional teaching method are no longer effective due to the characteristic of young learner who are tech-savvy. Integrating technologies such as video games into curriculum can be promising tools in enhancing students' problem solving. This research aimed to investigate the effects of gamification towards students' problem-solving skills in Malaysia art and design higher education and develop a framework of gamification. The respondents are being divided into two groups, i.e., treatment group and controlled group with approximately 30 students in each group. A specially designed learning task, which included all elements of gamification will be demonstrated to both treatment group and controlled group. Descriptive analysis will be used to compare the mean score of the treatment group and controlled group. The results show that gamification is effective towards the 9 sub-elements under problem-solving skills. Systematicity and information collection are the two sub-elements improved the most for the mean value, with mean difference of +1.10 and +1.00 respectively. This implies that students are more systematicity, which students can use flexible ways to implement the solution to problems and monitor the progress more effectively, and capable in information searching as gamification environment allows students to have different ways to access to the information and resources. The framework of gamification is developed based on the results and it is recommended future researchers can expand the respondent's scope as the study focused exclusively on design students at the diploma level, which introduces a demographic limitation.*

Keywords: Gamification, Problem-Solving Skills, Art and Design Education

1. Introduction

As the advancement of technology bringing the Industrial Revolution 5.0 which focusing on the digitalization and sustainability, the future employment criteria are evolving consistently with these changes. Problem-solving skills, as one of the highlighted skills that has been critically needed to fulfil the future employment requirement (Meditama, 2022), needed to be equipped by the future generation to fulfil the new workforce demand (Fiore et al., 2018; Graesser et al., 2017; Rosen & Rimor, 2012). As the frontline of shaping future workforce,

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higher education institution must be able to adapt to these changes. As the young learners are basically comprised of millennials who are well-known for their tech-savvy characteristic, education technology such as AI-driven learning platform, interactive content and utilization of gamification could be a supportive tool to enrich the learning experience (Islam et al., 2024). In addition, to equip students with excellent problem-solving skills, traditional ways of learning are not attractive to engage young learner as they are preferring to learn in student-centred approaches rather than teacher-centred approaches. As a result, there is an employment gap between the education and industry as the students are not engaged to learning and not competitive in problem-solving when going to the industry. This is especially a serious issue in art and design field. According to Meyer and Norman (2020), the current art and design field facing an issue by which designers seldom holding managerial roles which required high level of problem-solving and decision making, comparing to other expertise area. Therefore, intervention must be made to transform the teaching method aligning to the characteristic of today's young learners to solve this issue. Integration technologies such as video games can be a promising tool to enhance student learning. However, integrating real video game or as known as game-based learning may cause game addiction to students and affects their performance. By using game elements without playing the real video game, it can evoke students' interest and attraction to the subject topics. This can be achieved through gamification approach, which integrate the gaming elements, such as pointing system and reward system during the learning process to create the sense of competition and sense of achievement while learning among the learners without interrupting their study. Therefore, this study aims to integrate gamification elements into design students' learning process to enhance their problem-solving skills.

2. Research Objective

There are two research objectives in this study, which are:
i) To identify the effect of gamification on design students' problem-solving skills.
ii) To generate a gamification and problem-solving framework for design students based on the result

3. Literature Review

In this section, the key elements in this research are reviewed through previous studies and implication are found to support this research.

3.1 Problem-solving Skills

Generally, problem-solving skills are those capabilities that enable the students to manage problems based on their reasoning skills Reasoning skills could be inductive or deductive, which means focusing on the exploration of information to connects the problems (Fischer, Greiff, & Funke, 2012) and problem solving based on logical statements or rules (Care, Griffin, Scoular, & Awwal, 2015) respectively. According to the research of Hesse et al., (2015), which is focusing on the collaborative problem-solving skills, problem-solving skills or cognitive skills can be divided into two categories, which are task regulation skills and knowledge building skills. In this research, we will exclude the collaboration skills part as this research only focusing on the problem-solving skills.

The first sub-element, task regulation refers to the one's abilities in problem-analysis, resource management, goal setting, or information collection flexibly and systematically (Hesse et al.,

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2015). There are six components under the task regulation skills which has been illustrated in Figure 1 as follows:

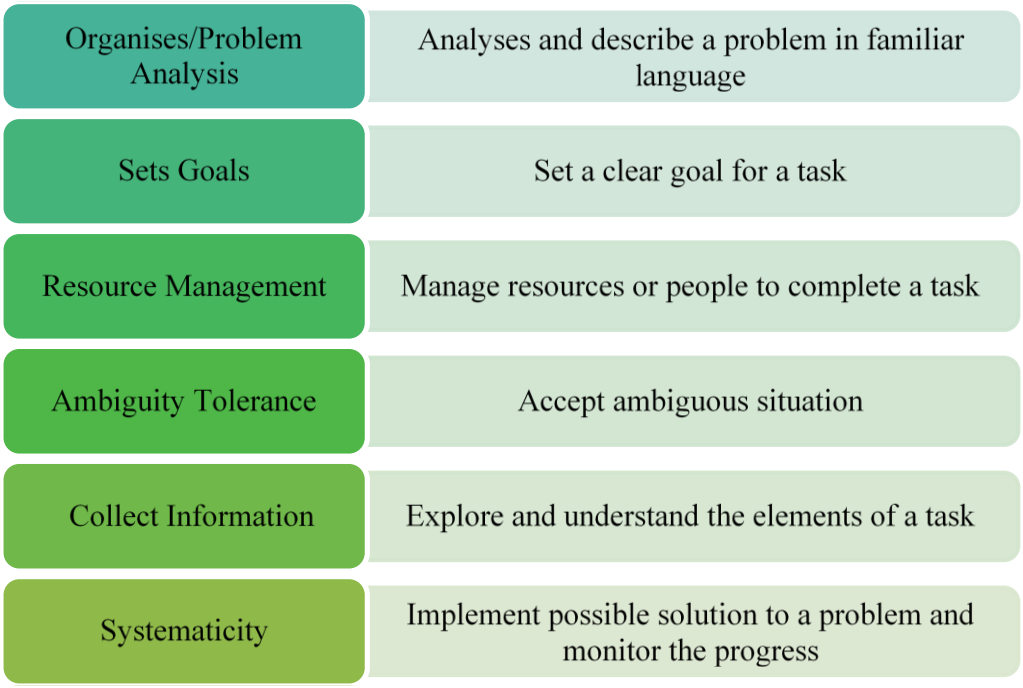

Figure 1: Components in Task Regulation Skills

Figure 1 shows all the components and respective explanation in task regulation skills. The first component, organization or problem analysis is related to the ability to describe problem in familiar language. One must be able to describe the problem before solving it as the identification of problem is critical to improve or solve the issue. Secondly, goal setting is also essential in problem-solving. The goal must be set according to the SMART criteria, where the goal must be specific, measurable, attainable, realistic and timely to develop a clear prediction for the desired future state. The third component is resource management, by which all the resources are utilized to maximise the strength and minimise the weaknesses of current situation. The fourth element, flexibility and ambiguity tolerance is to accept the ambiguous situation and willing to adapt to possible solution to solve the problem. Collect information component also important to gather relevant details related to the task and problem to effectively solve the issue. The last component, systematicity is implement possible solution and monitor the progress.

The second element under problem solving skills is knowledge building. A good knowledge builder is good in synthesis the input and utilizing current knowledge to solve a problem. There are four components under this element, which are knowledge acquisition, represent relationships, identifies consequences and hypotheses. Knowledge building skills enables one to represents and formulate the relationship and connection between issues, identifies the cause and effects and adapts reasoning or course of action as information or circumstances change. With these skills, problems can be solved effectively and efficiently through applying the knowledge and abilities.

3.2 Gamification

The gamification in education refers to using game elements to make the learning process more game-like. It is undeniable that gamification can enhance students' learning. Rewarding system

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or incentives is critical as the removal of these may disrupt motivation. Therefore, the rewarding system must be well-structured which align with the motivational levels of learners so that gamification is effective. According to Glover (2013), for a reward to be effective, it must be both attainable and appealing. Additionally, the reward should be constrained to create a sense of accomplishment when it is achieved.

In recent years, researchers have explored the use of gamification across various educational contexts (de-Marcos et al., 2016; Domínguez et al., 2013; Zhao et al., 2021). However, previous studies suggest that gamification may not be universally applicable to all forms of learning. Specifically, if the learning content is not tailored or adapted to align with the gamification elements, its effectiveness may be diminished. In other words, while engagement is a key factor influencing students' learning, the content itself must also be relevant and appropriate to the learners. According to Chou (2015), gamification can be implemented in diverse ways, as long as it involves incorporating the enjoyable and stimulating aspects commonly associated with games into the educational process.

3.3 Gamification Elements

In this research, there will be 8 gamification elements being used to enhance students' problem-solving skills, which are points, levels, leaderboard, progress bar, feedback, badges, avatar, and chat. Firstly, the pointing system considered as one of the most common and important elements in gamification. It can be used to measure the success and achievement of learners during their learning process. previous studies from several researchers found out that there is a notable effect of using points in gamification to improve students' performance (De-Marcos et al., 2016; Mekler et al., 2017). This is largely due to the point-based system increase the number of answered questions by the students in the classroom (Denny et al., 2018). The second element, levels, represent the learners' milestone in the study process. Leaderboards shows the status of learners, which higher ranking shows that the better performance of the learners in study. It creates a sense of competition among learners, attracting their willingness to improve their performance (Alomari et al., 2019). Progress bar shows the completion of lessons for each learner, giving a reference to learners regarding their progression. According to Toda et al. (2019), progress bars are highly significant in study process as Dignan (2011) argued that lack of progression can lead to feelings of frustration or anxiety among students. A progress bar enables learners to assess their position and tailor their learning according to their current skills and abilities. On the other hand, feedback from the test or assessment as well as the class activities allowed students to know their strengths or weaknesses, therefore, is essential for improvement. Kim et al. (2016) and Roosta et al. (2016) claimed that progress bar is essential in enhancing students' engagement towards learning, as well as improve their involvement in classroom. The next gamification element, which is badges are the virtual prizes that encourage learners to participate in activities, creating sense of achievement and honour while getting it. Similarly, avatar also have similar characteristic, by which the figure or photos represent the learners given as a reward of outstanding performance can be shown in their profile. Lastly, chat is the interactive function which allow group discussion or between learners and instructors to exchange ideas and create bonding with each other.

4. Research Methodology

This research is involving a treatment group and control group by using quasi-experimental research with non-equivalent control group posttest-only design. Specifically, students are separated into controlled group and treatment group which the controlled group undergo traditional way of learning while treatment group undergo the gamification process for the

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same subject topic. Each treatment group and controlled group students are then divided into group of 3 to carry out the learning tasks. After the demonstration and learning process, the assignments are being marked following the specially designed and validated rubrics which included all problem-solving elements. The assignments marks are then compared and the problem-solving levels of both controlled group and treatment group are then being analyse and mean difference are being calculated to interpret the problem-solving skills level of treatment group and controlled group.

4.1 Population and Sampling

The population of this research was focused on the art and design students in private higher education institution in southern part of Malaysia. A sample of 79 students with 33 students (11 groups in controlled group) and 36 students (12 groups in treatment group) are selected by using cluster sampling where the samples are chosen from one university college's art and design diploma students. To avoid bias, paring techniques is used to pair two students with similar demographic background and characteristic and separated these two students into treatment group and controlled group.

4.2 Instrument

The instrument of this research consists of two assignments, where the assignment questions are shown in the following section.

The first assignment is to assess students' problem-solving in terms of task regulation. The components under task regulation are organization, goals setting, resource management, ambiguity tolerance, information collection and systematicity. All these components are integrated into the assignment as follows:

Table 1: Task Description for Assignment 1

Task	Task Description	Element Measured
1	Each team of student is required to identify the problems in current society/ company	Organization
2	Students are required to set a desired effect or outcome of the broadcasting advertisement	Goals Setting
3	Students need to distribute the task among the team members	Resource Management
4	Students are required to solve the ambiguity and problems during the idea development and script production	Ambiguity Tolerance
5	Students need to carry out research through reliable online platform or websites to address the problems	Information Collection
6	Formation of ideas and draft of scripts are reviewed by instructor. Necessary amendments are made until the satisfactory idea and scripts are developed	Systematicity

Similarly for assignment 2 which measuring the students' problem-solving level in terms of knowledge building element. The components under knowledge building of problem-solving skills are represent relationships, identifies consequences, hypothesizes, and knowledge acquisition. Based on these 4 components, task instruction is designed as shown in Table 2:

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Table 2: Task Description for Assignment 2

Task	Task Description	Element Measured
1	Based on the scripts developed, students are required to connect the scripts to the problem identified in assignment 1 to solve the problem	Represent relationship
2	During the recording, students are required to identify the action to be done to make sure the recording sound is clear in different environment	Identifies consequences
3	Students are required to make prediction and planning on sound editing tools to be used in during the recording to bring the right atmosphere and effects	Hypothesizes
4	The final broadcasting advertisement is created by using the techniques and skills taught during the lessons	Knowledge acquisition

5. Design and Development of Learning Task

The design of learning task will be integrating the gamification elements into the learning task. A platform of gamification known as TalentLMS is being used as it has in-built gamification features which align with this study.

The first element, points is one of the features in TalentLMS by which student will earn points when they participated into classroom activities during the learning process. For instance, they will be given points based on the unit completion or based on assignment and test marks. Secondly, the learning task is divided into 6 levels. Students can unlock the levels based on the courses completed. In this learning task, only the student completed the course and achieved certain level can proceed to the next chapter. Thirdly, based on the points accumulated, leaderboards will show the ranking of students in their class. The fourth element, progress bar, showing students' progression, offering extrinsic guidance that helps them become aware of their current position within the lessons. In addition, feedback is also integrated into learning tasks as a key component of gamification. Feedback is typically provided after students submit their assignments or tests, offering them a deeper understanding of the subject matter. The following gamification elements are badges and avatar. There are 8 types of badges that will be given, i.e., activity badges, learning badges, test badges, assignment badges, perfectionism badges, survey badges, communication badges, and certification badges, according to the accomplishment and achievement of students. Avatar will also be awarded to student when they complete task outstandingly. The last element, chat, is a feature in the platform which students can choose to start group chat or private chatting with instructor or peer, to exchange ideas and enhance bonding.

6. Results, Findings and Discussion

After the demonstration of learning task, each of the students' work are being evaluated based on the rubric and summarized in Table 3:

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Table 3: Students' Results in Assignment 1 and Assignment 2

Elements	Controlled Group													Treatment Group												
	CG1	CG2	CG3	CG4	CG5	CG6	CG7	CG8	CG9	CG10	CG11	**Total**	**Mean**	TG1	TG2	TG3	TG4	TG5	TG6	TG7	TG8	TG9	TG10	TG11	TG12	**Total**	**Mean**
Assignment 1: Task Regulation																											
Organization	3	4	3	3	3	3	4	2	4	3	3	35	3.18	3	4	3	3	4	4	3	4	3	3	4	4	42	3.50
Goals Setting	3	4	3	3	3	1	4	2	3	3	2	31	2.82	4	4	2	4	4	4	3	2	2	2	3	3	37	3.08
Resource Management	2	4	4	3	2	3	4	3	2	4	3	34	3.09	4	4	2	4	4	4	4	3	4	4	4	4	45	3.75
Ambiguity Tolerance	3	2	2	3	3	3	3	3	3	3	3	31	2.82	3	4	2	4	2	2	3	3	2	5	5	3	38	3.17
Information Collection	4	3	3	2	3	3	4	2	3	3	3	33	3.00	4	3	3	4	4	5	4	5	3	5	5	3	48	4.00
Systematicity	2	3	2	3	3	3	3	3	3	4	2	31	2.82	3	2	3	4	5	5	4	4	4	5	5	3	47	3.92
Assignment 2: Knowledge Building																											
Represent relationship	3	3	2	3	3	4	4	3	3	3	3	34	3.09	3	2	4	3	3	4	4	4	4	3	4	4	42	3.50
Identifies consequences	2	3	2	2	3	3	3	2	4	4	3	31	2.82	4	3	4	4	2	2	3	3	3	4	4	4	40	3.33
Hypothesizes	2	4	2	1	4	3	4	3	4	4	2	33	3.00	3	3	3	3	3	2	3	3	3	3	4	3	36	3.00
Knowledge Acquisition	2	3	2	2	4	4	3	2	4	4	4	34	3.09	4	3	4	5	5	4	3	4	4	5	3	5	49	4.08

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Based on the result in Table 3, the mean score of controlled groups and treatment groups for each assignment are calculated. For assignment 1, the component under task regulations has the mean score ranging from 2.82 to 3.18, which organization (mean = 3.18), goal setting (mean = 2.82), resource management (mean = 3.09), ambiguity tolerance (mean = 2.82), information collection (mean = 3.00), and systematicity (mean = 2.82). For treatment group, the mean scores for the six elements are 3.50, 3.08, 3.75, 3.17, 4.00, and 3.92 respectively. Generally, it is clearly illustrated that controlled group scored lower in every component under this category. This indicate that gamification is effective in enhancing the task regulation skills among the treatment groups.

For assignment 2, the result of knowledge building skills is similar with those in assignment 1, where the controlled group mean score for each component under knowledge building is ranging from 2.82 to 3.09. While comparing the same component across the controlled and treatment groups, it is evident that the treatment group consistently scored higher in most of the components. The only exception was the component of "hypothesizes," where the mean scores are identical between the two groups. This suggests that gamification has no effect on improving this component while positively impacted on the component of representing relationships, identifying consequences and knowledge acquisition.

When comparing the mean differences between the treatment and controlled groups for each component, it can be concluded that the most significant improvements were observed in the elements of systematicity and information collection, with mean differences of +1.10 and +1.00, respectively. These findings shows that gamification allows student to improve their ability to implement solutions and monitor the progress effectively and able to collect the information through different channels. As these two elements is inter-related, they are impacted the most through gamification. This is because students can gather information through others' perspective and opinion while solving problems. Gamification approach provide a platform of chats and feedback to allow students to get information and improve their problem-solving skills.

The following highest impacted components included knowledge acquisition, under the knowledge building skills, which improved by +0.99. Other components showing improvement are resource management (+0.66), identifying consequences (+0.51), representing relationships (+0.41). Components which show lesser improvement are ambiguity tolerance (+0.35), organization (+0.32), and goal setting (+0.26). Ambiguity tolerance showed a moderate improvement, suggesting that students' flexibility in problem-solving improved to a moderate extent. This could be attributed to the emphasis in art and design curricula on developing ambiguity tolerance, which means students are already well-trained in this area. As a result, the improvement in this element was relatively less pronounced compared to the other components. On the other hand, organization also show lesser impacted. This may be due to students' backgrounds at the diploma level, where this component may require higher-order thinking skills that could be more challenging for students at this stage of their education.

Based on the results and findings above, a framework of gamification and problem-solving for art and design students are being developed as shown in Figure 2:

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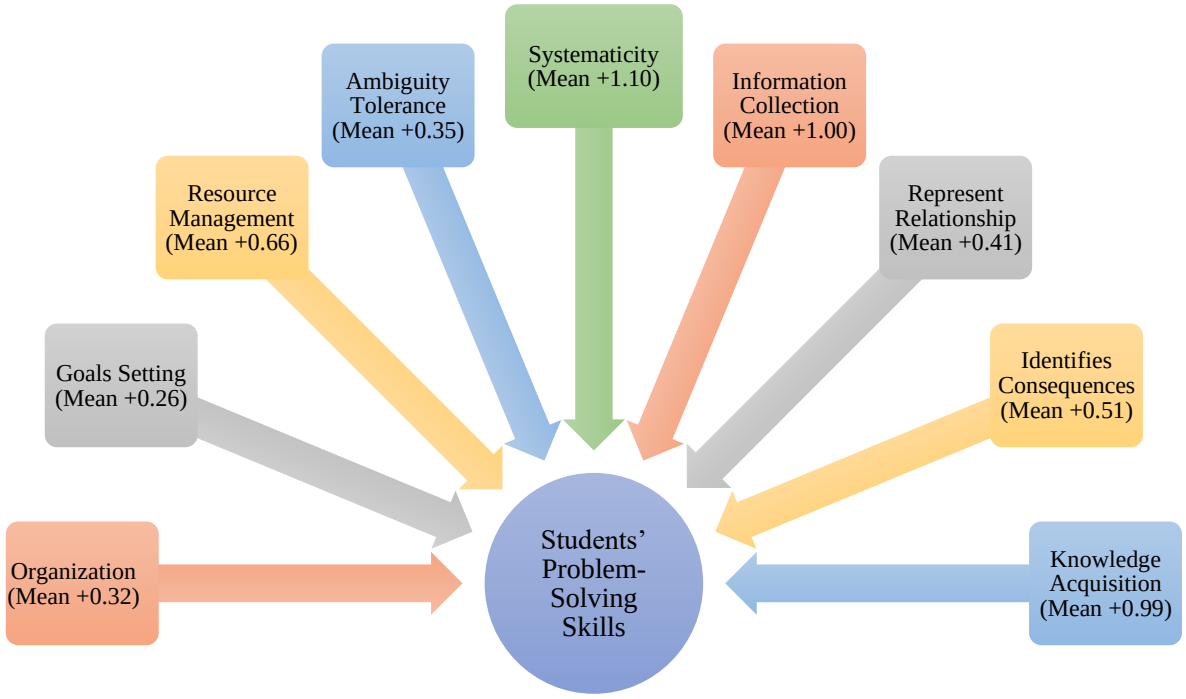

Figure 2: Framework of Gamification and Problem-Solving Skills for Art and Design Students

Figure 2 shows that all the components under gamification are being positively impact except for hypotheses component which has no improvement and has been excluded in the framework. The magnitude of impacted are also included into the framework.

7. Conclusion

From the results, it can be concluded that gamification has great influence on students' problem-solving skills in terms of task regulation and knowledge building. Except for the component of "hypotheses" under task regulation, all other components are positively impacted by gamification. This research provides an insight for the educators on the demonstration of gamification and its impacts on different component under gamification. For instance, it is notably that systematicity and information collection are components that are greatly impact through gamification approach. If the students are weak in these areas, educators can use gamification approach to improve the students' skills. On the other hand, the result of this research also provide insight to the education stakeholders, such as the Kementerian Pendidikan Tinggi Malaysia (KPT) and other policy maker of education field in formulating the effective teaching approaches.

8. Limitation and Recommendation

This research has several limitations need to be taken into consideration, i.e. demographical limitation and geographical limitation. For instance, demographical limitation is related to the constrain of respondents' background who are all diploma students. Future research could broaden the range of education level, for example, to include the bachelor's degree students or certificate students. On the other hand, geographical limitation is found where this research is only focusing on southern area of Malaysia. Future research can expand the study to whole Malaysia to include a more comprehensive sample.

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