Transforming Classrooms through Game-Based Learning:
A Feasibility Study in a Developing Country

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ABSTRACT

This article reports an exploratory study which investigated attitudes towards the practice of game-based learning in teaching STEM (science, technology, engineering and mathematics) within a Thai educational context. This self-administered Internet-based survey yielded 169 responses from a snowball sampling technique. Three fifths of respondents were female (59.2% or N=100 females and 40.8% or N=69 males). Slightly more than half (55.6%) of the participants were elementary, secondary and university students. An additional second group of thirty-five per cent (N=59) were teachers who were in charge of STEM educational programs. Almost one tenth (9.5%, N=16) were parents. Frequency tables were used to analyze the quantitative data. The qualitative data was derived from a single open-ended question. The study found some divergent opinions that are useful in considering game-based learning for STEM education in Thailand. The overall average attitude towards the usage of game-based learning was very positive (3.92 out of 5, S.D. = 0.80). The study found that the majority of informants preferred that the delivery mode was online through a web browser followed by the mobile mode through an application and the least preferred was the offline mode recorded on CD-ROM (55.0%, 31.4% and 13.6% respectively). Thai was still the most preferred language to be used though both students and parents surveyed had a stronger preference for English and a Thai-English bilingual mode than the teachers. An important finding in this research was that stakeholders expected game-based learning to be integrated into the traditional classroom because of its enhanced learning approach.

1. INTRODUCTION

Game-based learning (GBL) is claimed to be one of the best strategies to be implemented in the 21st century classroom. The objective of this current research was to explore how the three main stakeholders in the educational process, namely, teachers, students and parents, applied GBL to enhance the teaching of a new curriculum grouping, namely, science, technology, engineering and mathematics (STEM) education. A key focus of this research was GBL's

impact on the important aspects of increasing teacher, student and parent knowledge. Reeve (2013) stated that developing the specific skills of students as core foundations of STEM education. To remain globally competitive, Thailand's educational authorities have called for increased studies in the fields of STEM education. The Special Initiative Project Division under the supervision of the Institute for the Promotion of Teaching Science and Technology (IPST) supports the allocation of grants to underpin the development of strategic plans, conducting professional development initiatives, encouraging STEM activities and developing materials for both formal and informal education (Waitayangkoon, 2014). Digital game-based learning (DGBL) has become more common in Thai society with the capacity for delivery through multiple forms of computer devices available to students and people of all ages. Accordingly, it seems appropriate and even necessary, to explore stakeholder perceptions towards DGBL and its potential to boost educational engagement with the Thai STEM curriculum.

In order to transform classrooms through blending DGBL into teaching STEM in Thailand effectively, it has been found that many aspects require increased knowledge and clarification. Increased knowledge needed in: 1) formulating design strategies that balance the motivational elements of creativity that captivate students' propensity to "play", thus satisfying curriculum objectives; 2) integrating DGBL into the classroom learning experience focused around how to use games; and 3) leveraging collaboration across the education sector. It is important to note that STEM education is being taught already but research of STEM education using DGBL in Thailand is very limited. However, guidelines for DGBL initiatives remain scarce. Therefore, the research objective of this study was to conduct an online survey to explore the range of issues outlined above with teachers teaching the STEM curriculum using DGBL, the students being taught aided by DGBL as well as parental attitudes towards DGBL.

2. LITERATURE REVIEW

Disruptive technology has become a real phenomenon not only in developing and developed countries. People, particularly children and adolescents, have more opportunities to engage in new digital literacy practices, especially playing digital games on mobile devices as the price of these "gadgets" has become ever cheaper has vastly reduced. According to the International Telecommunication Union (2013) and Silicon India (2013) in 2014, the world will have more cell phone accounts than people on earth (7.3 billion accounts for 7.1 billion people). In 2013, two fifths (41%) of the world's households were connected to the Internet (International Telecommunication Union, 2013). In the developed world, 78 per cent of all households are connected to the Internet (International Telecommunication Union, 2013). The highest levels of household Internet penetration is the European region (87%) whereas the lowest levels occur in the African region (7%) (International Telecommunication Union, 2013). The profile of online entertainment and games in Thailand is similar to the U.S.A. where games have been the most popular mobile phone application followed by social networking - 64% and 56% respectively (International Telecommunication Union, 2011).

The Internet will definitely be a part of the core education infrastructure in Thailand. Under Thai government policy for the 3G network that is currently being implemented, the number of Internet users in Thailand was expected to reach 52 million by the end of 2013, an estimated 74.3 per cent of Thailand's total population that is approaching 70 million people (Williams, 2013). A staggering 865,090 tablets have been distributed in the 'One Tablet per Child Project' by the Thai government (One Tablet per Child Project of Thailand, 2012). The objective of this program was to support first-grade students who are generally six or seven years of age, in having a device to achieve two objectives: 1) to provide education opportunity and equality for all and

2) to enhance education quality (One Tablet per Child Project of Thailand, 2012). This provided an opportunity to very young Thai children to gain access to the Internet. As a 2013 research study found, nine out of ten Thai children aged 6+ years had access to a computer (Momypedia, 2013). From an educator's perspective, it is necessary to assess how young Thai Internet users perform online. One of the research studies conducted in Thailand reported that "games and entertainment" were the most searched keywords of any search engine (Prapakamol, 2014). In addition, Thailand was the biggest online gaming market in South-East Asia (We are social, 2011). 'Playing online games' was the most favored activity of Thai Internet users younger than 15 years old as revealed in the Thai government's report (Ministry of Information and Communication Technology of Thailand, 2013). Crucially, another study found that Thai children spent 80 per cent of their time using computers playing games (Momypedia, 2013). The Thai government report highlighted that in general Thai Internet users spent about 20 hours per week on the Internet but more than half (53.6%) of Thai teenagers accessed the internet to play online games. Interestingly, the same report remarked that a small group, or about one tenth (9%) of Thai Internet users, spent up to 105 hours per week (Ministry of Information and Communication Technology of Thailand, 2013). This implied that Thai teenagers were online for 15 hours, seven days a week. Another study found that approximately half of Thai children used a computer at the Internet café, while the remainder accessed the internet from homes and schools (Momypedia, 2013). These findings suggest that playing a computer game has become a normal part of Thai children and adolescents' routines. The same study found that about one third of Thai children who regularly play a computer game spent more than four hours a day playing games which eventually may lead to computer game addiction (Momypedia, 2013). The study raised the issue of computer game affliction awareness during long school breaks in Thailand (Momypedia, 2013). In light of this evidence, there is the potential to employ

DGBL to enhance Thai STEM education. The challenge is how to encourage children and teenagers to spend more time on education rather than entertainment.

Being an owner of a smart phone and playing computer games has gained prodigious popularity – at times with unexpected outcomes. This addiction phenomenon has also had social ramifications in Thailand as a local news item reported that a 19 year-old male confessed that he robbed a goldsmith's shop since he wanted to buy an iPhone for his girlfriend (Rakroon & Rakroon, 2014). A 35 year-old man, working in Pattaya, Thailand, accidentally fell from the fourth floor of a terrace above a building because he was so engrossed in the "Cookie Run" game in 'LINE', an application for instant messaging on smart phones and computers; he lost concentration because the game made him very excited when he reached a new level and he forgot where he was laying and accidentally fell off the roof (Pattaya Dailynews, 2014). It is important to tackle such threats from computer games, as in 2008, a 19 year-old student living in Bangkok, killed a taxi driver as he wanted money to continue playing 'Grand Theft Auto' (The Telegraph UK, 2008). Consequently, this game along with the whole series was banned in Thailand.

Game-based learning (GBL) can be defined as a type of game play that is focused on learning outcomes (Garg, Rana, Berger, & Prasanna, 2013). Similarly, 'gamification in education' refers to elements of online games (such as points, badges, leader boards, competition and achievements) which can drive learning behavior (Garg, et al., 2013; Lee & Hammer, 2011). DGBL has become more common in society with the capacity for delivery through any form of computer device available to students and people of all ages. Based on documentary research that reviewed 34 articles, it has been consistently found that the integration of DGBL can improve students' knowledge, skills, attitudes, motivation and behavior for teaching in computer science, software engineering, art design and other fields as opposed to traditional classroom teaching (Wu & Wang, 2012).

Gender difference in digital game-based learning is one key concern among others. According to German research, it was found that gender inclusivity was important to consider in game-based learning design (Erb, 2009). Similarly a research finding from an 80-day project from the European Union's Seventh Framework Programme concluded that gender differences impacted on game-based learning in many ways such as general attitude, game types, reason to play, skills and game characters and avatar preferences (Steiner, Kickmeier-Rust, & Albert, 2010). In the past, gender has often been a concern when applying DGBL to the curriculum, since it seems that gaming activity is associated with, perhaps supportive of, masculinity which might create an unfair advantage in the classroom (Lu, 2012). Research conducted in China concluded that in using DGBL, both female and male students can be encouraged to participate more (Lu, 2012). Another study with 17 boys and 24 girls at a secondary school in Singapore, using a mobile learning game named 'Statecraft X' to enact governorship, found males spent significantly more time playing than females (Tan, Chee, & Gwee, 2011). Counter-intuitively, no significant gender differences in their scores materialized (Tan et al 2011). The finding of Tan et al.'s (2011) research concluded that more time spent on game play did not correlate with learning outcomes statistically (Tan et al., 2011). The quasi-experimental research of DGBL in classroom-based science education for elementary levels found that not only did both gender groups consistently have better engagement, but DGBL also positively impacted upon content knowledge on science topics and on problem-solving skills (Lester et al., 2014).

Based upon these studies cited above, this research was accordingly influenced and aimed to proactively investigate 1) formulating design strategies that balance the motivational elements of creativity, being fun to play and satisfying curriculum objectives; 2) integrating DGBL into the classroom learning experience focusing on questions of how to use games; and 3) leveraging collaboration in STEM education among the three principal stakeholder groups in Thailand.

3. RESEARCH METHODOLOGY

This current research utilized an internet-based survey as the main research instrument to elicit both quantitative and qualitative data from three stakeholder groups. The researcher wrote the first draft of the proposed internet-based survey after reviewing all relevant literature, and sent it to be validated by three experts in related fields. The first draft of the online questionnaire was thus modified removing some ambiguous words. This internet-based survey was formulated in Thai. The researcher invited participants through the social networking page for seven days in the first quarter of 2014. The direction of this survey indicated clearly that it was a short survey for academic purposes only. This online questionnaire was distributed by the snowball technique as the participants were requested to encourage their other colleagues who were eligible to answer the online questionnaire. The initial directions on the online survey clearly indicated the definition of DGBL and the meaning of STEM education. The first part of the questionnaire was a demographic section asking about gender, occupation, place of living and age group. The second part of the questionnaire included 17 items using 5-point Likert rating scales, three items of multiple-choice and a last item was an open-ended question. The perceptions, attitudes and needs of the design style were investigated through the five-point rating scale items. The mode of delivery and demand of language were investigated through the multiple choice questions. Lastly, the qualitative data derived from the open-ended question will be discussed.

4. RESEARCH RESULT AND DISCUSSION

Participants' demographic profiles were able to be described from the 169 responses. Almost 60 per cent of respondents were female (59.2%

or N= 100). The participants were categorized into three groups. As the first group, just over half the participants were students who included elementary, secondary and university students. Secondly, almost one third were teachers who were in charge of STEM classes and, as the third stakeholder group, the remaining one tenth were parents (55.6% or N=94, 34.9% or N=59 and 9.5% or N=16 respectively). The average age of teachers was 37 years of age, for students it was 22 years of age and the parents 41 years on average. This online survey elicited responses from people from all over Thailand - the majority of respondents were living in northern Thailand, followed by the central part, then Bangkok, and, lastly, the north-eastern and southern parts of Thailand (33.1%, 30.2%, 28.4%, 5.3% and 3% respectively).

4.1. The Opinion towards DGBL

Table 1 outlines the online survey results of DGBL for STEM education in Thailand with the mean scores, standard deviations (SD), rank and the description of the 17 questions using the 5-point Likert rating scale. According to a statistical calculation using independent samples, the t-test comparing the two gender groups found no significant difference. Additionally, the f-test of ANOVA comparing the three stakeholder groups' opinion also found no significant difference – thus each stakeholder group expressed similar opinions toward the usage of DGBL. The average overall score on the 17 items of the survey was 3.92 (SD=0.80) which highlighted that participants agreed positively with all items in this survey. The top three items to be ranked showed that respondents strongly agreed that DGBL i) educates students with enjoyment, ii) motivates users or is a motivational learning instrument and iii) creates a friendly education environment (4.37 (SD=0.78), 4.35 (SD=0.81) and 4.20 (SD=0.76) respectively). These three were followed by respondents agreeing that DGBL iv) was in need of support and a collaborative research project, v) enhances students' creativity and vi)

provides better understanding or is a meaningful learning tool (4.17 (SD=0.90), 4.09 (SD=0.79) and 4.01 (SD=0.85) respectively). This response profile also showed that none of the 17 items scored less than a 3.41 average, indicating that participants agreed with every item. It was found that people agreed that the use of 'DGBL even if it is complex' as the lowest to be ranked (3.57, SD=0.90), which means that users had taken into consideration the 'ease of use' in order to integrate DGBL into a classroom.

4.2. DGBL Experience

Referring to Figure 1, approximately two thirds of participants had experienced using DGBL while the rest had not experienced being DGBL users (65.1%, 34.9% respectively). Almost eighty per cent of teachers had experience as DGBL users but both students and parents had similar ratios - about 60 per cent of them were DGBL users (79.7%, 57.4% and 56.3% respectively). This evidence suggests that Thai teachers have been introduced to DGBL more than the other two groups. Consequently, teachers' training and DGBL competition campaigns were to be encouraged in integrating DGBL into traditional classroom.

4.3. Preferred Mode of DGBL Delivery

The most preferred mode of delivery was "online" through a web browser follow by mobile mode through applications and the least preferred was the offline mode recorded on CD-Rom (55.0%, 31.4% and 13.6% respectively) (see Figure 2). The patterns of teacher, student and parent responses to this item were similar. Thus, this is a clear statement for the game developer to make DGBL available on the web browser version and develop it further for mobile application. However, in conducting DGBL in some rural areas of Thailand, the CD-Rom version might be useful to cover those areas with poor internet servicing.

Table 1. Online survey results of DGBL for STEM education in Thailand

Items		Overall Respondents' Perception			
		Mean	SD	Rank	Description
Formulating design strategies					
Q1	Improve teaching and learning method	3.96	0.73	7	Agree
Q2	Enhance teaching and learning quality	3.88	0.78	10	Agree
Q3	Improve quality of education	3.80	0.83	11	Agree
Q5	Provide better understanding (Meaningful)	4.01	0.85	6	Agree
Q6	Create better retention (Memorable)	3.93	0.89	8	Agree
Q7	Motivate users (Motivational)	4.35	0.81	2	Strongly Agree
Q9	Enhance students' creativity	4.09	0.79	5	Agree
Average score		**4.00**	**0.81**	**Agree**	
Integrating DGBL into the classroom					
Q4	Easy to implement	3.61	0.89	15	Agree
Q8	Educate with enjoyment	4.37	0.78	1	Strongly Agree
Q10	Create friendly education environment	4.20	0.76	3	Agree
Q11	Even though DGBL is complex I still use it.	3.57	0.90	16	Agree
Q12	DGBL is an important role of STEM	3.66	0.82	14	Agree
Q13	In the future, I will use it.	3.71	0.85	13	Agree
Average score		**3.85**	**0.83**	**Agree**	
Leveraging collaboration					
Q14	I need DGBL.	3.91	0.87	9	Agree
Q15	I prefer a commercial off the shelf application rather than create one by myself.	3.66	0.98	14	Agree
Q16	I need knowledge to create my own DGBL.	3.78	0.99	12	Agree
Q17	Need of support and collaborative research project	4.17	0.09	4	Agree
Average score		**3.88**	**0.73**	**Agree**	
Overall score of all items		**3.92**	**0.80**	**Agree**	

Range: 4.21-5.00 = Strongly agree; 3.41-4.20 = Agree; 2.61-3.40 = Neutral; 1.81-2.60 = Disagree; 1.00-1.80 = Strongly disagree

4.4. Preferred Language of DGBL

The responses, as shown in Figure 3, found that Thai was the most preferred language followed by English and then bilingual versions (60.9% 33.7% and 5.3% respectively). About 70 per cent of Thai teachers who were in charge of STEM education recommended DGBL in Thai because "Thai" is of course easier to understand for students and educators. In addition to this,

Thai is the only official language of Thailand. Therefore, the teachers indicated that "Thai" is the best language to deliver content and to communicate with all users. This might be a reflection of the teachers' experience that in order to provide a clear understanding context, a foreign language may be a barrier thus inhibiting learning. On the other hand, parents and students seemed to be more open to the use other languages, especially English, more

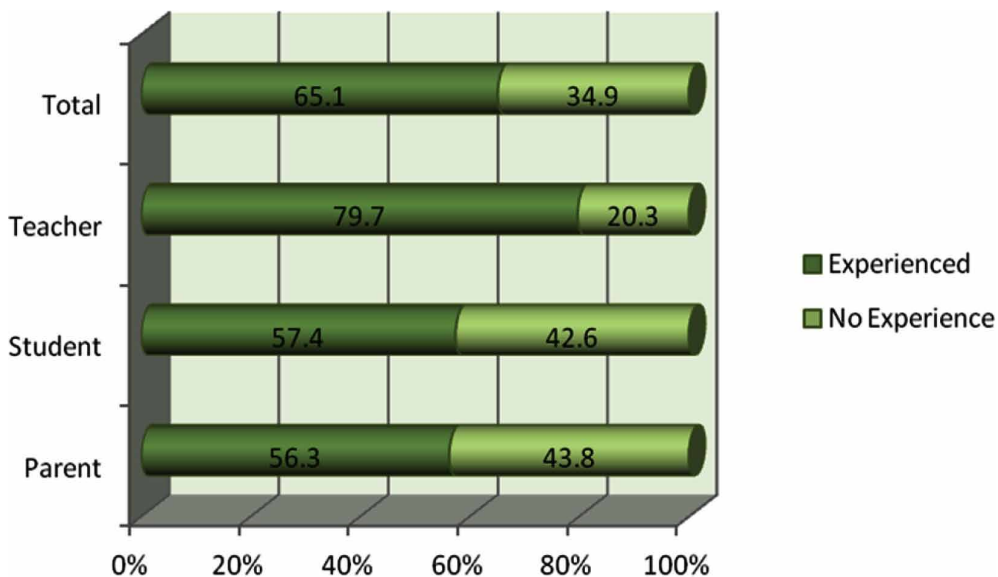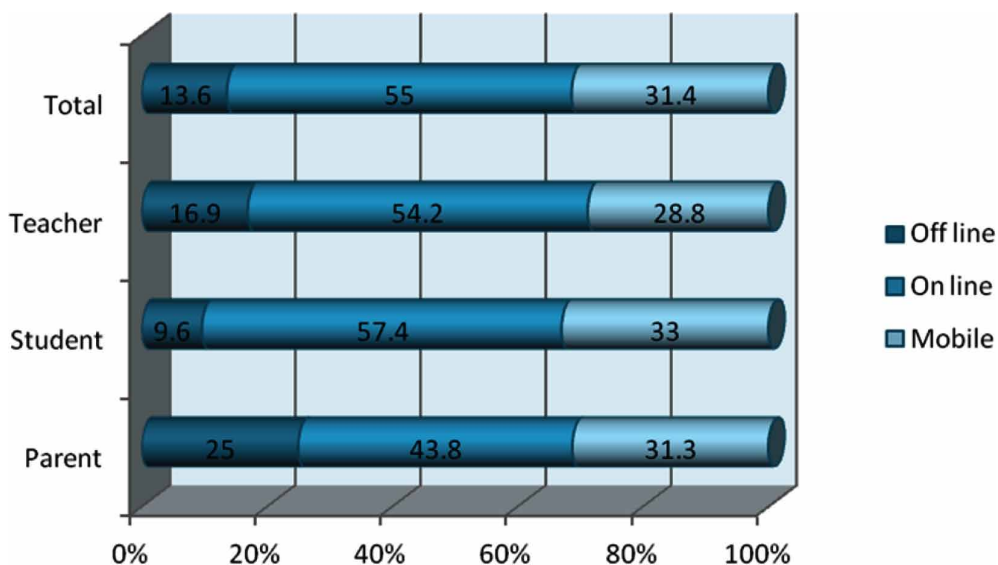*Figure 1. Experience of being a DGBL user*

Figure 2. Preferred mode of DGBL delivery

than teachers were (37.5%, 36.2% and 28.8% respectively). The reason for both students and parents who preferred English in DGBL might be the importance of English as a communication tool both in the present and in the future. Based on these statistics a further message for DGBL developers may be to use both Thai and English options. This notion is worthy of added consideration given that both students and parents may be concerned about

Figure 3. Preferred language of DGBL
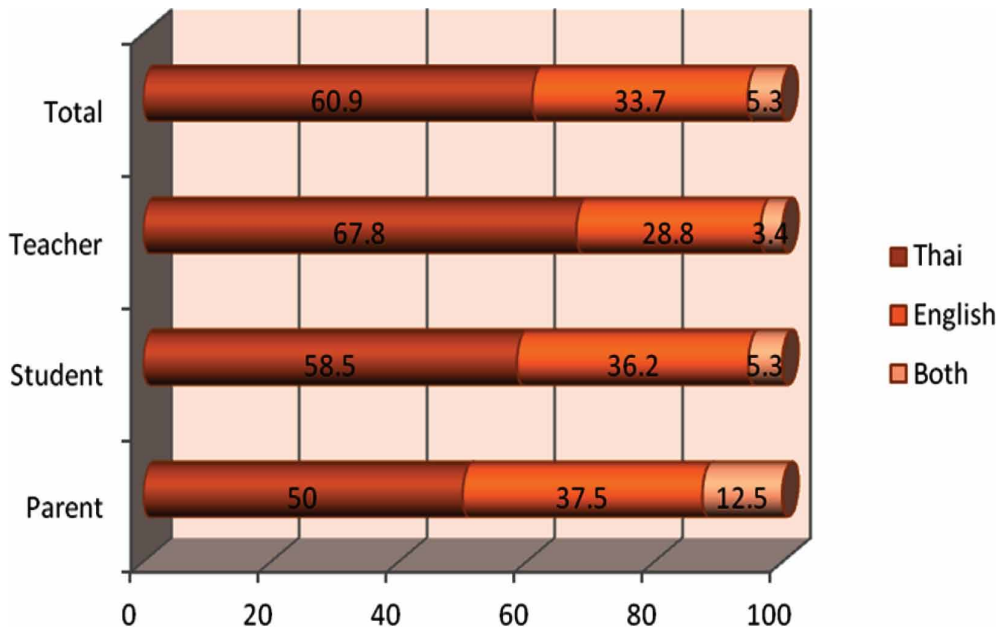
the establishment of the ASEAN Community in 2015, when English will become the official tool for communication among ASEAN member countries and its counterpart agencies.

4.5. Other Valued Qualitative Feedback

According to the responses to the open-ended question of this survey, many important aspects of DGBL implementation were highlighted. From the teachers' point of view, many advantages of DGBL were i) an effective learning instrument which can increase student motivation, ii) an excellent tool for teaching a measure of complicated content to enhance students' understanding of subjects and the topics more deeply, and iii) an optional strategy to provide a renewed and friendly learning environment. On the other hand, there were many concerns on using DGBL with many comments focusing on i) the ability to cover knowledge required as a learning objective or DGBL might not cover all aspects of the content, thus the instructor must select an appropriate DGBL which enhances a particular skill or emphasizes particular knowledge, ii) the capacity of the student to extract the particular knowledge via participating with DGBL since students might enjoy the fun part, but bypass the important information, and iii) the creation of an effective DGBL was not only time consuming but there were also budgetary considerations.

The teachers suggested that DGBL should offer an option either as a competition or as a stand-alone game which encourages students to do better by comparing themselves with their peers. An added issue that was raised was that the instructional designers should employ mobile technology to initiate DGBL that is adaptive to the students' abilities which will encourage each student to enjoy the experience based upon elements of self-paced learning thus preventing boredom in using DGBL and initiating a form of curriculum that induces enhanced educational equity. An important function of DGBL that many teachers required was as a "class control" which actually assists teachers to organize the class starting to play and pause DGBL while studying. The problem in

the class using DGBL was most students could not pause playing the game when the teacher needs them to pay attention to the content. One teacher shared his experience of using DGBL for teenager students in that it needed to be an attractive game rather than distractive if were a plain if not dull application of DGBL since students were already familiar with commercial digital games that were highly attractive and professionally developed. The simpler DGBL may work more effectively for kindergarten or elementary level students – or those with special needs. Many teachers stated that the available DGBL was not well-designed. The teachers also acknowledged that they still have only a limited knowledge of how to build their own DGBL and to integrate DGBL into their classroom teaching. The majority stressed that the existing DGBL does not educate students according to current learning theories.

Students who participated in this survey freely disclosed their opinions. On the positive site of DGBL, students expressed the view that DGBL was their favorite activity because of its usefulness, flexibility and creativity. The majority, not surprisingly, preferred the entertainment part of the game rather than the academic components. Consequently, students enjoyed playing any kind of computer games and other internet activities. The students expressed the view that it is hard to stop playing a computer game or using computers. Thus, some students expressed concerns that this would induce a risk of health problems and affect their eye sight and, above all, they might become addicted to computer games. Some students spent time on serving the internet overnight but could not finish other assignments on time. Students found that some DGBL was very boring since it kept repeating the same practice all the time and contained lots of text that was not concise and was the same as presenting it in the traditional book. Students did not like reading lots of text on the computer screen since it was not easy to highlight, or mark, and note as they were able to do with more traditional texts. Students found that well-known international computer games were more attractive rather than some DGBL

available in the Thai language. In addition, it was hard to find a good DGBL product that helped them to study according to the Thai curriculum or for an examination. Most of the DGBL in the Thai language was not free and students could not afford to pay for it. Students were attracted to interact with new features and technology such as serving on the internet, shaking a mobile device instead of pressing the on-button, taking photos, recording videos, scanning a quick response code in an instant. Students stated that they needed schools and teachers to provide enhanced flexibility within the education environment to support using a mobile or computer device for educational purposes during class. This is because most of the schools have declared an iron law that using a mobile device in class is prohibited as it distracts from study. One common point of student feedback was the poor internet bandwidth.

Parents who comprised the smallest group to participate in this survey shared very detailed information. They wanted to be good support by allowing their children to learn from DGBL; however, they were not clear that skills and knowledge learned from DGBL was either correct or appropriate for the real curriculum. Parents believed that computer literacy skill was an essential skill of the 21st century but worried that children might not know how to balance the virtual world and real world activity. Parents found that making conditions for playing computer games for a longer period can encourage children to finish their homework or assignment – this condition was easier than offering other rewards.

One family shared how computer games were the best baby sitter ever. One parent shared her own story that her child played a computer game all night very often and kept telling her that this was an educational game. After that, she found that the child suffered from insomnia at night when eventually the teacher reported that the child was falling asleep during class. This child faced difficulties in recovering from computer game addiction. The child needed special psychological treatment for many months. Another family found that their

children became most excited when given any new digital gadgets. Many children worryingly became isolated from their community but connected with strangers through the social network. Parents understood that DGBL aimed to enhance education but the side effects of health problems and computer addition should be well considered.

5. CONCLUSION AND RECOMMENDATIONS

This online survey found a compelling amount of crucial data reflecting the way to transform classrooms through blended DGBL in teaching STEM in Thailand. The opinion of the three stakeholder groups agreed positively that DGBL was an effective approach to STEM programs that balanced the motivational elements of creativity - being fun to play and at the same time satisfying curriculum objectives but there were some aspects of using DGBL that were concerning. In general, this research found that the three groups of stakeholders believed that DGBL represents an instruction tool that motivates users, enhances students' creativity, provides better understanding, improves teaching and learning methods, supports better retention, enhances teaching and learning quality and, lastly, improves the quality of education. The research findings supported the integration of DGBL into the STEM classroom as it showed that participants were confident because DGBL was enjoyable, was able to create a friendly education environment, played an important role in STEM, was easy to implement and, even though DGBL is complex, they still need to use it. The downside of DGBL was the unclear side effects from computer game addiction which can cause health problems. The ever increasing penetration of the internet and digital products is obvious. The design of DGBL can be both educational and attractive to learners but needs to integrate and address work life balance issues: this is an issue for added research.

Returning to the research objectives which attempted to summarize the way to formulate instructional design strategies - the first consideration focused on how to improve the quality of STEM education by DGBL adoption. This was followed by the issues of the appropriate methodology in designing DGBL in order to enhance teaching and learning quality and of how DGBL would create increased memory retention of content. It was found that the design part of DGBL needed to improve teaching and learning methods and provide a better understanding or meaningful content to students. The content of DGBL needed to be well-designed with meaningful figures, animation, video or multimedia with well-considered interaction opportunities to engage students. The demanding or complex DGBL content needs to be concise and provide a good story rather than the plain text the students would locate in traditional text books. The two last elements of successful instructional design for DGBL were the integration of creativity and the motivation of students to use games to self-educate. To address the second objective of this research on how to integrate DGBL into the classroom, the results would firstly recommend considering the ease of DGBL implementation from the instructor's vantage point. All users, including instructors and students, prefer DGBL that is not complicated and serve learning objectives. Then users need to consider the importance of DGBL concerning the STEM curriculum. The ideal DGBL can create a friendly education environment and, above all, enjoyment in education. The school policy of not using mobile device during class needs to be questioned and revisited as more students can and do bring their own devices to the education environment and there is an element of equity as not all students can afford laptops and tablet devices but are adept when using mobile phones. In addition, the internet bandwidth at schools needs to be uniformly strengthened to provide the support when more users are working online.

According to this current study, in order to leverage collaboration in STEM education among the three principal stakeholder groups is the off-the-shelf application which is freely

accessed. Then the next step is to provide knowledge to create DGBL for Thai instructors. Crucially, the demand for supportive and collaborative research projects concerning DGBL is very high in STEM education contexts of Thailand. Crucially, the demand for well-designed DGBL which is integrated with mobile technology suited to the STEM education curriculum needs to be highlighted. There is an argument to search for excellent DGBL products that are in English and encourage providers to furnish the material in Thai given the large population and commercial merit. By doing this the students have the option of using either or both languages which augurs well for the ASEAN Community when English is adopted as the universal language in 2015.

In conclusion, these survey results reflected important aspects of DGBL implementation for STEM education in Thailand. As a consequence, the popularity of DGBL in Thailand is growing as is the internet technology phenomenon in the Asia region. There were many gaps requiring fine tuning among three stakeholder groups' expectations to achieve the same goal as to leverage DGBL and to prevent the downsides of computer addiction or violence from games and the internet. It is crucial to construct a sustainable culture of knowledge society within the Thai culture. Thai educators have accepted DGBL; but the school rules do not allow students to use their own devices during class and relaxing these rules that belong to another century are worthy of reconsideration. Despite these complexities, the prevailing view among those surveyed was that DGBL represented a distinct need and focus if the educative process is to be improved. The recommendation for the near future of DGBL in regard to the STEM curriculum in Thailand is to develop an online-distribution mode and use the Thai language and English as inbuilt options - this is to extend students' opportunity to practice English and also prevent some lost information if students have some difficulty to understand any complicated content. In a global economy English proficiency is a must so positioning DGBL to improve language skills

as a residual outcome is wise. Conversely, the social consideration of internet user behavior which has emerged in entertainment and games rather than in educational contexts represents the challenge for Thai educators.

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