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The Needs Analysis in Game-Based STEM Module Development for KSSM Science Teachers

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Abstract: ***This study was conducted to identify the needs and requirements of a STEM Module based on game approach to teacher for teaching science for lower secondary school's students. The needs analysis was carried out on purposively selected science teachers from different schools in the northern district of Kedah, Malaysia. The data was collected through semi-structured interviews based on the purposive sampling of 7 teachers. The qualitative data obtained from the interview sessions with the teachers were analyzed into specific themes. Four major themes were identified, namely: (1) the sources and materials in motivating science learning, (2) the lack of focus on game-based approach, (3) the suitability of activities in game-based approach and (4) consideration on the level of students' knowledge. The analysis of the findings shows that the Game Based STEM module has a great potential to be developed for the use of science teachers in making active and motivating science learning among secondary school students. Aside from the four principle subjects recognized, recommendations and details got from meetings with the educators would give us valuable data for building up the substance for the module. The discoveries will be utilized for planning and building up the module in the following stage.***

Keywords: Game Approach, Game-Based STEM Module, KSSM, Science teachers.

I. INTRODUCTION

Since Malaysian Independence, the education system has undergone many changes, starting from the Razak Report (1956), all the way to KBSR, KBSM and KSSM, particularly in the field of Science education. In line with that, the National Science Education Philosophy aims to produce the culture of science and technology among students by focusing on the development of individuals who possess the competitive, dynamic, resilient and driven characteristics to master scientific knowledge and technological capabilities. KSSM was enacted to meet the new policy requirements under the Malaysia Education Blueprint (PPPM) 2013-2025 so that the quality of the curriculum implemented in secondary schools is comparable to international standards.

To ensure that the aspirations outlined in the 2013-2025 PPPM are achieved, the Ministry of Education has made suggestions for teachers to be innovative in their pedagogy by using new approaches in order to enhance students' interest in learning at school. The most obvious benefits of playing educational game is increasing motivation for learning (Bottino, Ott&Tavella, 2014; Groff, Howells & Cranmer, 2010; Hung, Huang & Hwang, 2014; Milosevic et al., 2010; Rosas et al.2003; Wastiau, Kearney & Van den Berghe, 2009; Yang, Chien & Liu, 2012; Yang, 2012; Shanmugam et al. 2019a). In addition, it makes learning more fun and helps students pay attention and stay focused (Perrotta et al., 2013).

The development of Game-Based Learning (GBL) in most western countries has become an innovation in educational pedagogy since people starting use computer to play digital games (Prensky, 2007). GBL is not only enhance students' skills, achievements, and motivation to learn, but also make students interested to learn more effectively (Yam San Chee, 2011). Additionally, GBL is also able to improve students' learning ability and strategies (Papastergiou, 2009). Ya-Ting (2012) believes that games can apply collaborative and active learning and the design of most learning methods is based on the principles of social constructivism.

II. BACKGROUND OF THE STUDY

A. Needs Analysis as the Initial Phase of Study

This study was conducted to obtain information from KSSM science teachers on the requirements of the module that will be developed to solve existing problems faced by teachers. In the module improvement study, the requirements examination study is a piece of the module's plan and advancement process. According to Richey and Klein (2007), the strength of the design and development of the module is that this study is used to solve problems in specific contexts. The analysis phase is the initial phase of the study when information is collected from the context and environment that is to be studied (Saedah, Norlidah, DeWitt, & Zaharah, 2013).Thus, before the module is developed, a necessary analysis is conducted to determine the probability of any problems taking place.

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The purpose of the analysis phase is to identify the reasons for the probability of the occurrence of problems (Branch, 2009; Gagne, Wager, Golas, & Keller, 2005) and to do what is necessary to solve the problems (Reinbold, 2013).The needs analysis phase provides important information in determining the design and development of instructional materials for the next phase (Gagne et al., 2005; Shanmugam et al. 2019b). In the context of this study, the needs analysis study was conducted at the beginning of the module development study to find out which type of teaching methods is most suitable for KSSM science learning in order to improve students' achievement and motivation, and eventually increase their high level thinking skills. In order to fulfill this objective, this research was conducted to identify the requirements needed by teachers in taking on the game-based approach to teaching science at schools.

Rashidah (2013) stated that the analysis phase was the first phase of a study, aimed at identifying some aspects related to the target group. The target group can provide useful information for developing modules that can meet the users' needs. During the structure and improvement procedure of the module, the needs analysis discoveries are assessed and used to create educating and learning exercises. In this research, the necessities investigation was done after the issue was distinguished and data on the subtleties and details of the module was acquired from the educator. According to Richey and Klein (2007) the needs analysis is for determining the product specifications. Thus, analytical study of needs is crucial in determining which products are suitable to be produced for teachers so that existing problems can be solved for the sake of a more effective science teaching. The discoveries and suggestions in the examination stage are utilized in the structure and module improvement stage (DeWitt, 2010). The resulting information from needs analysis is used to determine the optimum content for the instructional materials as well as the teaching methods (Richey & Klein, 2007).

B. Constructivist and Game-Based Learning

Playing is a significant action inside constructivist hypotheses as students make importance from their encounters (Tam, 2000). Integral to constructivist thoughts is the idea that kids effectively build learning and make their thoughts instead of essentially engrossing data (Tam, 2000; Pastore and Falvo, 2010). Research on computer games has demonstrated that games are regularly inalienably proactive and explorative exercises that support independent picking up making gaming situations a perfect setting for constructivist-based learning (Annetta et al., 2007). Jonassen (1994) portrays components of constructivist learning situations that contain numerous portrayals of the real world, present the regular multifaceted nature of this present reality, develop information rather than just imitate it, bolster community oriented learning building, and give assignments in setting as opposed to in deliberation. These are for the most part ideas exceptionally significant to game-based learning. There have been many researches directed on the utilization of constructivist hypothesis inside instructional conditions (Jonassen, 1999; Wilson, 1996) and games (Ahamer, 2004; Dickey, 2007). A few zones of constructivist hypotheses are especially significant when thinking about the plan of games: critical thinking to connect with understudies in handling learning ideas (Jonassen, 1999); reflexivity and mindfulness (Honebein, 1996); the social experience of learning (Honebein, 1996), and genuine world, case-based learning conditions (Jonassen, 1994).

C. STEM Games

There are small numbers of games that integrate science, technology, engineering, and math (STEM) concepts. Research has demonstrated the benefits of drawing in players in science games for taking care of complex logical issues (Cooper et al., 2010; Kawrykow et al., 2012). The science game, Foldit, offers a route for players to take part in genuine science and take an interest in a riddle that adds to the improvement of new systems and calculations for protein structure expectation (Cooper et al., 2010). Science games have additionally offered some incentive as learning and instructional guides for understudies to cause them to comprehend an idea more effectively. Annetta et al. (2009) assessed a wrongdoing scene examination computer game with hereditary qualities learning ideas, finding that, while there was no noteworthy contrast in realizing when contrasted with a control gathering, understudies that played the computer game were essentially progressively occupied with the hereditary qualities content.

Pastore and Falvo (2010) analyzed instructors' view of gaming in the study hall condition. Ninety-eight members finished a study. The consequences of the examination uncovered that most of the instructors concurred that gaming improves understudies' learning and rouses understudies. In any case, just about portion of the members showed that they utilized or expected to utilize gaming in their educating. Even though these discoveries show that inspirational frames of mind or discernments don't generally prompt conduct expectation, the writing doesn't clarify the help needs of the instructors who plan to utilize gaming in the classroom. Thusly, this need examination research was led to recognize the help or necessities required by educators in adopting on the game-based strategy to showing science at schools.

III. THE PROBLEM STATEMENT

The deterioration of students' interest and motivation in learning science and mathematics can have long term negative implications on the progress of a country (Mohd Norawi, 2014).In the Malaysian context, enrollment and entry to the science stream compared to the arts stream at the upper secondary level is less than the expected 60:40 ratio (MOSTI, 2012). The decline in the number of students choosing science and mathematical stream and the indifferent attitude towards science will pose a threat to the nation's progress. This situation, should it persist, can have negative impacts on the government's efforts to produce citizens with scientific literacy and culture, as envisioned in the Vision 2020. Therefore, the Ministry of Education (KPM) has introduced the STEM (science, technology, engineering and mathematics) field and undertakes various efforts to promote this field to all levels of education in Malaysia. However, according to Lay (2017), Malaysia still faces challenges in realizing the desire to produce competent students in the STEM field. International assessment findings show that Malaysian students' performance in the field of science is less encouraging due to the lack of competence in solving questions that require high-level thinking skills (KBAT) (KPM, 2018).

Among the issues and challenges in the STEM education that are often highlighted are the lack of interest among students and their opinions that the STEM field is difficult. Furthermore, students are not encouraged to enter pure science stream in order to maintain the performance and GPS of the school. TIMSS 2011 and 2015 assessments (IEA, 2012 & 2016) respectively reported that only 4 percent and 6 percent of Malaysian students perceived themselves as having high levels of confidence and motivation in the field of science. The Ministry of Education has carried out several strategies to enhance students' achievement and interest in the STEM field. One of the strategies is to use more enjoyable learning approaches such as more practical connections with the real world, open exploration approaches, the gamification of STEM, STEM comics and STEM digital games (Ministry of Education, Malaysia 2018).This strategy is a step towards enhancing existing routine-learning practices that require students to passively remember facts by memorization, involve transferring knowledge directly to students and is a curriculum that does not have context with the students' real life. There needs to be values added to this learning practice by adapting alternative teaching approaches that are more captivating in order to make students interested and motivated as well as to nurture high-level and innovative thinking.

Science teachers also lack instructional training, do not have enough exposure to content knowledge, and face the problems of insufficient facilities and not having adequate support in implementing STEM education (Ramli &Talib, 2017; Siew, Amir, & Chong, 2015).At the same time, teachers are also struggling to finish the syllabus to prepare students for examinations. These constraints cause teachers to be less creative in integrating the students' cultural experience in teaching activities according to the constructivist approaches, and instead prefer to use stereotypical and more teacher-centered approaches (Abdul Hadi, 2014).This learning environment makes students bored and weary because there is only a one-way communication. It creates a static atmosphere in the classroom. Students will have less motivation in having deeper understanding about things they learn.

The challenge for science education is to overcome the motivational problems among students using effective teaching strategies and approaches (Salmiza, 2008; Palmer, 2009).GBL can help increase motivation in the learning process (Schell, 2008; Ad Nor Azli, 2015; Anisha, 2015; Melvina , 2018). Instructors and understudies need to comprehend the estimation of game understanding and perceive its job in helping understudies' structure important logical data (Abrams, 2009). In this regard, the value of education is related to the pedagogical choice made by the teachers responsible in carrying out the teaching process (Bottino et al., 2008). The various types of game and challenges in GBL can attract students to learn and compete. The positive attitude arising from the implementation of this method will lead to an increasingly successful, cheerful and conducive learning atmosphere. The effectiveness of GBL in improving the motivation and ability of students to learn proves that the integration of technology in education greatly helps in strengthening teacher's pedagogy. Studies by Papastergiou (2009) and Tuzunet. al. (2009) show that students' motivation improved when the GBL method is applied in learning.

According to Miller and Almon (2009), the key challenge in implementing a fun practice of teachers using game-based approach is that many new teachers are not yet experienced enough to teach in a child-centered classroom. They still need resources, guidance, guidelines and training to improve their knowledge and skills, especially for teaching science in a student-centered learning environment. In Malaysia, the transformation of the standard-based curriculum in KSSM requires truly professional teachers, meaning that their teachings need to be up to standard and consider the needs of the students. To improve teachers' knowledge, guidance in the form of an instruction program needs to be developed so that teachers can adapt student-centered learning to the standard they need to achieve. In order to meet the standards, teachers need appropriate guidance so they can implement flexible game approaches (Almon & Miller, 2012).In the KSSM DSKP Science document, it is recommended that teachers perform the teaching and learning process of science through various activities and fun learning approaches (KPM, 2015). However, this document does not detail how this teaching and learning process should be performed. Therefore, a needs analysis should be done to identify the teaching and learning methods that need to be developed in the module.

IV. THE RESEARCH OBJECTIVE

This study was conducted based on the researchers' need to obtain data to produce a game-based approach module for KSSM science teaching and learning. A necessities examination was directed to distinguish the prerequisites of the module before the module is created and assessed in the following stage (Saedah et al., 2013).Thus, to obtain data that can be used to produce the module that can meet teachers' requirement, the objective of the study for the need's analysis phase is to identify the requirements for a module that is suitable to be used by teachers in the game-based approach for KSSM science teaching and learning at school.

Based on the objective of the study, this examination was likewise led to discover the response to the question: What is needed to produce a suitable module to be used by teachers in taking on the game-based approach for KSSM science teaching and learning at school?

V. THE RESEARCH METHODOLOGY

This study utilized semi-structural interview methods on seven different Ministry of Education (KPM) Science teachers from different schools. This method was used by Norlidah (2010) and Aliza and Zamri (2015) to obtain the data for needs analysis to produce physics pedagogical module and pre-school Malay language module. Sample selection techniques were conducted by purposively selecting respondents from homogeneous groups who could provide diverse information. Respondents were selected based on the criteria of teachers who conducted KSSM in schools. In addition, the respondents also have academic qualifications at the undergraduate/postgraduate level and have experience in the field of education for a minimum of five years. Table 1 shows the demographic information of the respondents involved in this study.

Table 1: Demographic information

Respondent's Code	Working Place	Level of Education	Teaching/Working experience
R1	SMK1	DEGREE	8 years
R2	SMK1	DEGREE	20 years
R3	SMK2	DEGREE	17 years
R4	SMK3	DEGREE	18 years
R5	SMK4	DEGREE	15 years
R6	SMK5	MASTER	13 years
R7	SMK6	MASTER	15 years

In anticipation of questions that could provide better information, interview protocols that were piloted before actual interviews were considered. Researchers selected a respondent who had the same characteristics as the actual study samples and interviewed the respondent to see the suitability of the questions. Based on the pilot study, three questions were simplified and improved. The improved questions were used in the actual study. After the interview was recorded, we converted it into a transcript. Once the process of interviewing and data collection in the actual study was done, the researchers completed the transcript and returned the transcript to the respondents for review. After the transcripts had been reviewed, the respondents signed an interview confirmation form to confirm the interview information. Validated interview transcripts were analyzed with the help of Atlas.ti version 7 software. The transcript analysis process was done thematically, by giving separate labeling code for each study respondent. The data of the interviews were categorized, subcategorized and analyzed using deductive coding methods based on the predetermined themes (Miles & Huberman, 2014). Figure 1 shows the flow chart the qualitative analysis of this study.

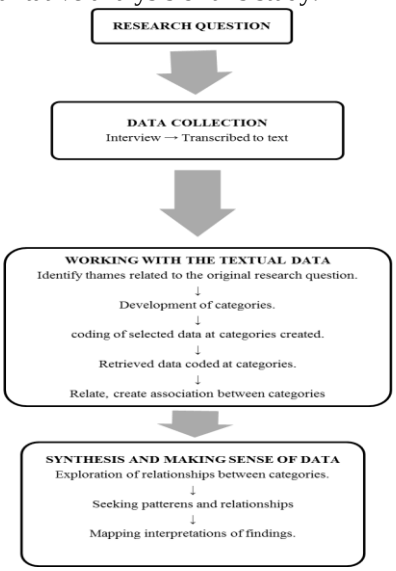

Fig. 1: The flow chart the qualitative analysis of this study

VI. FINDINGS & DISCUSSIONS

Based on interview data analysis, the findings from the seven respondents produced four themes, which are listed here:

Theme 1: The requirement of resources and teaching materials to motivate Science teaching

All seven respondents agreed that they needed appropriate resources and materials to take on the game-based approach for teaching and learning science in schools. They proposed a module that detailed how to teach science using game-based approach. Among the suggestions presented were detailed steps, teacher guides, time allocations, game suggestions and appropriate game material suggestions. Four respondents suggested that the module should detail the implementation steps and explain how the implementation can be done. A total of four respondents suggested that this module should contain a clear lesson plan and teaching objectives. The other two respondents recommended that there should be an adaptable time portion and the rest (two respondents) proposed that the components of abnormal state thinking abilities (KBAT) should be incorporated into the games. All respondents agreed on the need to create a module as a resource for guiding teachers to implement game-based learning approaches in teaching and learning science in schools. For example, respondent 1 **(R1)**, respondent 3 **(R3)** and respondent 4 **(R4)** said there ought to be a module proposing how to approach the educating of science to understudies.

R1: "... For me there is a need for a module! I think we need clear instructions, which students can read and understand. With easy-to-understand game guidelines and guide for the time allocation so that the games can be carried out easily. Students are not just playing games, they can also understand which scientific concepts are involved in the games...."

R3: "... For me, I strongly agree if anyone is trying to produce a game-based module for Science, it's great. In the module there should be a teacher's guide; teachers' guides are really important so that teachers are better prepared, they know how to play, what materials to prepare before the game. Additionally, the titles, subtitles and objectives to be reached should be told in the teacher's guide...."

R4: "... For me a module is really necessary. I would like to recommend a module that contains game guides, tailored to the developmental stage of the students, easy to understand and readily available...."

From the quotes given, we can conclude that teachers really need a proper Game-Based STEM Module to be developed, which can help them with the teaching and learning process in the classrooms.

Theme 2: Existing teaching activities are less focused on game-based approaches.

Every one of the respondents conceded to the utilization of game-based methodology when gotten some information about the utilization of this methodology at school, however five respondents professed to have never applied it in their classes. The seven respondents said that game-based approach made learning fun of the students and think that students are more motivated and able to learn better through playing. However, teachers are more engaged in student-centered and exam-oriented activities because they are tied with too much syllabus and the need to improve school performance. The approach is simply to fulfill the requirements that have been outlined. Teachers give the more difficult and burdensome new syllabus as the excuse for why they cannot diversify their teaching approaches. For example, respondent 7 **(R7)** and respondent 5 **(R5)** said that:

R7: "... The activities carried out mostly are unplanned activities, we don't exactly have many ideas for them. If we feel like doing something then we do it, otherwise if we don't have any ideas then we don't do it. After all, with the new KSSM, teachers are still learning about it, the students are still learning about it, it's difficult.... "

R5: "... We focus more on giving students exercises for them to do and then discussing the exercises... It is safe to say that teaching is more exam-oriented... The new KSSM syllabus has many topics to be taught and is more difficult..."

Theme 3: The suitability of game-based teaching approaches in teaching KSSM Science

All seven respondents agreed that the use of game-based approach is very suitable for teaching and learning in schools. They said that game-based approaches make it fun for students to learn. Six respondents believed that children were more motivated and able to learn better by playing but gave certain reasons they could not make the game-based approach as their teaching approach in the classroom. For example, according to respondent 1 **(R1)**, material, time and control are factors for why he rarely uses this approach at school.

R1: "... Students like the game-based approach, but sometimes because of time constraints we cannot do it. There isn't enough time and it's hard to control the students. The problems are in terms of time and materials.... "

The same response was also given by respondent 2 (R2).

R2: "... We can do game-based learning activities, because students will be more interested in learning, understand their lessons more easily and are not bored in class ... We can do it if there are materials...."

Respondent 4 **(R4)** stated that time and planning were the factors why most teachers did not implement this game-based learning approach.

R4: "... For me it's time, when we play it will take a long time. I personally think there isn't enough time if we play. It is okay if we still want to play but there should be a guide, some planning and time settings. So, it won't drag on to the next period..."

The findings of this interview show that game-based teaching approach is very suitable, and teachers need assistance in the forms of material resources to implement it at school to ensure that students are more interested and motivated to improve their achievement in science. This observation was also shared by Russell (1999), who mentioned in his research paper that one of the advantages of playing games was that the students would learn from each other better, as opposed to obtaining information from teachers just by hearing it being repeated.

Theme 4: The activities prepared should consider the level of knowledge of the students.

Most students who go to high school are still childish by nature. It is natural for children to play and playing can act as an intermediary and helps to improve children's learning to optimum levels (Zakiah, Azlina & Yeo, 2013). Mastura (2008) depicts game-based learning as a most reasonable curricular methodology for youngsters as this methodology relates to the normal qualities of kids who are normally fun loving. In line with this argument, six out of seven respondents interviewed stated that game-based teaching is appropriate because students liked to play. However, the game activities should be in line with their level of knowledge. For example, respondent 3 **(R3)** stated that:

R3: "... Game activities are very suitable, because students really like to play. If we let them play, sometimes they don't want to stop. But the types of games need to be suitable with their level of knowledge. We cannot underestimate them! Sometimes they're more knowledgeable than we expected...."

This opinion was also supported by respondents 6 (**R6**):

R6: "I think game-based learning approach is very good, there are still not many materials related to the Science subject, but we need take into account the level of our students' knowledge, maybe even the less-advanced classes can learn if we give them games that match their level... The most important thing is they can learn, and it is fun.... "

VII. DISCUSSION

The study of need analysis at the beginning phase of this research has provided useful information regarding science teachers' current practice and their opinions towards the use of game-based approach in teaching and learning science in secondary schools. The findings of need analysis will be used to design and determine the contents of instruction module. At this stage, the probable cause for performance gap and teachers' suggestions for improvement become points to consider in the design and development product. In the analysis stage, several causes and kind of solutions relative to the human performance problems may be discovered (Gagne, et al. 2005). From the findings, it shows the need of resources and teaching materials to motivate science teaching. Teachers at school did not much time to prepare the teaching materials to make their lesson more interactive and interesting. Teachers are not established to the new approach in teaching strategies and keep doing their routine in class. All seven respondents agreed that the use of game-based approach is very suitable for teaching and learning in schools but they are comfort with the teacher's centered strategies as traditional method such as drilling, lecture, and reading to the textbooks in order to chase down too many syllabus and to increase the examination results of the subject. Standard three in the document The Malaysian Teacher Standards (KPM, 2009) outlines teachers should use a variety of approaches, methods and techniques for performing teaching and learning processes. The development of the instructional module in this study will contribute to the improvement of teachers' knowledge and practice in teaching and learning science through game-based approach. However, the extent to which teachers develop their capabilities in teaching will depend upon their willingness to learn new knowledge (Aliza and Zamri, 2015).

VIII. CONCLUSION

A necessities examination study expects specialists to accumulate data about the unique circumstance and circumstance of the exploration from instructors who are additionally the objective clients of the module. With regards to this investigation the specialists accumulated data about the current routine with regards to instructors and their needs so the data got can assist the analysts with producing a module fit for taking care of the current issues looked by educators. The results of the needs analysis show that a game-based approach module should be developed to help teachers improve their teaching and learning of science.

The findings show that most teachers agree on the importance of game-based approach and the benefits of this approach to children. However, teachers rarely take this approach at school because of certain constraints.

The discoveries demonstrate that most educators don't organize game-based methodology in science instructing although they know the advantages of this way to deal with understudy learning. Factors, for example, the absence of assets for the educators, improper game materials, arranging and time imperatives cause them to infrequently utilize this methodology. To take care of the issues looked by educators, materials as modules should be created to upgrade their insight and abilities in arranging and leading science instructing and discovering that are progressively proficient and dependent on the understudies' needs. Branch (2009) says that great instructing materials are materials that can sharpen one's capabilities by increasing knowledge and skills. In light of the aftereffects of the requirements examination, the module advancement procedure should consider the viewpoints that can upgrade the information and aptitudes of educators such as ways to fulfill the learning objectives stated in the DSKP KSSM Science. In addition, the teaching activities in this module should consider the aspects that can improve teachers' skills on how to use teaching resources, get students to focus and follow learning activities, and guide students in small groups.

The discoveries likewise demonstrate that instructors need assets and showing materials as modules that detail how to educate and learn. This instructional guide should include fun game activities for teaching and learning and considers the level of student knowledge. In short, the modules developed should consider suggestions and specifications such as being easily available, can explain to teachers how to provide teaching aids as well as the ways games are performed. Teachers also suggest that this module contains examples of daily lesson plans, game activity suggestions and explanations about the types of games. Needs investigation study is significant in getting data about the substance and details of the module to be created. The results of the analysis show that a game-based approach module for the teaching and learning of language skills should be developed. The development of modules should consider teachers' problems and existing needs so that the module produced is appropriate for the teachers to use. According to Gagne et al. (2005), in the analysis phase several causes for problems related to teaching are identified, as well as their solutions. Accordingly, when the requirements investigation procedure is be finished, analysts ought to have the option to decide the kind of training that can take care of the issues and propose methodologies dependent on the exact information so the educating should be possible well (Branch, 2009). The discoveries of this need's examination will be utilized by specialists as a manual for planning and creating modules in the following period of the improvement procedure. Findings from the need's analysis show that a game-based approach module for teaching and learning science has the potential to be developed and used in schools by KSSM science teachers.

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