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Game-Based Learning Innovation to Development of Analytical Thinking Ability

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Abstract

As global trends have changed, the pattern of game-playing has adapted. It is transitioning from single-player or multiple player game and playing with friends or indeed strangers. The opportunity exists to leverage educational innovation to harness game-play in a constructive curriculum grounded manner through "Game-Based Learning". This, through various simulations, encourages students to play and learn simultaneously. Critically, this will not only create a new learning environment grounded in academic principles and curricula but facilitate learners honing more important analytical skills which are the bedrock of all forms of advanced thinking. In employing such a pedagogical approach, teachers in designing game-based learning are advised to gain a clear understanding of its characteristics before applying it to the teaching curriculum. Two evident alternatives exist, bespoke games designed by the teacher and learning games already available. In building a learning game, teachers should be mindful to give explicit attention to the learning goals and outcomes sought in developing such games to enhance the benefits to students and thus engender a positive and efficient learning conjunct to traditional teaching methods.

Introduction

As the world progresses in the 21st Century evident and consequential transformations exist in the economic, social, political, technological, communication and lifestyle domains. Children have to be capable of adapting their characters to live a productive life with skills necessary for the 21st Century. Parenting and learning management also have to change from the past. Therefore, child development cannot focus merely on intellectual capacity but also needs to focus on skill acquisition requisite for life in the 21st Century skills. (Panich, 2014). Including, for example, thinking skills, self-learning skills, skills to acquire information, skill to comprehend the dynamic world in which they exist, skills to work efficiently and effectively with others and skills for creative problem solving as well as being good citizens of society and having general transferable life skills. The 21st Century skills with an increasingly globalized community will continue to see rapid and transformative changes to innovation and technology potentially resulting in "Information Overload Era" and thus will have a profound impact on optimal learning approaches. If we cannot distinguish or critically assess information carefully, we face a problem with susceptibility to fake news items or be the unwitting victim of lies and fraud

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with no control or filter over the information we receive. Therefore, learning and teaching in this new era should focus on helping students to be able to consume information smartly. (Tangjuang, 2011) Similarly, Sinlarat (2015) stated understanding behind learning and teaching has transformed significantly, particularly we need to allow the students to be able to critically think and analyze independently. It is crucial for society and the education system to create a system which is connected and coherent and at the same time consistent with the broader changes in society and allows young people to obtain benefits and be able to apply principles so learned into their everyday lives. This, as a result, would create a valuable and productive human resource to enter society and bring forth leaders capable of guiding society in an appropriate, worthy and meaningful direction. This is indeed consistent with Section 24 of the National Education Act B.E. 2542 and the Amendment (No.2) B.E. 2545 which focuses on enabling students to be able to learn independently, to train their thinking processes, develop situational management and application skills so as to anticipate, prevent and ultimately solve problems. Moreover, Section 4 also focuses on helping students to have analytical thinking, synthesis thinking, discretion, creative thinking, and to enhance contemplative thinking and vision.

Developing thinking capabilities should focus on analytical thinking as such thinking can be viewed as providing the core foundation for all types of advanced thinking. Analytical thinking skill has ranges or levels in terms of its scope and depth. Without analytical thinking skills, it is difficult to achieve evaluation skills, critical thinking skills or indeed creative thinking skills. (Laowreandee, Kitrungraung, & Sirisamphan, 2017) Also, Susoarat (2013) stated that teaching how to think in class is highly significant because it supports thinking processes which encourage and facilitate optimal learning, particularly analytical thinking which is a significant foundation for learning and living a constructive life. Any person who has developed an advanced analytical thinking ability would clearly have a higher ability than other less adept persons. This is because analytical thinking is the basis for all typologies of thinking, and it is a skill that anyone can (to some degree) develop. This skill consists of various significant skills such as observation, comparison, prediction, application, assessment, classification, categorization, developing assumptions, and ultimately at realizing reasoned conclusions. Having criteria for making rational decisions renders the analytical thinking skill as a higher order skill which is a significant element in all thinking processes. In order to develop children to employ such a worthy and valuable characteristic, a teacher is often the central figure due to their proximity and role in organizing learning management programs and activities to enhance the intellectual capacity of the students. If the teacher possesses such qualities, then this should positively affect the learning outcomes of their students. Therefore, in order to adequately prepare a primary school child to be ready for 21st Century skills, the teacher must be able to appropriately manage the learning by transforming from the old role of being the transfer of such knowledge to one that seeks to develop and enhance the environment such that the students themselves can gain experience and develop in accordance with their ages. And the most important thing is to develop the child to have sufficient skills and competences for the 21st Century skills. In order to develop children to acquire such a skill set the teacher can be compared to a "framework," a good framework should also own such skills and be a model for analytical thinking which is in line with the demands of the 21st Century skills.

Thus, training the thinking process to be able to handle situations and applying it to prevent and solve problems in real life against the context of an increasingly complex, dynamic and interrelated world of the 21st Century skills are viewed as the central issue that needs to be addressed. For primary school children, besides the parents, the other person who has significant role in developing the young child's brain to develop into its full capacity is the primary school teacher who has to be a thinking leader, with attuned and advanced analytical skills as the basis for achieving more advanced critical level thinking as already mentioned. Therefore, it is necessary to study and get a clear understanding of all the relevant aspects in various dimensions so as to more rigorously and systematically dissect the relevant components of the analyzed object and to inspect and set out a structural relation between the main elements and sub-elements as well as to present analytical data in an easy to comprehend manner. (Thatthong, 2011)

From the study, the author determined that Game Based Learning (GBL) could be one of the innovations that might be useful and valid in teaching the curriculum to develop analytical thinking abilities. This view is in accordance with Intasara (2019) who stated that at present the direction of the modern teaching curriculum

has advanced from the past - from focusing on academic aspects to learner focused methods. Thus, modern teaching at the present time focuses on interesting activities and interactive media to allow the learners to understand and to experience learning by doing (LbD). The new learning media has been designed to apply game-based learning through applying a game to the learning-based environment where varying simulations have been created in such a way that allow the student to play and learn simultaneously.

Game-based learning: The basis for playing and learning

Playing games does not only bring happiness, fun, and enjoyment, but it also facilitates more effective learning.

Researchers both in Thailand and abroad have offered varying definitions for Game-Based Learning or GBL. El-Said & Mansour (2008 stated that Game-Based Learning is one of the educational innovations which use a format of interaction and the fun of the game and presenting it along with content of the subject - the deciding aims to be a mixture where the learner receives both knowledge and enjoyment simultaneously. Cojocariua & Bohian (2014 defined and interestingly noted that game- based learning is the foundation which should be appropriately designed to include both content and skills which aim to develop competences in daily life. For the Thai researcher, Sriharee (2018) game-based learning means learning by using games as a learning tool where the learner' s attention is encouraged so that to learn and achieve skills in accordance to its purposes and to reach the designated learning outcome while being entertained at the same time. Prachublarp (2016) mentioned about the focus of the game that influences learners to participate in the learning process until they are able to realize independent and self-directed learning. Moreover, Khemmanee (2018) determined game-based learning similar to earlier definitions but in addition she noted that it also takes the results of the game into consideration in order to discuss and summarize learning.

From the above analysis, the author can synthesize and summarize that game-based learning (GBL) refers to one of the learning innovations which is designed to encourage students to have an interest in learning with interaction and to support skills or abilities which are in accordance with the purpose as designated by the teachers, for example, analytical skills with setting the playing rules and use of content, game data, playing behavior, playing approaches and the results of playing games at the end of the game as the basis for discussion to summarize the learning in a manner as set out by the learning outcomes. This will help the learner receive knowledge and enjoyment in sync and besides knowledge, the learner can apply it to daily life.

Analytical thinking the foundation of all advance thinking

Analytical thinking is the ability to analyze, review, evaluate, classify, distinguish, categorize into sub-categories or categories based on those derived as a component from knowledge, attitudes, and skills by analyzing the content and evaluating it before concluding. This allows decision-making on both the main elements and sub-elements; finding the truth or the significance of the designated items by analyzing the relationships and to understand the relationship within each element in terms of both causation and impact. This involves disseminating each small or fundamental part of a particular situation or content to see what is its components, goals, or purposes and to see if each significant small component has any co-relation with each in respect to other components and the principal analysis is applied in order to investigate the relationship between each situation based on the relevant principles. This is consistent with Southammavong (2014) who stated that analytical thinking is an advanced form of thinking where the learner can reasonably distinguish data and components of a particular situation that occurs in such a way so that the learner can link the relationship between such surroundings so as to conclude the principles which can be used in life.

The components of analytical thinking

There are various theories regarding the components of analytical thinking. For the purposes of this article, the author seeks to present the concept of analytical thinking as posited by Marzano & Kendall (2007) who distinguish thinking into various aspects where the analysis is considered to be a process of differentiating the knowledge which is a core content based on principles, classifying the taxonomy which is co-related with knowledge, reasonably summarizing so as to be able to identify the drawbacks and improve significance, thus to make it more accurate and predicting the consequent result based on the database. These aspects consist of:

1. Matching: an ability to observe and differentiate the detail of matters or situations to see what are similarities and differences by disseminating matters into various elements based on principles in an easy- to-understand manner and then to compare, identify, exemplify, and identify similarities and differences as well as grouping matters or situations beginning at the easiest level up to more complex levels of abstraction, such as:

(1) Identifying the object of analysis;

(2) Identifying characteristics or qualifications in order to classify or distinguish the object of analysis;

(3) Identifying the similarities and differences;

(4) Accurately summarizing the similarities and differences.

2. Classifying: an ability to use the knowledge to set a structural system of the knowledge into categories by grouping, sorting, categorizing matters based on their characteristics or qualifications based on principles or rules;

3. Analyzing errors: a process of identifying errors or correlations and indeed non-correlations between matters/ variables by linking their relationship to a reasonable conclusion, and identifying what is right or wrong for a particular situation. Employing existing knowledge together with new knowledge to lead to reasonable conclusions and exemplification based on the existing knowledge with the data or supporting evidence to support the truth. The main elements of this knowledge include:

(1) Existing knowledge that is accurate, true and commonly accepted;

(2) Knowledge from experts;

(3) Knowledge from existing evidence which is reliable and for which data can be found in support;

(4) Data which has been proved or experimentally tried out to be true;

(5) Other data which is considered to be true and can be used to support the idea which is deemed acceptable.

4. Generalizing: a process that uses existing knowledge as data which leads to new knowledge or principles or applying it to a new situation or to solve problems in daily life appropriately and accurately. This process infers an inductive reasoning where the reasoning or thinking derives from sampling data or content which can be concluded into principles, approaches, theory, or new knowledge.

5. Specifying: a process which applies general principles or commonly accepted or understood principles to specifically predict the future situation; having a knowledge and understanding of the situation, identifying and detailing a particular situation so as to better predict what will happen next; applying a new knowledge from existing principles; predicting the future; knowing what is true or untrue; being able to adapt problem solving methods appropriately. This process infers deductive reasoning which requires reasoning or thinking where the conclusion is reached reductively by applying general rules to each detailed premise or to the samplings.

From these five components of Marzano & Kendall's analytical thinking, the author views that this covers an ability of analytical thinking which can be used to facilitate student development by designing forms of game-based learning.

Transforming game-based learning to an innovation developing analytical thinking ability

A good learning process for developing analytical thinking has various strategies, for example, a questioning strategy, grouping or categorizing strategy, and a supporting thinking environment strategy. These examples are strategies which are commonly accepted in the education sector which are deemed capable of enhancing a learner' s analytical thinking ability. Laowreandee, Kitrungraung, & Sirisamphan, (2017) agreed that employing these strategies has various benefits. However, there are also some limitations on their levels of engagement, lacking fun and/or lack of energy in learning. Many educators develop learning innovation to make it more appropriate by applying the game concept with learning and call it game-based learning. This is an innovation in teaching the curriculum which allows learners to learn with fun in such a way that fits with each learner's interest along with ability while challenging the learner to seek solutions as well as creating a new body of knowledge gained independently by the learner through this game learning process. This indeed matches with the Maria and Constantinos's study regarding the use of games to stimulate learners where they noted that learning management which uses game-based learning as a basis for teaching is one of the methods of teaching which highly encourages the learner to participate in learning, allowing them to have fun derived from learning through playing. Trybus (2014) conducted a teaching and learning comparison by comparing game-based learning with lecture-based

learning and training and found that the game-based learning has more benefits such as more participation received from learners, learners being more energetic to learn, data being instantly transferred back to the learner, and it is easier for learners to link the content in the studying chapter or game with real life contexts. This is also consistent with Johnson, Smith, Willis, Levine, & Haywood (2011) who stated that games can encourage cooperative learning, problem solving, as well as thinking processes. Moreover, game-based learning (GBL) is a learning innovation which is commonly accepted in our dynamic society and the game-based learning approach is successfully employed in various sciences at university level (Byun & Loh, 2015; Lertwittayakul, 2017; Soflano, Connolly, & Hainey, 2015)

In cases where the learner is already familiar with the game, if the teacher develops innovation in a form of game-based learning and applies it to learning experiences and learning management to create a new learning atmosphere which encourages the learner to have fun with learning, then this would represent a significant approach to bring more students back to the classrooms. The term "innovation," according to The Royal Society of Thailand (2012), refers to new things which have been created or developed and which may be in the form of a thinking system, a method, practices or tools which have been invented. Innovation may be things that have been newly innovated wholly or in part or may be new in a particular context or at a particular time. In general, innovation which is in a trial process is developed to solve specific problems and therefore if it is developed to solve education problem this represents an exemplar of educational innovation.

Game-based learning: GBL uses psychology relevant to incentives as the basis of a game by letting the learners have a role in the educational tool by playing in an open structured and flexible manner. Therefore, game-based learning does not only refer to cases where a game is created for learners to play but also refers to a case where the component of the game is used to design learning activities which can engender idea creation and suggests approaches and end goals for the learners. Indeed, game-based learning focuses on combining various techniques together into varying systems (Pho & Dinscore, 2015). As a result, game-based learning can stimulate learners' interests and develop learners' analytical thinking ability, making them enjoy the lesson by developing the style of the lessons as well as varying patterns of learning media innovation, as will be described in detail subsequently regarding game-based learning design.

Game-based learning is an innovation which has begun to warrant increasing attention. There are many people who apply it both locally and abroad. As Chumwuttisak & Silanoi (2015) studied on "The Developing Grade 5 Students's Analytical Thinking Skill and Attitude Towards Democratic Citizenship in The Learning Unit on "Good Citizen in a Democracy" Social studies S15101 Course" which studied game-based learning. Their research aimed to (1) develop analytical skills, (2) develop attitudes of good citizenship in line with democracy and (3) develop learning achievement of primary school Grade 5 students through game-based-learning in the Social Science 5 Course. The result demonstrated that 70 % of students achieved a score over 70 %. The target group was primary school grade 5's students of Wat Khok Sra Noi School and was conducted in the first semester of the academic year B.E. 2557 (2014). The research tools used were 1 eight lesson management plans which included game- based teaching methods 2 tools to reflect the impact of activities including observation forms for teaching behavior of teachers, an observation form denoting the learning behavior of students, a teachers' daily journal, a students' interview form and an end of process quiz 3 an analytical thinking skill test form, the attitude towards citizenship within a democratic system test form, and the learning achievement test form. The research result indicated : (1) students had an average score of analytical thinking skill at 70.45 percent out of the full score and there were 9 students who passed the threshold which was set at the rate of 81.82 % (2) Students had average score of citizenship under a democratic method at 80.54 % with 11 students who passed the threshold which was at the rate of 100 % (3) students had average score of learning achievement at 70 % and there were 8 students who passed the threshold which was at the rate of 72.72 % . These results correspond to research that show game-based learning approach to improve students' learning achievement in Data Flow Diagram course have significantly improve upon students' learning achievement. (Puthyrom, Suwanna, & Suriyong, 2017). While Yamkuan & Niwattanakul (2017) studied the using of game-based learning for promoting mathematics process skills of 6th grade students. The experimental results indicate that the experimental group has a significantly higher mathematical skills than the

control group at the .05 level for all skills and the experimental group has a significantly higher post-test mathematical skills than pre-test at the .05 level for all skills.

According to the aforementioned research, it is clear that researchers could use game-based learning to better develop and enhance analytical thinking skills.

Designing game-based learning to develop analytical thinking ability

In the following section an outline is presented about designing the game-based learning to develop analytical thinking ability in order to glean a clearer insight into the practical application of the phenomena under review.

(1) Practice: Designing game-based learning requires a mix and blend with analytical thinking skill training to allow the learner to experience a change arising from the experiment;

(2) Learning by doing: It is necessary to encourage learners to learn through game-based learning by themselves. Learning by doing is more likely to gain a deeper understanding.

(3) Learning from mistakes: Allow learners to experience mistakes. Learning from mistakes is not an impairment but instead will allow learners to better memorize and adapt from such mistakes.

(4) Goal-oriented learning: That means to have a clear goal in a game so that the learner will strive to achieve the goal. Such an objective that the author referred to would be the components of analytical thinking as stated by Marzano & Kendall (2007) as mentioned earlier.

(5) Learning point: Needs to be embedded with the information or all relevant and significant issues which the learners should know so that the learners would use this knowledge in real practice. This information would be in the form of content information for lessons which are deemed relevant to analytical thinking. (Suksiri, 2007)

Besides designing game-based learning to develop analytical thinking abilities as mentioned above, in the following section an outline regarding the approaches in assessing the design of game-based learning to develop analytical thinking ability is presented:

(1) Designing a game command: requires considering the development of analytical thinking, level of learners' education and information provided in such games, for example, a learner who is capable of reading and understanding may design a command in a game that he can read while a learner who does not have requisite reading skills, the game designer will need to consider creating other formats for game commands to reduce any game play limitations.

(2) Designing game content: requires establishing appropriate content which can be developed through game media and also needs to consider the learning objective of each lesson to facilitate reflective review of content or to develop analytical thinking ability.

(3) Designing game interaction: requires consideration of the interaction between the game and the learner as well as equipment and an environment that supports analytical thinking learning.

(4) Designing a game assessment engine: requires giving due reflection as to both the learning objectives and learning outcomes as well as may require considering designing the game playing level, for example playing a game from an easy level to more difficult levels so that the learner feels challenged. Moreover, in assessing the progress of the learner, the teacher should design the activity in such a way that the learner will have freedom, fun, something engaging and challenging, and receive feedback to plan his self-development seamlessly.

(5) Designing a game that supports the learner to develop attention or encourage such learning. However, learning should not focus too much on competition but instead needs to encourage the learner to learn until they achieve a learning objective. Moreover, it should be considered to design a learning feedback system in which a learner could follow- up learning independently while still allowing the teacher to be able to monitor the learner's progress throughout a game.

(6) Designing a method for integrating games into learning and teaching: for example, determining clear assessment measures when using games as a tool together with other teaching and learning activities.

(7) Designing a good game should be flexible in both content and output. In general, the game design should tend to be fixed both in terms of content and output. However, designing a game to develop analytical thinking abilities sometimes requires flexibility in such a way that a teacher can improve the content himself and to be able to organize the content to prioritize the order of teaching.

(8) Designing the pedagogical method: for example, teaching that focuses on developing analytical thinking ability should be designed in such a way that allows the learner to develop his analytical thinking

ability or teaching that focuses on problem solving should focus on designing a game with a problem simulation.

In designing game-based learning, besides what the author has stated above, it is possible to have further issues to be considered depending on the characteristics of a particular lesson or course.

Characteristics of game-based learning to be used in learning and teaching management

According to the study, it is found that several scholars have talked about the characteristics for game-based learning differently. For this article, the author synthesized the data by distinguishing the characteristics of game-based learning used in learning and teaching management into two categories as follows:

(1) Game-based learning developed by teachers: a teacher may create a game in such a way that fits with the learning objectives according to the program for each particular course. This is a typology of game creation with a clear end- point objective. The way this game is created follows from concepts which are in accordance with the lesson' s content, for example, if the objective is to develop analytical thinking ability, the teacher may create a game which allows the learner to have fun and follow the rules stipulated within a game and at the same time the learner will use his knowledge to organize his learning structure by grouping, ordering or characterizing matters for further learning. The teacher, therefore, should consider several learners and activities involved in such game development by considering relevant materials, equipment and learning methods. If there is a lot of learners, sufficient materials and equipment should be enough to serve the learner and be of a size sufficient as to be clearly observable to all learners. Moreover, if the teacher is the one who developed the game-based learning, besides considering the aforementioned objectives, the teacher should have knowledge and understand about the creation method and may need to experiment several times before having confidence that game-based learning will best serve the objectives.

(2) Game-based learning materials already available in the market: the teacher may take an already-made game in a market to appropriately apply or adopt in such a way that suits with the learning objective and the need of the teacher that wants to use such a game to deploy in a particular part of teaching. For example, using game-based learning as a leader into a lesson whether at a teaching level, summary level or assessment level, merely for lesson revision or indeed using it for the whole process of learning and teaching management. In a case of adaptation, the teacher should study such game-based learning thoroughly before adapting and experimenting with it. In a case of direct application, the teacher should analyze first if the game does in fact correspond to the learning objective in each course or not by studying and playing such game initially to assess if there are any issues or struggles so that the teacher can solve such drawbacks beforehand resulting in a smooth game playing experience for the learner. Moreover, if it is a game that is available in the foreign market, the teacher should significantly consider using different contexts say for example in terms of geography, cultural aspect as well as to enhance the convenience and worthiness in playing the game. (Khemmanee, 2018; Ratdee, 2009).

Conclusion

Game-based learning can be applied to create fun and build a positive environment that encourages class participation, and which will hopefully result in positive interaction with the learners. Although some learners might not be interested in a game, the teacher needs to understand that a normal game and a game that encourage analytical thinking ability are different. Sometimes, the objective of playing the game is to review and act as a lead into a lesson and encourage attention. Therefore, besides developing a game-based learning to serve the purpose of the teacher, another way is for a teacher to use already-made games which are readily available in the market to be employed for learning and teaching.

However, game-based learning is merely one of the innovations that help students to learn and adopt analytical thinking ability. Therefore, the author concludes that the learning and teaching management in Thailand may apply this approach of using game-based learning as a valuable learning and teaching tool. Indeed, teachers should be trained to develop further so as to be encouraged to apply game-based learning in the classroom concretely so that they will be better equipped to be able to take care, advise and monitor the game playing of the learner and as a result will enforce Thailand to be truly ready for inexorable challenges and dynamics of the 21st Century world.

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