GAME-BASED ACTIVITIES AND GAMIFICATION IN THE MASTERY OF SCIENCE PROCESS SKILLS: A SYSTEMATIC LITERATURE REVIEW

Verjel D. Macayan[1], Diana C. Baguistan[2], Jieceryl B. Golias[3]

[1, 2, 3]*Bataan Peninsula State University-Graduate School, Balanga City, Bataan, Philippines*

ABSTRACT

This paper utilized systematic literature review method to determine and analyze the pros and cons of incorporating game-based activities and gamifications in science education. Also, this paper reviewed relevant research studies, articles, and literature reviews to identify educational innovations and programs that can potentially enhance the strengths and alleviate the problems of utilizing and integrating game-based learning activities in science online learning. It was found that game-based activities and gamifications had the capability to support and digitize classroom instructions with smooth transition, and can increase students' motivation and interest towards learning, and social and communicative skills from working with their peers. And in spite of the fact that these innovative tools revealed its positive effects and impactful results in education, numerous challenges and drawbacks were identified and determined. Concerning these snags, it was determined and reported from several research studies and literature reviews that some of the game-based elements and features which are leader scoreboards, badges, level of challenges, and reward systems were saturated with problems and negative impacts on student learning. Concurrently, it was also found that teachers strove to a lot of pedagogical and technical problems when utilizing and integrating gamified learning activities in their classroom instructions. It was concluded that this paper could be used as basis for more research studies that would be conducted in the future, and scrutinizing the effectiveness and educational barriers of game-based learning and gamifications must continue to present and provide relevant educational resources and professional and technical preparations from educators to prevent the possible risks.

KEYWORDS— *Game-based learning, gamification, game-based instruction, online science learning*

I. INTRODUCTION

Last December 2019, a novel "immunity-suppressor" arose, and within weeks, ushered to the emergence of the biggest global health crisis seen to date. The virus "SARS-CoV-2", begets coronavirus disease which was named "COVID-19" by the World Health Organization (WHO). The rapid spread of this infection caused a national state of panic in the country. The metastasized action of this deadly infection turned a source of public worry and several ambiguities regarding the pathogen that causes the infection. Several geographical lockdowns and prolonged quarantines induced fear and posed psychological stress which led to many cancellations and suspensions of work and other social activities, including classes in many schools (Anwar et al., 2020). And within the years that the country has faced the challenges brought by the pandemic, the provision of education to the learners have depended on several but limited choices: distance learning though the modular modality and the blended or also called the hybrid learning. These learning modalities have brought a lot of difficulties in classroom instructions, especially in science education. Because of the pandemic and the provisions of the Department of Education on learning modalities, science education, as well as other academic subjects, has shifted the traditional method of teaching with virtual classroom instruction that were conducted online to conserve the process of learning. And

since scientific concepts have to be performed and applied, the popularity of using online learning tools, like game-based activities and gamification, increased (Estrellado, 2021).

Gamification is a peculiar term which means the use of game concepts to make learning and instruction more enjoyable (Kapp, 2012). A Game-Based Learning application has been placed in a scientific lesson to improve students' emotional and behavioral engagement (Yousef et al., 2014). Game-based activities and gamification have long been thought of as a significant part to learn and understand science.

In the study of Barab et al. (2007), the main goal of science education is to assist students in flourishing their knowledge, skills, and epistemologies that is demanded in dealing with the 21st century. In addition, they discussed about the inclusion of inquiry-based learning, involving new forms of technology, and have a game-based scenario in the curriculum. Furthermore, game-like virtual learning experiences can furnish a sturdy sense of collaboration and engagement to all learners. They also have the possibility to gain participatory narratives that can aid learners in developing a contextual understanding of what are all too often presented as decontextualized scientific facts, concepts, or principles.

Because educational activities have relied on the use of online platforms and online applications, technological

subjects such as, smartphones, computers and laptops have become the necessities as the pandemic went on. Avila et al. (2021) cited that these technological gadgets are required among students to cope up with their online class. And since online classroom instructions are dependent on the use of technological media, educators must embed their pedagogical approaches to the technology they are using by incorporating online, game-based activities and other types of gamifications. Harris et al. (2015) posited that technology could be the catalyst of education that promotes motivation to the students and provides a meaningful impact on their academic achievements. And so, educators should bear in mind the importance of incorporating online, game-based type of activities and other types of gamifications, in tackling their lessons, especially those that are very hard to understand like the myriad processes and concepts in science, which is responsive to the level of teaching that is needed by the learners as they are truly striving in education during the pandemic (Smiderle et al., 2020).

For this reason, this paper is made and written to explore the use of game-based activities and gamification in the mastery of science concepts and skills. Also, this paper is written to examine and understand the positive impacts of utilizing game-based activities in learning science concepts and skills. Lastly, this paper is written to recognize the future tendencies and educational innovations in the education system.

II.   OBJECTIVES

This paper aims to assess the game-based activities and gamification in the mastery of science concepts and skills. Specifically, the paper seeks answers to address the following questions:

1. What are the different kinds of game-based activities and gamifications and how do these game-based methodologies apply on the different strategies of online learning?
2. Which gamification and game-based elements are most used in promoting an effective science online learning?
3. What are the positive impacts of utilizing game-based activities and gamifications on science online learning?
4. What are the challenges and pedagogical barriers encountered in integrating game-based activities and gamifications on science online learning?
5. What future tendencies and educational innovations and programs can be suggested to mitigate and lessen these challenges and pedagogical barriers in using game-based activities and gamifications on science online learning?
6. What future tendencies and educational innovations and programs can be identified from the analysis of the current conditions of integrating game-based activities and gamification on science online learning?

III.   METHODOLOGY

This paper utilized the systematic literature review method of investigation. In this method, the researcher answered specific research questions; and then pointed out, selected, reviewed, and synthesized high-quality research evidence and arguments pertinent to those questions. In principle, a systematic literature review is defined as "research about research" and uses the same process of reviewing literature that is normally done in primary research papers.

In this investigation, the Google Scholar search engine was utilized as the research tool. Such was used because the search engine contains repositories of quality and relevant educational research. Four combinations of search terms were used in browsing for appropriate literature to wit "GAME-BASED LEARNING", "GAMIFICATION", "GAME-BASED INSTRUCTION", and "ONLINE SCIENCE LEARNING". There were at least 100 potentially relevant hits in all search results using at least three combinations of the keywords chosen, and so, the dataset was filtered to select relevant manuscripts based on the following criteria: 1) the relevant papers must be written in English; 2) they must be articles, studies, and/or conceptual manuscripts, and 3) they must be papers published locally or internationally in the last 10 years.

All 17 studies were thoroughly reviewed based on this paper's objectives. Each intervention's delivery or methodology were described in-detail to fulfill the first objective. Each project's seeming features, the issues encountered by their implementers and clienteles upon their implementation, and the challenges they posed to involved entities were discussed to meet the second objective. Lastly, inferences from the researcher, mainly covering each intervention's prospects for possible local usage in the future, were given to satisfy the sixth objective.

IV.RESULTS AND DISCUSSION

Even before the pandemic, game-based activities and other types of gamifications have truly been adapted and implemented in the setting of classroom instruction. And when the pandemic came to humanity, the positive impact of game-based activities has been blended with the utilization of technological mediums, and the pedagogical approaches in education has undergone a lot of modernization. This educational move has brought a lot of advantageous effects in teaching, especially as this process of concerted sharing of knowledge is dependent on the use of online tools and application, and is undertaken through online, game-based type of activities and other types of gamifications (Smiderle et al., 2020). These educational changes are truly evident and applicable in science education since the world of science is open to many innovations.

On the other hand, while many educational institutions are accustomed this adaptation of technology and game-based teaching strategies and approaches in the classroom in the midst of pandemic, especially in science education, there still have been many predicaments and concerns on how the post-pandemic mode of learning delivery will be (Avila, 2021). Also, scientific studies have shown some unfavorable outcomes of using technologies, online tools, and advanced online applications especially on web linkages among the users, actions performed while users participate in online, game-based activities, and game-based elements (Smiderle et al., 2020). From these diverge impacts and setups of game-based activities and gamifications in learning and science education, especially in the mastery of science process skills in the online world, this paper is necessary to uplift its purpose by addressing the provided research questions through conducting a systematic literature review of research studies and articles.

Different kinds of game-based activities and gamifications and the game-based elements that are most used in promoting an effective science online learning. While this paper was on its initial stage in answering the first and second research questions, there were many foreign studies and literature reviews initially found as a result of database research. In relation to the first two research questions, these foreign studies and literature reviews were focused on the different kinds of game-based activities and gamifications and the game-based elements that are most used in promoting an effective science online learning.

The foreign studies and literature reviews that this paper have chosen were mostly found game-based activities and gamifications with a lot of diversifying impacts in science online learning which are dependent on the type of game-based activity, and the findings were predicated mainly from mixed methods research studies and experimental innovations. The first was a mixed methods research study conducted by Buzko et al. (2018) on the relevance of integrating mobile learning applications and augmented reality game-based elements in binary lessons. Binary lessons refer to lessons that combine and integrate two different educational disciplines.

Contextualizing this pedagogical innovation in science education, it is indistinguishable to some degree in STEM education which combines and interlaces four distinct disciplines. And as part of the research study, binary lessons were conducted and implemented with the utilization of gamification and game-based elements of augmented reality. In the study, the researchers recruited teachers to conduct classroom instructions using the three provided binary lessons:

"Diffusion in Nature and Science", "Science and Technical Progress. Light Phenomena in Nature and in Technology", and "Environmental Problems of Nuclear Energy". Before the lesson, the students were asked to download the "Augmented Nuclear Plants' Application". During the lesson "Environmental Problems of Nuclear energy", two teachers, one English teacher and one Physics teacher, announced the theme and the objectives of the lesson. Concurrently, the game-based elements of augmented reality were put in with the assistance of mobile learning applications. Then, during the evaluation and after the classroom instruction has ended, the students were instructed to give their responses to the provided questions related to the topic contingent on their observation. Through this study, the researchers affirm that game-based activities and gamification, and augmented reality in science education let on the student participants to have meaningful involvement in the educative process inside and outside the classroom setting.

The second study meanwhile was by Su and Cheng (2015) and was made to investigate how Mobile Gamification Learning System (MGLS) influences science learning and students' achievement and motivation towards learning. The contextualized mobile learning application under this learning system, called "Find Insect Mobile Application", comprised a series of game-based activities and other types of gamifications that was established and actualized in an elementary school science curriculum to enhance student motivation and to let on the students to have meaningful involvements in their learning activities.

The researchers recruited student participants to log in and instructed them to browse the mobile learning application and choose one of the learning games. Also, student participants were oriented that this mobile application will send a reminder with instructions on how to do and accomplish the task of the gamified activity. Then, the learning contents will be projected on the screen of their mobile device after the students scan the QR code of a particular learning competency. After actualizing the procedures and strategies of the research study, sets of questionnaires and pre-test and post-test were given to the student participants. The responses of the student participants demonstrated that integrating mobile learning application and game-based activities in science learning process could obtain a better student performance and an elevated degree of motivation than either conventional learning activities or traditional classroom instructions.

Similarly, a research study conducted by Pechenkina et al. (2017) as cited in Loganathan et al. (2019) was made to determine and scrutinize how gamified mobile learning application utilized to increase the engagement, retention, and academic achievement of the students as they dwell on and study myriad science lessons. The researchers innovated a mobile application incorporated with gaming features and the main concern was to evaluate on what they have obtained in lecture method and how advance is their knowledge on scientific contents/concepts. In the mobile learning application trial, the researchers recruited first year student participants from the overpopulated course programs/units which were, that time, accounting and science. They let the student participants to choose whether they were used the mobile learning application or not. Those who were opted to use the mobile learning application had been notified about lecture notes and invitations to take multiple-choice type of assessments which were sent via their mobile learning application. And based on students' login history, a leader scoreboard was projected and the student who won the challenge was awarded with digital badges. The study concluded that the students who utilized the mobile learning application showed higher performance in quizzes compared those who did not utilize the application. Also, student participants had shared their experiences as they spent time using the mobile learning application which was the implication part of the study in relation to their career.

Quiz-Creation-and-Learning-Game-Based-Activities like Kahoot, Quizizz, and Quizlet are online quizzes portals that let on the teachers to list down and set questions that can be administered via online platforms to assess the learnings of the students based on the knowledge they learned from the lessons they have taken. These game-based activities are also known as Audience Response System (ARS) Platforms and these online learning platforms, students are provided with choices to answer the questions individually or in groups. They accumulate points situated on the speed and accuracy of the answers and responses provided which will be showcased in the leader scoreboard (Mader & Bry, 2019). The actualization of these game-based activities has gained its demand and popularity among educators in the Philippine Educational System. Numerous studies have found out that these gamified online platforms are useful and relevant, especially among undergraduates, with respect to how these online applications induce student motivation and engagements (Lin et al., 2018). However, in a research study that was conducted by Boutaba et al. (2018) as cited in Loganathan et al. (2019), it was highlighted the limitations of utilizing online game-based activities, especially if the online learning platforms are dependent on internet connection.

The research study of Mader and Bry (2019) led to the advancement of game-based online learning activities by introducing team-based social gamification as part of their study. In this social gamification, students are allowed to provide responses in online quizzes as team. The researchers recruited student participants and regrouped them to form two teams. As teams, student participants were instructed to give their best since their performance in giving answers to the questions posted on Quizizz will be of good advantage to their teams as a whole. The accumulated points of each team from answering the online quiz will be projected on the screen which promotes students' motivation and engagement to actively participate in game-based online activity. Though it was found on their research study that this approach is effective only in a small class but still, it can empower the collaborative skills of the student participants as they are participating with their peers and can uplift students' interest and engagement towards learning.

To further enhance and develop the generalizability of their research study, the researchers proposed some approaches to make this team-based social gamification suitable and more applicable in large class of students. At the same time, this uplifting the degree of generalizability on team-based social gamification is important to the researchers to produce new approaches under this game-based online activity that will allow students the opportunity to choose their peers to work with.

It was reported from a research study published by Aşıksoy and Sorakin (2018) the execution and actualization of clicker-aided flipped classrooms interlaced with Quiz-Creation-and-Learning-Game-Based-Activities (Audience Response System) in a classroom instruction in Physics. In this research study, the Physics course was taught and instructed with the utilization of flipped classroom model. The related notes and videos of the content were uploaded by teachers before the online classroom instruction to serve as preparatory phase for the students. During the time where the student participants were about to assess and evaluate based on the knowledge they learned from the lesson, they were instructed to answer the provided quizzes in the online learning portal. For quizzes that were done individually, a time limit was set for student participants to answer the game-based online activity. The research study has resulted to an indication of the positive effects of clicker-aided flipped classroom model in enhancing and improving students' motivation, achievements, attitude, and skills in dwelling on and studying a lot of learning competencies in Physics and other sciences.

Positive impacts and challenges in utilizing and integrating game-based activities and gamifications on science online learning. As man is in the midst for development, innovations are inevitable. This is true in education. With the needs and priorities brought about by the fast-changing society, it is most likely that innovations will occur. But despite of the positive impacts that this innovation has brought to humanity, challenges and barriers have always been emerged as this innovation is utilized and integrated in education. In relation to game-based activities and gamifications as these online learning applications have gained its demand and popularity in the field of education, its utilization and integration in the educative process, particularly in science online learning, provide a lot of advantages and somewhat disadvantages to teachers, students, and the entire process of education.

This paper provides foreign studies and literature reviews to diversify and to have a deeper understanding of the positive impacts and challenges in utilizing and integrating game-based activities and gamifications on science online learning, and to uplift the purpose of this paper by addressing the third and the fourth research questions. The foreign studies and literature reviews that this paper have chosen were mostly found game-based activities and gamifications have a marked influence on science online learning which converges depending on the type of game-based activity, and the findings were based mainly from long-term research and experimental works.

Mellor et al. (2018) posited that enhancing and improving the skills of students in learning scientific practices should be contemplated on the knowledge on how these practices are utilized, integrated, and contextualized in real-life scenarios. Teachers and students should bear in mind that scientific concepts and actualization of science contexts through investigations and discoveries must be predicated mainly from social necessities. Interlacing this context to online learning activities, game-based activities and gamifications must aid students to create an array of interconnectedness between scientific concepts and practices and the practical world to support a lot of aspect they need in real life. In utilizing and integrating game-based online activities and other types of gamifications in science online learning, lecturers and educators must be integrated these online learning applications and platforms only in science contexts through which its elements could sustain these contexts of practicing and investigating scientific concepts in relation to social and real-life contexts.

It was scrutinized in the research study conducted by Morris et al. (2013) the utilization and integration of game-based activities and gamification in science education by outlining the rationale for why game-based online activities have the capability to be contextualized to improve science education. The researchers have found and suggested that game-based activities and other types of gamifications are socio-cultural and educative media in science education and that game-based online activities have its strengths to be used in augmenting science education.

Utilizing ang integrating these educational innovations in classroom instruction, particularly in dwelling on with myriad science contexts, demand cautious basis of considering their strengths and weaknesses. Also, online and gamified activities must be viewed as socio-cultural and educational media which are capable to support the three key elements of scientific literacy: knowledge of content, process skills, and comprehension towards the never-ending saga of science. Concurrently, researchers asserted that there are three ways in which game-based activities and gamification may aid to empower scientific thinking skills and science education. First, through the utilization of serious educational games, knowledge of scientific concepts is discussed using gaming contexts and elements to further inquiry-based learning. Second, there are game-based online activities which promote creativity in making scientific investigations, aiding the students to embed scientific process skills in socio-cultural contexts. Lastly, educational games and gamifications may further the skills, attitudes, and values that are significant to develop the scientific thinking and practicing of scientific contexts.

The second was an exploratory multiple case study conducted by Feinstein and Vu (2017) wherein the impacts of game-based learning activities and gamifications on students' academic performances and behaviors in STEM classrooms, and the perceptions of teachers toward the implementation and actualization of these educational innovations in classroom instructions were evaluated. The exploratory case study comprised of four cases that were analyzed and gauged over a course period of one and a half year. The data utilized in this case study include 101 students' pre-test and post-test score, and four detailed and structured written reflection papers by four STEM teachers who participated in the case study by implementing game-based activities and gamifications they chose to integrate into their classroom instructions in a week.

According to Feinstein and Vu (2017), implementing game-based learning activities and gamifications could lead to meaningful improvement on students' cognitive aspects of academic performances in terms of the test scores they got from playing the game. In addition, students' behaviors were observed to change positively. Students were noticed that they performed pro-social skills which they learned from collaborating with their peers inside the gaming environment. At the same time, the game-based learning activities implemented inside the classroom induced the positive mood states of the students. Finally, teacher's perceptions about game-based learning activities and gamifications altered before and after they utilized and incorporated the gamified activities in their classroom instructions. This shifting of their perceptions on game-based learning activities was due to the positive result of students' cognitive aspects of academic performances in terms of the test scores they got and good behaviors toward these gamified activities.

Another was a mixed methods research study conducted by Hursen and Bas (2019) and was about the impact of game-based online learning applications in science education and on students' science learning motivation. In this research study, the learning motivation of students toward science and the opinions of students and parents on gamified learning applications were determined and discussed. The research study comprised of two phases that were analyzed and gauged over a course period of 12 weeks and 36 hours. The researchers recruited 16 student participants studying at primary schools as well as their parents. In the research study, researchers utilized quantitative and qualitative approaches of gathering and collecting data. To qualitatively gather and collect data, researchers recruited and interviewed the head of the school where the gamified learning applications would be utilized and conducted, supplying information on the study. After the said procedure, they recruited the parents of Grade 4 students who were voluntarily participated on the day when the research study was conducted. For student participants, the researchers were asked first the consent of their parents through written permission. Parents and students were instructed to give their opinions on game-based learning activities and gamified applications.

Quantitative data needed in this study were gathered and collected by utilizing a single group pre-test-post-test experimental approach and it was used and conducted on Grade 4 science education. A research instrument, known as the "Motivation Scale for Learning Science" was utilized in order to ascertain the impact of science education aided by game-based activities and other types of gamified applications on students' motivation toward science learning.

Hursen and Bas (2019) found out in their research study that there is significant increase in students' motivation, interest, and willingness to participate in learning science before and after game-based activities and gamified applications have aided the classroom instructions over the given course period. They believed that this increase in motivation of students towards doing research, performance, and communicative and collaborative studies in science education have resulted from the effective approach of utilizing and integrating game-based activities and gamified applications in classroom instructions. Also, the research study itself received positive opinions from the parents toward game-based activities and gamified applications. For parents with no background information about game-based activities and gamified applications, they found and determined the gamified learning approaches effective and beneficial as these educative innovations are utilized and integrated in classroom instructions. Concurrently, parents asserted that they had the chance to communicate their concerns and commendations effectively with the teachers and elucidated that they could track the learning progress of their children closely. Moreover, parents commended that game-based learning activities and gamified applications motivated their children to perform, communicate and collaborate with their peers in the class. Considering everything, the research results gained from the opinions of parents regarding the utilization and integration of game-based activities and gamified applications are consistent with the opinions of their children.

Although game-based learning activities and other types of gamifications divulged its positive effects and interesting results in classroom instructions, it was however identified and determined that drawbacks might occur. Lecturers and educators must consider the downsides of these gamified applications before utilizing and integrating them in their practice. About these snags, some of the game-based elements infused with negative impacts on student learning are leader scoreboards, badges, and rewards (Fleischmann & Ariel, 2016). This finding seems to support and align the outcomes and results of a 2x2 factorial research study conducted by Ronimus et al. (2013) where they investigated the effects of time, level of challenge, and reward systems on students' engagement in digital game-based learning activities. The research study comprised of phases where student participants were tasked to play GraphoGame, a game-based learning activity that could train the student participants to learn the connections between letters and sounds. The gathered and collected data within these phases of conducting the research study were analyzed and gauged over a course period of 8 weeks.

The researchers recruited student participants studying via sending them an e-mail and instructed them to register as GraphoGame users. All student participants with affirmative consent form returned by their parents to the researchers and those who took part in the game during the course period were covered in the study. In the research study, researchers utilized quantitative and qualitative approaches of gathering and collecting data. these data concerning student participants' performance in playing GraphoGame were automatically put down and keep on the game's online server and were retrieved later from the online server to scrutinize. Researchers also utilized the observations and evaluations of parents concerning the level of motivation and concentration of their children while playing the GraphoGame via sending them online questionnaires.

Ronimus et al. (2013) found out in their research study that student participants were happy playing GraphoGame and the level of enjoyment was not afflicted by the game-based elements and features being scrutinized and evaluated. When the data for Time Vs. Reward were graphed, the researchers found out that the presence of reward could afflict the session duration of the students. This direct relationship between the time that the students spent in playing the game and the presence of reward system seemed to increase students' interest in game-based learning activities. However, the researchers asserted based on their observations that while the reward system can suddenly elevate students' interest and engagement towards learning, this impact of rewards as a provoking factor for motivation depresses as the session goes on for a long period of time. Furthermore, this research study identified and determined some problems and shortcomings in terms of control design, setting for tasks and main goals of the game, and feedback features which may have bestowed to lower level of students' participation while they are in the game. Considering everything, the researchers concluded that when making and upgrading game-based learning activities and gamifications, it is significant that the gamified activities and applications, together with its game-based elements, must have design features that will meet the needs of the students and support interminable engagement and interest towards the subject matter. To determine these game-based elements and features that are most effective and efficient at obtaining these goals, more thorough studies with persistent course period of observations of students' engagement and interest are entailed.

Similarly, it was reported from a research study conducted by Jääskä and Aaltonen (2022) the pros and cons of using game-based activities and gamifications in project management higher education. This paper has chosen the aforementioned research study since its findings seem to be relevant in science education, especially in determining the challenges and pedagogical barriers that can afflict the efficiency and effectiveness of the educative process in science.

The research study utilizes qualitative methods and establishes detailed interview data from 22 professional teachers who have rich experiences in project management teaching background. The research study comprised of four phases wherein participants were tasked to answer several semi-structured qualitative interviews to get an extensive understanding of their perspective of integrating game-based concepts in education. As the data were gathered and collected from the responses of participants, the researchers tracked and transcribed the responses to construct a basis for systematic data analysis. After this phase, the data were condensed through organizing, categorizing, and giving more focus on the important data in order to highlight the main focus of the research study. On the last phase, the data were graphed and reclassified again to first-order and second-order categories to make conclusion.

As the research study has come to its tail end, Jääskä and Aaltonen (2022) found out somewhat drawbacks and challenges of game-based activities and gamifications for students and teachers. For students, they are confronted with increased load and stress on cognitive knowledge of the contexts. Students get more frustrated with the pedagogical approaches if teachers do not give coherent and enough instructions on how the students participate and cooperate, or how to take part in the game. Concurrently, students find game-based activities and gamifications irrelevant and not align from the learning objectives. Game-based activities and gamifications have provided a lot of drawbacks and challenges to teachers. It seems that teachers who are required to utilize and integrate game-based learning activities need to spend more time to learn and understand the educational game. They also strive to a lot of pedagogical and technical problems when utilizing and integrating gamified learning activities in their classroom instructions. In terms of assessments and evaluations, teachers seem gamified learning activities as providers of trouble in terms of controlling or measuring the learnings of their students fairly. Considering all this findings, game-based learning activities and gamifications can provide positive impacts and negative returns and so utilizing and integrating these educational innovations need relevant educational resources and professional and technical preparations from educators to prevent the risks, some that have already mentioned in this paper, that may happen later.

Future tendencies and educational innovations and programs that can be identified from the analysis of the current conditions of integrating game-based activities and gamification on science education, and those that can be suggested to mitigate and lessen the challenges and pedagogical barriers that these gamified learning activities and applications have brought to science online learning. The recent obstacle of nations around the world toward outliving and competing in the changing needs of economy and education is to make it necessary for the students to acquire reasoning. To attain this, science, technology and engineering have imparted a significant role and can only perform their duties when the subjects were taught in a conducive learning environment that supports students' reasoning skills which are believed to be supported by game-based learning (Talib et al., 2019). For that reason, teachers should acknowledge the use of game-based learning to enhance reasoning skills for better productivity. In addition, the enhanced reasoning skills of the students lead the way for critical thinking, problem-solving skills and creativity which serves as important elements of 21st-century education. For this part of the literature review, this paper provides foreign studies and literature reviews to diversify and to have a deeper understanding of the educational innovations and programs that have been identified from the analysis of the current conditions of integrating game-based activities and gamification on science education, and the innovative programs that have been suggested to mitigate and lessen the challenges and pedagogical barriers that these gamified learning activities and applications have brought to science online learning. Also, this paper presented foreign studies and literature reviews to uplift its purpose by addressing the fifth and the sixth research questions. The foreign studies and literature reviews that this paper have chosen were mostly found game-based activities and gamifications as pedagogical machineries that can provide educational innovations for the betterment of students' learning and the educative process as a whole, and the findings were based mainly from research studies and experimental works.

Studies about game-based and gamification in learning have acquired expanding observations in the past years as a result of the enhancement in technology. As a result, teachers, students, and other stakeholders are now becoming aware of the new trend of learning approach. Klopfer, et al. (2010) as cited in Foster and Shah (2016) mentioned that analyzing the result of the studies about the use of game-based learning and gamification while giving the same amount of attention to the process of game integration and the context in which the game is embedded is recommended for the advancement and innovation in the field. Moreover, the analysis of the current conditions on the integration of game-based learning in teaching and learning process can be the direction for the game-based learning to move forward as games are becoming more incorporative, immersive, and collaborative. There has been a remarkable rise in the integration of game-based learning as the demand for the adoption of technology in the teaching and learning process is increasing. Consequently, this brings the introduction of latest game-based activities with new concepts. In the study of Ornebring (2007) as cited in McGrath and Bayerlein (2013), Alternate Reality Gaming (ARG) is an interesting new medium in which it paved the way for the creator and consumer that exhibits a more engaging and collaborative learning experience.

Future trends regarding the game-based learning serve as the basis for the future researchers. According to the systematic review of Xie et al. (2021), there are different factors in analyzing the future tendencies of game-based learning. The first is to make the game itself more interesting and immersive to learners, cater the different learning styles of the students, and how students can learn new knowledge while in the game world. Furthermore, external support, technology integration and cooperative development, and the theme type, which contains the game topic and the dialectic of playfulness and education should also be taken into account. Based from the analysis of the present condition regarding the game-based integration in teaching, future studies could emphasize more on how to enhance game-based learning strategies and models which are more distinct, educational, and suitable for all ages after examining the learning strategies adopted in the existing digital game-based learning (Chang & Hwang, 2019).

Although game-based learning activities and other types of gamifications revealed its positive impacts and meaningful results in classroom instructions, it was however found that problems and challenges might occur. Since some of these drawbacks are inevitable, especially in all aspects of education, several research studies, articles, and literature reviews have been made to minimize and diminish their impacts. In various studies that have been reviewed, there were recommendations and suggestions that can be mitigated and lessen the challenges when it comes to integrating game-based activities and gamifications on science online learning. In the study of Lutfi and Hidayah (2021) that aimed to determine the response of teachers and students towards the use of computer-based games as medium for learning sciences, it was mentioned that it is critical to continue developing computer games as a learning medium for science therefore it was suggested that games placed on computers or cellphones might help students avoid boredom when studying at home for an extended period of time, such as more than a month.

In addition, Morris, et al. (2013) proposed that games must be cultural and educational tools for scientific education, with distinctive qualities that may be utilized to enhance science teaching and learning and when incorporating games into scientific instruction, it requires careful assessment of its advantages and disadvantages. Furthermore, according to Su and Cheng (2014), gamification allows students to not only establish a perspective that encourages them to attempt new things without being apprehensive, but also to engage students in exciting activities for the sake of learning and with these, it was suggested in the study that to attain authentic ways of instructing students, schools should apply technologies and integrate teaching settings. Also, future research must continue to investigate the emerging mechanics and applications connected with developing gamification technologies and be prepared to build new learning theories if necessary.

V. CONCLUSION

This paper presents the findings of a systematic review of literature on game-based activities and gamifications, for the purpose of providing a deeper understanding of its positive impacts and challenges and drawbacks, educational innovations and programs that further enhance and improve science education, and innovative milestones to lessen and mitigate the challenges and pedagogical barriers that these gamified learning activities have brought to science online learning. Considering everything, the niche of game-based learning activities and gamifications as educational approaches is to aid other approaches and not to cover their relevance in education. Game-based learning activities and other types of gamified activities have the capability to support classroom instructions with ease and provide more conventional methods of teaching. Concurrently, gamified learning activities and applications can elevate students'

interest and engagement towards learning, and pro-social skills from collaborating with their peers inside the gaming environment. However, utilizing and integrating these innovative educational tools need relevant educational resources and professional and technical preparations from educators to prevent the risks, some that have already mentioned in this paper, that may arise later.

In today's world, particularly in education, the actualization of these game-based activities has gained its demand and popularity among educators in the Philippine Educational System. Numerous research studies have found out that these gamified online applications and platforms are useful and relevant with respect to how these online applications induce student motivation and engagements. However, there are some research studies that highlight the challenges and drawbacks of utilizing online game-based activities in science online learning and education. Considering all of these, more research studies must be made and continue to scrutinize and investigate the game-based elements, features, and procedures that are related to gamified learning activities and applications and be prepared to build new teaching and learning principles and theories for the betterment of the educative process..

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