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Innovative Learning Spaces as Catalysts for an Emerging Innovative Skill of Grade 10 Learners

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ABSTRACT

This study aimed to compare the effectiveness of interactive, game-based and inquiry-based learning spaces to the development of students' innovative skills such as creativity, critical thinking, collaboration and communication. The study involved 150 Grade 10 Junior High school students of Santisimo Rosario Integrated High School during the academic year 2024-2025. Frequency and Percentage were used to summarize and analyze categorical data of learners' characteristics. The findings indicated that majority of the respondents are approaching proficiency to proficient and have access mostly to printed textbooks and computers and mostly are visual learners. However, there are also learners that fall under the advanced level and have access to mobile phones, e-learning materials and online courses. The results also implied that the pre-performance level of the students in terms of creativity, critical thinking, collaboration and communication skills is approaching proficiency to proficient, while on the post-performance, the students are in the advanced proficiency level. One-Way ANOVA and Tukey Post-Hoc Test were used to determine the significant differences among the three experimental groups of respondents. The findings indicated that there is a significant difference in the pre and post performance of the students as to their innovative skills when exposed to innovative learning spaces. The results also revealed that there is a significant difference in the post performance of the students as to their innovative skills when grouped according to their science proficiency level except for the critical thinking skills, and no significant difference was observed in the post performance of the students when grouped according to access to learning materials and learning preferences. The findings also revealed that there is a significant difference in the post performance of the three groups of respondents as to their innovative skills in terms of collaboration and no significant difference in the post performance of the three groups of respondents as to their innovative skills in terms of creativity, critical thinking and communication.

Keywords: Interactive learning space, Game-based learning space, Inquiry-based learning space, creativity, critical thinking, collaboration, communication, proficiency level, VAK learning preferences

INTRODUCTION

Education serves as a key for enhancing life quality, likely being the most essential means for bringing about a change in one's life. Education offers the advantage of instructing us in critical, logical, and independent thinking, as well as in the skill of making sound judgments. Through proper education, individuals can transform their weaknesses into strengths. It supplies numerous resources and techniques for understanding and overcoming future challenges, helping us to effectively address these difficulties. Education plays an important role in developing the skills, knowledge, values , and attitudes that enable people to contribute to sustainable development (Sari, 2016).

Every nation's development and advancement are fundamentally based on education. The educational system in the Philippines has experienced several changes, the most significant is the implementation of the K–12 curriculum in 2013 (Barrot, 2021).

The Department of Education acknowledges the benefit of the K-12 curriculum in delivering higher-quality instruction built on a spiraling curriculum that begins with basic subjects becoming more complex as they progress, allowing students to master ideas and abilities. Establishing a working fundamental system is the aim of the K–12 Basic Education Program that will generate law-abiding, responsible, and productive citizens who possess the necessary training and jobs. According to the Department of Education's K–12 Education Vision, each graduate of the Enhanced K–12 Basic Education Program is an individual who has gained knowledge through a curriculum that is excellence-focused and built around solid ideas (Abragan, 2022).

Evaluating the effectiveness of the Philippine education system is a challenging task because of the various complex problems and difficulties that the industry and society are facing. The Philippines has participated in PISA 2018. This involvement provided the Philippines' Department of Education (DepEd) with standard data on the country's quality of education. An indication of the nation's basic education status is the result of the Programme for International Student Assessment (PISA), which revealed the Philippines' lowest rating, at 78/78 in 2018, and 78/80 in the year 2022 (356 PISA Score, ranking 78/80, 2022). Among the 79 participating countries, the Philippines got the lowest rating in reading and second to the lowest in Mathematics and Science. This low performance led to the urgency of enhancing the quality of basic education in the Philippines (DepEd, 2019).

On the other hand, school-based data gathered from the results of assessments are necessary for improving instructions, alteration of assessments, and even in school management. Mean Percentage Scores, or MPS, are a useful starting point for improving lesson delivery, utilizing learning resources, and creating and adjusting school improvement plans (Raganit, 2021).

Santisimo Rosario Integrated High School in the Division of San Pablo evaluates the performance of the students in Science subjects by monitoring the Mean Percentage Score (MPS) of the quarterly examination. The results revealed Grade 10 students' performance level in Science in the last school year 2023-2024 with MPS of 61.42 in Quarter 1, 60.04 in Quarter 2, 68.36 in Quarter 3, and 66.36 in Quarter 4.

This is based on the distribution of scores with descriptive equivalents such as 76-100% (Superior), 51-75% (Upper Average), 26-50% (Lower Average), and 0-25% (Poor) (Department of Education, 2015).

To give more emphasis on several ways to cater to the challenges of how students develop their skills, innovative learning environments specifically in this digital era could resolve these emerging science-related concerns. Innovative learning spaces today typically aim to offer alternative teaching and learning methods instead of traditional ones, as well as integrate new technologies. The level of innovativeness varies along a spectrum in comparison to conventional, mutually agreed-upon methods of teaching. Dewey emphasizes the importance of incorporating thorough conceptualizations of the activities occurring in these educational settings (Ossiannilsson, 2019).

Innovative learning environments emphasize the usage of acquired new knowledge, utilization of problem-solving strategies, and knowledge through collaborative creative expression (Ossiannilsson, 2019).

The findings of this study are important for developing contexts to be aware of the learning environments the majority of the students would be able to acquire knowledge and 21st-century skills specifically innovative skills. This could assist teachers in providing activities suited or appropriate to learners' needs and interests.

Furthermore, this research explored the impact of innovative learning spaces on the improvement of students' innovative skills. This also explained how interactive, game-based, and inquiry-based learning environments help students to possess skills in creativity, critical thinking, collaboration, and communication.

OBJECTIVES OF THE STUDY

This study aimed to compare the effectiveness of innovative learning spaces in terms of interactive, game-based and inquiry-based learning environment as catalysts for an emerging innovative skill of Grade 10 students enrolled at Santisimo Rosario Integrated High School in the academic year 2024-2025.

Specifically, it aimed to answer the following questions:

1. How is the learner's profile be described as to their:

1.1 Science proficiency level;

1.2 access to learning resources; and

1.3 learning preferences?

2. What is the innovative skills level of students on their pre and post performance in terms of:

2.1 creativity;

2.2 critical thinking;

2.3 collaboration; and

2.4 communication?

3. Is there a significant difference in the pre and post performance of the students as to their innovative skills when exposed to innovative learning spaces?

4. Is there a significant difference in the post performance of the students when grouped according to the learner's profile?

5. Is there a significant difference in the post performance of the three groups of respondents as to their innovative skills in terms of:

5.1 creativity;

5.2 critical thinking;

5.3 collaboration; and

5.4 communication?

METHODOLOGY

This study used the quasi-experimental research design to compare the effectiveness of innovative learning spaces such as interactive, game-based and inquiry-based learning environments in improving the innovative skills of the students. It is a kind of study design that aims to establish a cause-and-effect relationship. This study was conducted to determine if there is a significant difference in the pre- and post-performance of Grade 10 students as to their innovative skills when exposed to innovative science learning environments. This was also conducted to assess if there is a significant difference on the post-performance of the three groups of respondents as to their innovative skills.

The researcher collected quantitative data through survey questionnaires and teacher made pre-and post-performance assessments on science 10 competencies to accurately describe the study participants to achieve these goals.

This study utilized the population of Grade 10 students who are enrolled at Santisimo Rosario Integrated High School in San Pablo City in the academic year 2024-2025. The study included 150 Grade 10 students who served as the respondents. To perform this study, a purposive sampling was employed. This type of sampling is a method of identifying and selecting cases that uses limited research resources effectively and is used to select respondents that are most likely to yield appropriate and useful information (Palinkas et al., 2015). Three experimental groups were utilized in the study including interactive learning environment where students are engaged in learning Science through virtual laboratory simulations; game-based learning environment where students are engaged in educational games to better understand scientific concepts and inquiry-based learning environment where students participate in hands-on, inquiry-driven and exploratory activities.

In a study on innovative science learning environments as catalysts for improving the innovative skills of the students, various statistical treatments of data are applied. Some of these treatments include analysis of variance (ANOVA). The statistical technique known as analysis of variance (ANOVA) was used to compare the means of three or more groups in order to determine whether there are any statistically significant differences between them. When working with numerous groups, it is especially helpful in determining if observed variations in sample means accurately reflect differences in population means. This study also utilized frequency and percentage to describe, summarize and analyze categorical data of learners' characteristics. These helped the researcher to identify how learners' characteristics are distributed within a group.

RESULTS AND DISCUSSION

Table 1

Learner's profile in terms of their Science Proficiency Level

Science Proficiency Level	Interactive Group		Game-Based Group		Inquiry-Based Group	
	F	%	F	%	F	%
90% and above	17	34	12	24	11	22
85% - 89%	17	34	21	42	20	40
80% - 84%	14	28	16	32	19	38
75% - 79%	2	4	1	2	--	--
75% and below	--	--	--	--	--	--
Total	50	100	50	100	50	100

90% and above (Advanced); 85% - 89% (Proficient); 80% - 84% (Approaching Proficiency); 75% - 79% (Developing); 75% and below (Beginning)

Table 1 shows the respondents' profile in terms of their science proficiency level. The learners were grouped into three experimental groups including Interactive, Game-based and Inquiry-based Group. In the Advanced category, the Interactive group had the highest percentage (34%), followed by the Game-based group (24%) and Inquiry-based group (22%). This indicates that the students in the advanced level can comprehend scientific concepts and be able to use or apply them to solve real-world problems. They could also define concepts in science and differentiate two or more key scientific terms and be able to perform science experiments independently where they can follow laboratory procedures accordingly and make minimal errors in the results. On the other hand, majority of

the learners in all groups fall under Proficient and Approaching Proficiency level. The results indicates that students in the proficient category could understand and explain scientific ideas clearly, however, they could only apply them in limited scenarios. While the students that fall under the approaching proficiency level signifies that they have developed essential skills and knowledge through the guidance of the teacher. They could also understand and define scientific concepts however they lack skills in comparing two or more key scientific ideas.

No learners scored in the beginning level indicating an overall satisfactory performance of all the respondents, however, there are students that fall under the developing level emphasizing that they lack deep understanding of scientific knowledge and information.

Table 2

Learner's profile in terms of their access to learning resources

	Interactive Group		Game-Based Group		Inquiry-Based Group	
Access to learning resources	f	%	f	%	F	%
Online Courses	1	2	3	6	5	10
E-learning Materials	7	14	6	12	8	16
Mobile Phones	6	12	7	14	4	8
Computers	14	28	23	46	16	32
Printed Textbooks	22	44	11	22	17	34
Total	50	100	50	100	50	100

90% and above (Advanced); 85% - 89% (Proficient); 80% - 84% (Approaching Proficiency); 75% - 79% (Developing); 75% and below (Beginning)

Table 2 shows the respondents' profile in terms of their access to learning resources. The learning materials are categorized into online courses, E-learning materials, mobile phones, computers and printed textbooks. This table depicts that printed textbooks were commonly used by the Interactive group (44%) and least likely used by the Game-based group (22%). The results showed that majority of the materials that are available to students are printed textbooks and computers. During science learning sessions, the students of Santisimo Rosario Integrated High School commonly utilized printed modules, books and Learning Activity Sheets (LAS). These resources serve as the students' learning references.

On the other hand, computers were widely used by the Game-based group (46%) and Inquiry-based group (32%) and least used by the interactive group (28%). This implies that majority of the respondents have high access to computers since this equipment are easily available for the students especially during class sessions. The school has a computer laboratory, and the students are allowed to use these computers for educational purposes.

Mobile phones, E-learning materials and online courses have limited usage among the three experimental groups. Most of the students have mobile phones however, they are utilizing these gadgets only for entertainment and seldom use for science learning. Most of the students utilized these gadgets in using online platforms for leisure such as facebook, youtube, messenger, tiktok, and others rather than for educational purposes. While E-learning materials and online courses have low percentage usage since the students are provided mostly of printed textbooks containing science most essential learning competencies.

Table 3

Learner's profile in terms of their learning preferences

	Interactive Group		Game-Based Group		Inquiry-Based Group	
Learning Preferences	F	%	F	%	F	%
Visual	15	30	21	42	18	36
Auditory	21	42	13	26	16	32
Kinesthetic	14	28	16	32	16	32
Total	50	100	50	100	50	100

90% and above (Advanced); 85% - 89% (Proficient); 80% - 84% (Approaching Proficiency); 75% - 79% (Developing); 75% and below (Beginning)

Table 3 shows the respondents' profile in terms of their learning preferences. These include Visual, Auditory and Kinesthetic categories. The table shows that majority of the respondents are visual learners.

This table also illustrates that the Game-based group had the highest percentage (42%) of visual learners, while these types of learners have low percentage (30%) in the Interactive group. This indicates that the learners in Game-based group are mostly visual learners wherein they are most likely to understand science concepts using charts, diagrams, illustrations, maps and tables. The learners also preferred watching video films and animations to better comprehend scientific experimentations. They are most likely to understand experiments better when reading instructions or procedures in performing the tasks rather than listening.

Auditory learning preferences are commonly found in the Interactive group with the highest percentage (42%) and least likely found in Game-based group with the lowest percentage (26%). The learners with an auditory learning preference are most likely to learn best by listening to podcasts, and auditory lectures and preferred listening to instructions rather than reading them. They perform best during discussions, collaborative works, debates and other activities involving oral communication tasks.

On the other hand, Kinesthetic learners are found in both Game-based and Inquiry-based groups with similar percentage (32%) compared to Interactive group with low percentage (28%). This suggests that most learners with kinesthetic learning preference achieve high academic performance by engaging to hands-on activities such as project-making, building models, participating in fieldtrips and manipulating equipment and laboratory apparatuses.

Table 4

Innovative Skill Level of Students in their Pre and Post Performance in terms of Creativity

Raw Score	Interactive Group				Game-based Group				Inquiry-based Group			
	Pre		Post		Pre		Post		Pre		Post	
	f	%	F	%	F	%	f	%	F	%	F	%
15-17	3	6	24	48	3	6	22	44	4	8	31	62
12-14	20	40	23	46	19	38	26	52	20	40	19	38
9-11	27	54	3	6	28	56	2	4	26	52	--	--
6-8	--	--	--	--	--	--	--	--	--	--	--	--
5 and below	--	--	--	--	--	--	--	--	--	--	--	--
Total	50	100	50	100	50	100	50	100	50	100	50	100

15-17(Advanced); 12-14 (Proficient); 9-11 (Approaching Proficiency); 6-8 (Developing); 5 and below (Beginning)

Table 4 shows the innovative skill level of the respondents on their pre and post performance in terms of creativity. Before the learning intervention, the raw scores of the learners among the three groups fall under Proficient and Approaching proficiency level. This indicates that during the pre-performance assessment, the learners can comprehend science concepts and possess basic skills but unable to utilize this knowledge in producing output.

After the conduct of the learning intervention, an increase was observed in all three experimental groups and the Inquiry-based group had the highest increase from 8% to 62% under the advanced level of proficiency. This indicates that during the conduct of an inquiry-based learning approach, the students are grouped together to create a concept map showing the key concepts of the lesson. The students were also asked to collaborate in answering the provided guide questions based on the implemented activity. The result may imply that the activities for the learners helped them improve their creativity skills. The pre and post performance activities involved in terms of creativity are the following: multiple choice test questions, creating of an evolution comic strip showing the different theories of evolution and creating a post showing the importance of the occurrence of evolution.

On the other hand, there was also a big improvement in scores of each experimental group after the intervention. The result indicates that when students are exposed to learning environments where they can engage, observe, reflect and interact with their teachers and peers and be able to perform tasks with the aid of technology, the students are more likely to improve their creativity skills. Creativity skills of the students involve the students' ability to create outputs that are based on a specific lesson or learning competency. They are also able to follow instructions and procedures accordingly in order to create or produce new products.

Table 5

Innovative Skill Level of Students in their Pre and Post Performance in terms of Critical Thinking

Raw Score	Interactive Group				Game-based Group				Inquiry-based Group			
	Pre		Post		Pre		Post		Pre		Post	
	F	%	F	%	F	%	f	%	F	%	F	%
15-17	8	16	21	42	6	12	26	52	7	14	22	44
12-14	21	42	25	50	30	60	23	46	23	46	25	50
9-11	19	38	4	8	14	28	1	2	20	40	3	6
6-8	2	4	--	--	--	--	--	--	--	--	--	--
5 and below	--	--	--	--	--	--	--	--	--	--	--	--
Total	50	100	50	100	50	100	50	100	50	100	50	100

15-17(Advanced); 12-14 (Proficient); 9-11 (Approaching Proficiency); 6-8 (Developing); 5 and below (Beginning)

Table 5 shows the respondents' innovative skill level on their pre and post performance in terms of critical thinking. Three experimental groups were used and were exposed to different learning spaces including Interactive, Game-based and Inquiry-based. Before being exposed to each learning space, interactive, game-based and inquiry-based group have low percentage score ranging from 12-16% under the advanced level. Majority of the students before the intervention fall under the proficient and approaching proficiency category. The result indicates that most of the students during the pre-implementation could understand ideas in science but lack in the application concepts. The students could only do familiarization and memorization of inform however, they do not have the ability to differentiate two or more ideas and observations.

An increase in percentage of each experimental group under the Advanced proficiency level was observed after being exposed to each learning environment. Improvement in Advanced proficiency level was highly observed in Game-based group (52%), indicating that critical thinking skills could be enhanced when students experienced activities involving games. This also implies that students' cognition is utilized to solve game-based problems. They need to think critically to perform the tasks or the procedures of the game accordingly. During the implementation of the game-based learning environment, the students are asked to solve a puzzle to answer the provided guide questions. This puzzle involves an illustration of body structures of different species of fish. The students' task is to form the illustration to answer questions related to the illustration.

On the other hand, proficient level learners increased across all experimental groups. In the interactive learning space, the students are asked to visit PHET simulation site to perform a specific task about the topic while in the inquiry-based learning environment, the students are exposed to a group work that will collaborate to answer questions based on the selection given by the teacher.

The results may also emphasize that critical thinking skills could be developed when exposed to innovative learning spaces where in they could analyze, assess, evaluate and solve real life scenarios or problems.

Critical thinking skill is the ability of the students to comprehend certain situations and be able to think rationally to solve problems accordingly. It also refers to the learners' ability to utilize their higher order thinking skills to come up with a solution to a problem.

Table 6

Innovative Skill Level of Students in the Pre and Post Performance in terms of Collaboration

Raw Score	Interactive Group				Game-based Group				Inquiry-based Group			
	Pre		Post		Pre		Post		Pre		Post	
	f	%	f	%	f	%	f	%	F	%	F	%
15-17	--	--	2	4	--	--	15	30	--	--	20	40
12-14	--	--	32	64	18	36	35	70	23	46	30	60
9-11	50	100	16	32	32	64	--	--	27	54	--	--
6-8	--	--	--	--	--	--	--	--	--	--	--	--
5 and below	--	--	--	--	--	--	--	--	--	--	--	--
Total	50	100	50	100	50	100	50	100	50	100	50	100

15-17(Advanced); 12-14 (Proficient); 9-11 (Approaching Proficiency); 6-8 (Developing); 5 and below (Beginning)

Table 6 shows the innovative skill level of the respondents on their pre- and post-performance in terms of collaboration. This table shows the percentage scores of three experimental groups namely Interactive, Game-based and Inquiry-based group. Before the intervention, no students were categorized as Advanced among all groups. This indicates that during the pre-performance assessment, most of the students perform individually and lack cooperative skills among their peers.

After implementing the learning intervention, 40% of Inquiry-Based learners and 30% of Game-Based learners reached the Advanced proficiency level. This result indicates that the collaborative skills of the students are enhanced after being exposed to an inquiry-based learning space filled with group activities where they could share insights and listen to other group members on their suggestions in achieving a common goal. The game-based learning environment where the students are asked to solve a puzzle enhances the ability of the students to collaborate with their peers to perform a challenging activity.

While under the proficient level, the learners from the Game-based group increased their percentage score from 36% to 70% and the Inquiry-based group increased from 46% to 60%. The result implies that the interactive group shows minimal improvement in the advanced level of proficiency in collaboration. This signifies that the use of PHET simulation could be a difficult activity to perform a collaborative effort since it was done individually by the students.

The data revealed that the students have more improvement in their level of proficiency when exposed to game and inquiry-based learning environments compared to interactive space. This simply means that the learners are more likely to develop their collaboration skills when exposed to learning activities where in they interact with their peers to achieve a common goal, they work together and implement meaning decision making in solving real-world problems.

Table 7

Innovative Skill Level of Students in their Pre and Post Performance in terms of Communication

Raw Score	Interactive Group				Game-based Group				Inquiry-based Group			
	Pre		Post		Pre		Post		Pre		Post	
	f	%	f	%	f	%	f	%	F	%	F	%
15-17	3	6	18	36	2	4	20	40	2	4	22	44
12-14	25	50	29	58	20	40	26	52	26	52	27	54
9-11	22	44	3	6	28	56	4	8	22	44	1	2
6-8	--	--	--	--	--	--	--	--	--	--	--	--
5 and below	--	--	--	--	--	--	--	--	--	--	--	--
Total	50	100	50	100	50	100	50	100	50	100	50	100

15-17(Advanced); 12-14 (Proficient); 9-11 (Approaching Proficiency); 6-8 (Developing); 5 and below (Beginning)

Table 7 shows the respondents' innovative skill level on their pre and post performance in terms of communication. Three experimental groups were exposed to various learning environments. Before being exposed to learning environments, the pre-test scores of the students in the Advanced level ranged from 4% to 6% only. Majority of the students fall under the level of proficient and approaching proficiency. This indicates that before the learning intervention, the students are capable of understanding science concepts however, they could not explain or restate ideas clearly and accordingly. They can memorize facts and observations but unable to organize their thoughts and ideas.

After the exposure to innovative learning spaces, the results show higher proficiency level across all learning groups. Inquiry-based group has the highest percentage of 44% in the Advanced level, followed by the Game-based group (40%) and Interactive group (36%). This emphasizes that the use of question-and-answer activities help students improve their understanding and being able to communicate ideas clearly. The results also indicate that communication skills could be developed when students are exposed to learning spaces that are innovative where in they could experience and perform tasks through utilizing virtual laboratories (PHET Simulation), improve learning when exposed to activities involving games and acquire deeper understanding of science concepts through inquiry and discovery.

Table 8

Pre and Post Performance of the Students as to their Innovative Skills when Exposed to Interactive Learning Space

Innovative Skills	Pre-Test		Post-Test		t-value	Df	p-value
	Mean	SD	Mean	SD			
Creativity	11.24	2.06	14.40	1.90	-12.57	49	< .001
Critical Thinking	11.92	2.34	14.08	2.04	-11.62	49	< .001
Collaboration	9.48	0.61	12.22	1.35	-14.66	49	< .001
Communication	11.98	1.66	13.72	1.59	-15.82	49	< .001

Note. * p < .05, ** p < .01, *** p < .001

Table 8 shows the mean, standard deviation, t-values and p values of the pre and post-performance of the respondents as to their level of innovative skills when exposed to interactive learning environment. Pre performance assessment was administered to all the respondents across interactive group. The performance served as the baseline of their level of innovative skills before engaging in the learning interventions.

During the learning session in the interactive learning space, the students are asked to use an online application known as PHET Simulation. This is an example of a virtual laboratory wherein the students are given the opportunity to perform a task entitled "Fossil Dig". This activity provides students with learning experiences to perform digging of the different layers of rocks and be able to identify fossils found underneath the ground. After performing the digital laboratory activity, the students are asked to answer questions associated with the given activity. The activities provided for the learners include the use of a virtual laboratory where students are asked to open PHET simulation website, then the students would pick or choose one link related to the topic of evolution. The task involves procedures such answering guide questions that help them use their critical thinking skills, brainstorming with their group members about the different fossils that they had found that will allow them to work collaboratively and explaining ideas and insights about the activity to improve their communication skills. On the other hand, the students are asked to create an evolution comic strip that is relevant to the topic presented in the PHET simulation.

After the respondents' exposure to the abovementioned innovative learning space, a post test was administered to assess their improvements. This table shows the significant improvement in the respondents' level of innovative skills across interactive group. The p values (< 0.001) indicate that there is a strong significant difference between the pre and post test scores of the learners in all the innovative skills including creativity, critical thinking, collaboration and communication.

In terms of communication, the interactive group had the highest pre test mean of 11.98 while in the post test, the inquiry-based group had the highest post test mean of 14.40 indicating that the students could explain, state ideas, organize thoughts and communicate ideas effectively through engaging to an inquiry-based learning space where students are encouraged to develop deep understanding through discovery and making queries to be able to explain ideas clearly and connect them to other ideas.

The result may imply that when students are exposed to an interactive learning environment, they are more likely to improve their performance level. This indicates that the use of PHET simulation or virtual laboratories is an effective tool that can be utilized to make the teaching and learning process more flexible and accessible to carry out experiments without conducting a real one (Gonzales et al., 2017). The result may also emphasize that students would be able to explore and discover more science concepts in an interactive way with the help of the advancement in technology (Muzana & Astuti, 2017).

Table 9

Pre and Post Performance of the Students as to their Innovative Skills when Exposed to Game-based Learning Space

Innovative Skills	Pre-Test		Post-Test		t-value	df	p-value
	Mean	SD	Mean	SD			
Creativity	11.36	1.90	14.20	1.60	-13.36	49	< .001
Critical Thinking	12.48	1.71	14.42	1.40	-10.55	49	< .001
Collaboration	10.66	1.29	13.96	1.09	-15.54	49	< .001
Communication	11.28	1.69	13.98	1.60	-12.6	49	< .001

Note. * p < .05, ** p < .01, *** p < .001

Table 9 shows the mean, standard deviation, t-values and p values of the pre and post-performance of the respondents as to their level of innovative skills when exposed to a game-based learning environment. Pre-performance assessment was administered to all the respondents across game-based group. The pre-performance of the students served as the baseline of their level of innovative skills before engaging in the learning interventions.

In the game-based learning space, the learners are exposed to activities that are associated with games. The task given to students is to solve a puzzle to form an image for them to answer the guide questions. The students are also asked to perform a quiz bee game related to the topic.

After the respondents' exposure to the abovementioned innovative learning space, a post test was administered to assess their improvements. This table shows the significant improvement in the respondents' level of innovative skills across game-based group. The p values (< 0.001) indicate that there is a strong significant difference between the pre and post test scores of the learners in all the innovative skills including creativity, critical thinking, collaboration and communication). The nature of the game-based learning environment includes the use of puzzle making activity where students will be forming an illustration to answer the provided questions. This activity was done collaboratively and they are able to use their critical thinking and communication skills in answering questions and explaining or stating ideas related to evolution.

In terms of critical thinking, the game-based group had the highest pre and post test mean of 12.48 and 14.42. This result indicates that engaging activities that involve the use of game improve an individual's critical thinking skills. The cognitive ability of the students is enhanced when students are provided with complex procedures or mechanics of a game-based approach.

The result may imply that a game-based learning environment is an effective space for students to improve their innovative skills. Engaging games in a learning activity help students perform complex tasks. This could enhance students' performance and create a meaningful teaching-learning process (Krath et al., 2021). Educational games could also foster and develop skills such as problem solving, argumentation, critical thinking and collaboration (Jan & Gaydos, 2016).

Table 10

Pre and Post Performance of the Students as to their Innovative Skills when Exposed to Inquiry-based Learning Space

Innovative Skills	Pre-Test		Post-Test		t-value	df	p-value
	Mean	SD	Mean	SD			
Creativity	11.60	1.90	14.78	1.20	-13.43	49	< .001
Critical Thinking	12.08	2.17	14.36	1.60	-9.54	49	< .001
Collaboration	11.18	1.45	14.22	1.22	-13.98	49	< .001
Communication	11.74	1.70	14.40	1.43	-12.37	49	< .001

Note. * p < .05, ** p < .01, *** p < .001

Table 10 shows the mean, standard deviation, t-values and p values of the pre-and post-performance of the respondents as to their level of innovative skills when exposed to an Inquiry-based learning environment. In an in Inquiry-based environment, the learners are exposed to activities that involve deep exploration and questioning to better understand scientific ideas.

Pre performance assessment was administered to all the respondents across inquiry-based group. The pre-performance served as the baseline of their level of innovative skills before engaging in the learning interventions.

During the implementation of activities in an inquiry-based learning space, the students are asked to form a group to perform a collaborative task. The groups are asked to read a short selection about the topic of evolution and create a concept map showing the different evidence of evolution. They are also asked to answer the guide questions following the activity. In an inquiry-based environment, the students were divided into several groups. They were asked to create and perform a short presentation about the topic evolution. They had presented this presentation using any creative and interactive way. After the presentation, a question-and-answer type of activity was also conducted about their ideas on the occurrence and evidence of evolution.

After the respondents' exposure to inquiry-based innovative learning space, a post test was administered to assess their improvements. This table shows the significant improvement in the respondents' level of innovative skills across three experimental groups. The p values (< 0.001) indicate that there is a strong significant difference between the pre and post test scores of the learners as to their innovative skills when exposed to an inquiry-based learning space.

The result showed that during the pre-and-post performance assessment of the students in terms of creativity, inquiry-based group had the highest mean (11.60 and 14.78). This indicates that the group activities or collaborative work that involve question-and-answer activities help students improve their creativity skills. Through collaboration, the students can help one another to create new product or output.

The result also showed that during the pre-and-post performance assessment of the students in terms of collaboration, inquiry-based group had the highest mean (11.18 and 14.22). This indicates that the use of group work activities could help students improve their collaboration skills since the students are working together to achieve the task's objectives and goals.

The results implied that an inquiry-based learning environment could help students improve their knowledge and acquire essential skills. Dinihari et al. (2021), reported that when students went through series of inquiry activities, discoveries and investigations and undergone inquiry-based learning intervention, he/she is more likely to develop cognitive skills, critical thinking and problem-solving skills. In this kind of learning space, students are also allowed to construct knowledge and improved their level of understanding (Deng et al., 2020).

Table 11

Significant Difference in the Post performance of the Respondents when Grouped according to their Science Proficiency Level

Innovative Skills	F	df1	df2	P
Creativity	4.38	3	9.63	0.034
Critical Thinking	3.58	3	10.38	0.053
Collaboration	11.39	3	11.91	<.001
Communication	8.04	3	10.02	0.005

Note. * p < .05, ** p < .01, *** p < .001

Table 11 shows the significant difference on the post performance of the respondents when grouped according to their science proficiency level across creativity, critical thinking, collaboration and communication skills.

Using One-Way ANOVA, the innovative skills of the respondents display significant differences across the level of proficiency (Advanced, Proficient, Approaching proficiency, Developing and Beginning). The results revealed that the p-value (<.001) of collaboration skills shows strong statistically significant differences, while the p value of creativity (0.034) and communication (0.005) shows moderate significant differences. This result indicates that the level of science proficiency of the students affects their performance result. The result also indicates that when students have high proficiency level, they are more likely to produce good result and performance. The result implies that the students' performance shows variation depending on their level of science proficiency. This simply implies that advanced learners are more likely to develop creativity, collaboration and communication skills compared to lower category of science proficiency. On the other hand, the p value of critical thinking skill (0.053) is not statistically significant indicating that all proficiency level categories perform similarly in this innovative skill. This signifies that all proficiency levels could develop critical thinking skills.

The result revealed that students with high proficiency level has high creativity skills since they can understand concepts better and able to apply them. In terms of collaboration, the students under proficient and advanced level could enhance their collaboration skills compared to learners under developing level since they have more experience in game-based and inquiry-based environment and could work better with peers or group members. On the other hand, students with high proficiency level has good communications skills than those with low proficiency since they could easily understand and organize ideas.

The results revealed that the students at approaching proficiency level had low score in creativity, collaboration and communication than those under the proficient and advanced level. This implies that science proficiency level of the students could influence their performance in terms of creativity, collaboration and communication skills. This signifies that providing innovative learning tasks based on students' science proficiency level could help them better develop innovative skills particularly those students that belong to lower levels of proficiency.

Table 12

Significant Difference in the Post performance of the Respondents in terms of Creativity when Grouped according to their Science Proficiency Level

Creativity

Science Proficiency Level		Developing	Approaching Proficiency	Proficient	Advanced
Developing	Mean difference	—	-0.129	-1.023	-1.333
Approaching Proficiency	Mean difference		—	-0.894 *	-1.204 **
Proficient	Mean difference			—	-0.310
Advanced	Mean difference				—

Note. * p < .05, ** p < .01, *** p < .001

Table 12 shows the significant difference in the post performance of the respondents in terms of creativity when grouped according to their science proficiency level. The result revealed that there is a statistically significant difference between the advanced group and approaching proficiency group with a mean difference of -1.204. This result implies that students belonging to the advanced group has high creativity skills in the implemented post performance rather than those students belonging to the approaching proficiency level. The result also revealed that there is a significant difference between the proficient level and approaching proficiency. This also means that students in the proficient level had high creativity performance than those in the approaching proficiency level.

Table 13

Significant Difference in the Post performance of the Respondents in terms of Collaboration when Grouped according to their Science Proficiency Level

Collaboration

Science Proficiency Level		Developing	Approaching Proficiency	Proficient	Advanced
Developing	Mean difference	—	-2.10	-2.270	-2.1417
Approaching Proficiency	Mean difference		—	-0.175	-0.0464
Proficient	Mean difference			—	0.1284
Advanced	Mean difference				—

Note. * p < .05, ** p < .01, *** p < .001

Table 13 shows the significant difference in the post performance of the respondents in terms of collaboration when grouped according to their science proficiency level. The result revealed that there is a low significant difference among the proficiency level. This result implies that students belonging to the advanced, proficient, and approaching proficiency level has similar collaboration post performance. The result indicates that higher proficiency levels could perform tasks collaboratively having similar and minimal differences. The result also indicates that students belonging to the advanced, proficient and approaching proficiency level are more likely to improve their collaboration skills while those belonging to lower level could find it difficult to perform tasks involving collaboration skills.

Table 14

Significant Difference in the Post performance of the Respondents in terms of Communication when Grouped according to their Science Proficiency Level

Communication

Science Proficiency Level		Developing	Approaching Proficiency	Proficient	Advanced
Developing	Mean difference	—	-0.197	-0.546	-1.59
Approaching Proficiency	Mean difference		—	-0.349	-1.39 ***
Proficient	Mean difference			—	-1.05 **
Advanced	Mean difference				—

Note. * p < .05, ** p < .01, *** p < .001

Table 14 shows the significant difference in the post performance of the respondents in terms of communication when grouped according to their science proficiency level. The result revealed that the learners showed improvement in their communication skills as their science proficiency level increased. This only means that the proficiency level of the students has impact on their performance in terms of communication. There is also a need to provide students under the developing and approaching proficiency level with intervention activities that will help them improve their skills in communication. Proper assessment strategies and feedback are encouraged to help students in the developing to approaching proficiency achieve the advance level.

Table 15

Significant Difference in the Post performance of the Respondents when Grouped according to Access to Learning Resources

Innovative Skills	F	df1	df2	P
Creativity	0.743	4	38.1	0.569
Critical Thinking	0.761	4	36.7	0.558
Collaboration	2.009	4	36.6	0.114
Communication	0.487	4	37.6	0.745

Note. * p < .05, ** p < .01, *** p < .001

Table 15 shows a One-Way ANOVA Test analyzing the differences in learners' post-performance based on their access to learning resources across creativity, critical thinking, collaboration and communication skills.

The results shows that the p values for the innovative skills are greater than 0.05 wherein creativity has a p value of 0.569, critical thinking (0.558), collaboration (0.114) and communication (0.745). This result signifies that there is no significant difference between students' performance and their access to learning materials. This means that utilizing any available materials such as printed textbooks/modules, computers, mobile phones, e-learning materials and online courses yield to a similar result. This may indicate that no difference would be yielded whether the students used variety of learning resources. This also implies that there are other factors the help students improve their innovative skills including teaching pedagogy, students' engagement and quality of instructions and assessment.

Table 16

Significant Difference in the Post performance of the Respondents when Grouped according to their Learning Preferences

Innovative Skills	F	df1	df2	P
Creativity	2.2288	2	96.7	0.113
Critical Thinking	2.4409	2	97.6	0.092
Collaboration	0.5133	2	96.9	0.600
Communication	0.0600	2	97.8	0.942

Note. * p < .05, ** p < .01, *** p < .001

Table 16 shows a One-Way ANOVA test analyzing the differences in learners' post-performance based on their learning preferences (visual, auditory and kinesthetic) across the following innovative skills: creativity, critical thinking, collaboration and communication skills.

The results shows that the p values for the innovative skills are greater than 0.05 wherein creativity has a p value of 0.113, critical thinking (0.092), collaboration (0.600) and communication (0.942). The result signifies that no significant difference was found in the post-performance of the learners when grouped according to their learning preferences. This emphasizes that the performance level of the respondents does not vary whether they are visual, auditory or kinesthetic type of learners. This also implies that students' engagement with the learning process is more significant that their learning preferences. Students improve their knowledge and understanding through involvement in the learning process and be able to experience variety of activities that will cater their needs.

Table 17

Significant Difference in the Post performance of the Three Groups of Respondents as to their Innovative Skills

Innovative Skills	F	df1	df2	P
Creativity	2.244	2	94.5	0.112
Critical Thinking	0.484	2	96.0	0.618
Collaboration	35.304	2	97.3	<.001
Communication	2.602	2	97.7	0.079

Note. * p < .05, ** p < .01, *** p < .001

Table 17 shows a One-Way ANOVA and Tukey Post-Hoc Test analyzing the differences in the post-performance of the three groups of learners (Interactive, Game-based and Inquiry-based group) as to their innovative skills: creativity, critical thinking, collaboration and communication.

The table also revealed that the interactive group had the lowest performance in terms of collaboration as compared to game and inquiry-based learning environments. This suggests that learning interventions may be given to interactive group to enhance collaboration skills. Using the interactive or digital way or platform, students may be provided with learning activities that involve the use of virtual laboratories that may be performed collaboratively.

The table shows that there is no significant difference on the post-performance of the three groups of respondents as to their creativity skills. This implies that the use of PHET simulation where students can experience a real-world scenarios using the digital media, the association of games in the learning process and the use of self-directed learning activities could enhance the learners' creativity skills.

In terms of critical thinking, the result shows that there is no significant difference on the post-performance of the three experimental groups. This signifies that students' critical thinking could be developed in all innovative learning space where they can experience conducting experiments utilizing virtual laboratory and other online applications, can solve problems and make decisions accurately, and can experience hands on tasks.

The table also shows that there is no significant difference on the post-performance of the three experimental groups as to their communication skills. This implies that all innovative learning spaces yield to similar result of enhancing the communication skills of the students.

The result revealed that the only innovative skills that has a significant difference across the three experimental groups is the collaboration skills. This signifies that there are variations on the post-performance of the students. The inquiry-based group had the highest mean score of 14.2, while the interactive group had the lowest mean score of 12.2. This implies that the use of inquiry-based approach where learners experience a student-centered learning, allowing them to acquire information through observation, making queries and obtain results through experimentations and discovery. These activities allow students to collaborate and share ideas within the group. These could also help students explore scientific concepts with the help of each member of the group.

Table 18

Significant Difference in the Post performance of the Three Groups of Respondents as to their Innovative Skills In terms of Collaboration

Collaboration				
		1	**2**	**3**
1	Mean difference	—	-1.74 ***	-2.000 ***
2	Mean difference		—	-0.260
3	Mean difference			—

Note. * p < .05, ** p < .01, *** p < .001

Table 18 shows a Tukey Post-Hoc Test analyzing the differences in the post-performance of the three groups of learners (Interactive, Game-based and Inquiry-based group) as to their innovative skills in terms of collaboration.

This table shows that there is a significant difference between the interactive and game-based group with a mean of -1.74. This means that game-based group performs better than the interactive group in terms of collaboration. This also shows a significant difference between group 1 and group 3 and no significant difference between game-based and inquiry-based group. This indicates that students belonging to inquiry-based group performs better than interactive group. This also suggests that students in the game-based and inquiry-based group performs similarly in terms of collaboration skills.

The result revealed that group 1 has the lowest improvement in terms of collaboration skills, therefore, the teachers or educators may provide learning interventions involving programs that promote groupwork, teamwork, peer learning and others. An interactive learning environment involving the use of the digital media may be offered to students where in they could access technology through online platforms and be able to perform collaborative tasks and activities.

CONCLUSIONS

Following are the conclusions of the study:

1. Since there is a significant difference in the pre and post performance of the students as to their innovative skills when exposed to innovative learning spaces, therefore, the null hypothesis is not sustained.

2. Since there is a significant difference in the post performance of the students as to their innovative skills when grouped according to their science proficiency level except for the critical thinking skills, and no significant difference in the post performance of the students when grouped according to access to learning materials and learning preferences, therefore, the null hypothesis is partially supported.

3. Since there is a significant difference in the post performance of the three groups of respondents as to their innovative skills in terms of collaboration and no significant difference in the post performance of the three groups of respondents as to their innovative skills in terms of creativity, critical thinking and communication, therefore, the null hypothesis is partially supported.

RECOMMENDATIONS

Based on the conclusions above, the following are the recommendations of the study:

1. Learning activities based on Science proficiency level. Teachers may provide students with personalized learning activities that are applicable to their needs, interests and abilities. Differentiated activities may be provided to approaching proficiency and developing students, while advanced/enrichment activities may be offered to students of advanced and proficient level.

2. Improving collaboration skills. Collaboration skill was identified to significantly varied by the innovative learning spaces, where game-based and inquiry-based environments had high score than interactive spaces. Various activities and tasks may be introduced to students including group activities, problem solving exercises, think-pair-share, solving puzzles and etc.

3. Innovate inquiry-based learning space. An inquiry-based learning environment was identified in the study as one of the effective learning spaces in improving the innovative skills of the students. Therefore, innovating an inquiry-based learning environment with the aid of technology could provide students with more engaging and interactive experiences inside the classroom.

4. Future research. This study could provide future researchers with various information about the effectiveness of each studied innovative learning space. They could also explore more concepts specifically combining three innovative learning approaches and its effect to students' achievement.

REFERENCES

Abragan, F., Abarcas, V., Aquıno, I. M., & Bagongon, R. E. (2022). Research review on K-12 curriculum implementation in the Philippines: A generic perspective. *European Journal of Educational and Social Sciences*, *7*(1), 1-8.

Adipat, S., Laksana, K., Busayanon, K., Asawasowan, A., & Adipat, B. (2021). Engaging students in the learning process with game-based learning: The fundamental concepts. *International Journal of Technology in Education*, *4*(3), 542-552.

Almasri, F. (2022). Simulations to teach science subjects: Connections among students' engagement, self-confidence, satisfaction, and learning styles. *Education and Information Technologies*, 27(5), 7161-7181.

Azhar, A., Irianti, M., & Rahmadhani, M. (2023). The Effectiveness of The Virtual Lab-Assisted Guided Discovery Learning Model on Students' Science Process Skills. *Jurnal Penelitian & Pengembangan Pendidikan Fisika*, *9*(1), 35-40.

Barrot, J. S. (2023). K to 12 curriculum reform in the Philippines: Towards making students future ready. *Asia Pacific Journal of Education*, *43*(4), 1193-1207.

Behnamnia, N., Kamsin, A., & Ismail, M. A. B. (2020). The landscape of research on the use of digital game-based learning apps to nurture creativity among young children: A review. *Thinking Skills and Creativity*, *37*, 100666.

Brezovszky, B., McMullen, J., Veermans, K., Hannula-Sormunen, M. M., Rodríguez-Aflecht, G., Pongsakdi, N., ... & Lehtinen, E. (2019). Effects of a mathematics game-based learning environment on primary school students' adaptive number knowledge. *Computers & Education*, *128*, 63-74.

Cardno, C., Tolmie, E., & Howse, J. (2017). New spaces–new pedagogies: Implementing personalised learning in primary school innovative learning environments. *Journal of Educational Leadership, Policy and Practice*, *33*(1), 111-124.

del Moral Pérez, M. E., Guzmán Duque, A. P., & Fernández García, L. C. (2018). Game-based learning: Increasing the logical-mathematical, naturalistic, and linguistic learning levels of primary school students. *Journal of New Approaches in Educational Research*, *7*(1), 31-39.

Department of Education. (2019) *Statement on the Philippines' ranking in the 2018 PISA results.* GOVPH. https://www.deped.gov.ph/2019/12/04/statement-on-the-philippines-ranking-in-the-2018-pisa-results/

El Mawas, N., Trúchly, P., Podhradský, P., Medvecký, M., & Muntean, C. H. (2022). Impact of Game-Based Learning on STEM Learning and Motivation: Two Case Studies in Europe. *Knowledge Management & E-Learning*, *14*(4), 360-394.

Emerson, A., Cloude, E. B., Azevedo, R., & Lester, J. (2020). Multimodal learning analytics for game-based learning. *British journal of educational technology*, *51*(5), 1505-1526.

Estriegana, R., Medina-Merodio, J. A., & Barchino, R. (2019). Student acceptance of virtual laboratory and practical work: An extension of the technology acceptance model. *Computers & Education*, *135*, 1-14.

Fonseca, I., Caviedes, M., Chantré, J., & Bernate, J. (2023). Gamification and Game-based Learning as Cooperative Learning tools: A systematic review. *International Journal of Emerging Technologies in Learning (iJET)*, *18*(21), 4-23.

Georgieva-Tsaneva, G., & Serbezova, I. (2022). Research on the impact of innovative interactive technologies in the education of health care students. *International Journal of Emerging Technologies in Learning (Online)*, *17*(20), 283.

Gök, M., & İnan, M. (2021). Sixth-Grade Students' Experiences of a Digital Game-Based Learning Environment: A Didactic Analysis. *Journal of Research and Advances in Mathematics Education*, *6*(2), 142-157.

Grodotzki, J., Ortelt, T. R., & Tekkaya, A. E. (2018). Remote and virtual labs for engineering education 4.0: achievements of the ELLI project at the TU Dortmund University. *Procedia manufacturing*, *26*, 1349-1360.

Gudadappanavar, A. M., Benni, J. M., & Javali, S. B. (2021). Effectiveness of the game-based learning over traditional teaching–learning strategy to instruct pharmacology for Phase II medical students. *Journal of education and health promotion*, *10*(1), 91.

Gui, Y., Cai, Z., Yang, Y., Kong, L., Fan, X., & Tai, R. H. (2023). Effectiveness of digital educational game and game design in STEM learning: a meta-analytic review. *International Journal of STEM Education*, *10*(1), 36.

Hamed, G., & Aljanazrah, A. (2020). The effectiveness if using virtual experiments on students' learning in the general physics lab.

Hartanto, T. J., Dinata, P. A. C., Azizah, N., Qadariah, A., & Pratama, A. (2023). Students' science process skills and understanding on Ohm's law and direct current circuit through virtual laboratory based predict-observe-explain model. *Jurnal Pendidikan Sains Indonesia (Indonesian Journal of Science Education)*, *11*(1), 113-128.

Hasan, A. M. (2024). The Use of Inquiry Learning Model on Plant Growth and Development Material to Improve Students' Science Process Skills. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 982-990

Hughes, J. M., & Morrison, L. J. (2020, July). Innovative learning spaces in the making. In *Frontiers in Education* (Vol. 5, p. 89). Frontiers Media SA.

Huh, K., & Lee, J. (2020). Fostering creativity and language skills of foreign language learners through SMART learning environments: Evidence from fifth-grade Korean EFL learners. *TESOL Journal*, *11*(2), e489.

Ibragimov, G. I., Murkshtis, M., Zaitseva, N. A., Kosheleva, Y. P., Sadykova, A. R., & Shindryaeva, N. N. (2023). Research trends on learning environment in science education. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(11), em2351.

Karakoç, B., Eryılmaz, K., Turan Özpolat, E., & Yıldırım, İ. (2022). The effect of game-based learning on student achievement: A meta-analysis study. *Technology, Knowledge and Learning*, *27*(1), 207-222.

Kucher, T. (2021). Principles and Best Practices of Designing Digital Game-Based Learning Environments. *International Journal of Technology in Education and Science*, *5*(2), 213-223.

Kühn, C. (2017). Are students ready to (re)-Design their Personal Learning Environment? The case of the e-Dynamic. Space. *Journal of New Approaches in Educational Research*, *6*(1), 11-19.

Lin, J. W., Yen, M. H., Liang, J., Chiu, M. H., & Guo, C. J. (2016). Examining the factors that influence students' science learning processes and their learning outcomes: 30 years of conceptual change research. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(9), 2617-2646.

Mbanefo, M. C., & Ebokab, O. C. (2017). Acquisition of innovative and entrepreneurial skills in basic science education for job creation in Nigeria. *Science Education International*, *28*(3).

Morris, J. E., & Imms, W. (2022). Designing and using innovative learning spaces: What teachers have to say.

Mutlu, A. (2020). Evaluation of students' scientific process skills through reflective worksheets in the inquiry-based learning environments. *Reflective Practice*, *21*(2), 271-286.

Nja, C. O., Umali, C. U. B., Asuquo, E. E., & Orim, R. E. (2019). The Influence of Learning Styles on Academic Performance among Science Education Undergraduates at the University of Calabar. *Educational Research and Reviews*, 14(17), 618-624.

Ossiannilsson, E. (2019). Innovative learning and innovative learning spaces. *Asian Journal of Distance Education*, *14*(1), 98-116.

Ovbiagbonhia, A. R., Kollöffel, B., & Brok, P. D. (2019). Educating for innovation: Students' perceptions of the learning environment and of their own innovation competence. *Learning environments research*, *22*, 387-407.

Priyatni, E. T., & As'ari, A. R. (2019, August). Project-Based Learning Paper: Learning Model to Develop 4cs:(Critical and Creative Thinking, Collaboration and Communication Skills). In *1st International Conference on Education Social Sciences and Humanities (ICESSHum 2019)* (pp. 441-448). Atlantis Press.

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. *Computers in human behavior*, *63*, 50-58.

Raganit, A. A. (2021). A Comparative Analysis of Mean Percentage Scores (MPS) of Senior High School Classes. *International Journal of Multidisciplinary: Applied Business and Education Research*, *2*(7), 587-590.

Reisoğlu, İ., Topu, B., Yılmaz, R., Karakuş Yılmaz, T., & Göktaş, Y. (2017). 3D virtual learning environments in education: A meta-review. *Asia Pacific Education Review*, *18*, 81-100.

Saleh, A., Yuxin, C., Hmelo-Silver, C. E., Glazewski, K. D., Mott, B. W., & Lester, J. C. (2020). Coordinating scaffolds for collaborative inquiry in a game-based learning environment. *Journal of research in science teaching*, *57*(9), 1490-1518.

Saleem, A., Kausar, H., & Deeba, F. (2021). Social constructivism: A new paradigm in teaching and learning environment. *Perennial journal of history*, *2*(2), 403-421.

Santos, M. L., & Prudente, M. (2022). Effectiveness of virtual laboratories in science education: A meta-analysis. *International Journal of Information and Education Technology*, *12*(2), 150-156.

Sari, D. M. M., & Wardhani, A. K. (2020). Critical thinking as learning and innovation skill in the 21st century. Journal of English Language and Pedagogy, 3(2), 27-34.

Tan, R. M., Yangco, R. T., & Que, E. N. (2020). Students' Conceptual Understanding and Science Process Skills in an Inquiry-Based Flipped Classroom Environment. *Malaysian Journal of Learning and Instruction*, 17(1), 159-184.

Taub, M., Sawyer, R., Smith, A., Rowe, J., Azevedo, R., & Lester, J. (2020). The agency effect: The impact of student agency on learning, emotions, and problem-solving behaviors in a game-based learning environment. *Computers & Education*, *147*, 103781.

Uğur, S. A. R. I., Duygu, E., ŞEN, Ö. F., & Kirindi, T. (2020). The effects of STEM education on scientific process skills and STEM awareness in simulation based inquiry learning environment. *Journal of Turkish Science Education*, *17*(3), 387-405.

Urdanivia Alarcon, D. A., Talavera-Mendoza, F., Rucano Paucar, F. H., Cayani Caceres, K. S., & Machaca Viza, R. (2023, May). Science and inquiry-based teaching and learning: a systematic review. In *Frontiers in Education* (Vol. 8, p. 1170487). Frontiers Media SA.

VAK Learning styles self-assessment questionnaire. (n.d.). https://www.businessballs.com/freepdfmaterials/vak_learning_styles_ questionnaire.pdf

Von Kotzebue, L., Zumbach, J., & Brandlmayr, A. (2022). Digital escape rooms as Game-Based learning environments: A study in sex education. *Multimodal Technologies and Interaction*, *6*(2), 8.

Wale, B. D., & Bishaw, K. S. (2020). Effects of using inquiry-based learning on EFL students' critical thinking skills. *Asian-Pacific Journal of Second and Foreign Language Education*, *5*, 1-14.

Wang, M., & Zheng, X. (2021). Using game-based learning to support learning science: A study with middle school students. *The Asia-Pacific Education Researcher*, *30*(2), 167-176.

Zhang, J., & Hu, Z. (2024). Advancing game-based learning in higher education through debriefing: Social constructivism theory. *Journal for the Education of Gifted Young Scientists*, *12*(1), 15-27.

Zhao, J., Zhou, K., & Ding, Y. (2022). Digital games-based learning pedagogy enhances the quality of medical education: a systematic review and meta-analysis. *The Asia-Pacific Education Researcher*, *31*(4), 451-462.