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Eureka Role Playing Game: An Instructional Tool in Improving The Proficiency Level in Chemistry 7

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ABSTRACT

The Eureka Role Playing Game is a game-based instructional tool for learning science concepts. The study aimed to improve the proficiency level of the learners in Science 7, particularly in Chemistry subject. This study utilized a Quantitative Method to measure the gathered data and test the hypothesis. The quasi-experimental pretest-posttest research design was also used with a validated questionnaire and Eureka Role-Playing Game (RPG) as the primary data gathering instrument to evaluate students' proficiency level improvement as the intervention was administered to the experimental group and traditional teaching method for the controlled group. Results showed that in the controlled group, the mean post-test result was higher than the mean pre-test result, but still at the beginning level of proficiency. Meanwhile, the mean post-test result of the experimental group is higher compared to the mean pre-test result. Therefore, the level of proficiency of the experimental group has improved from a beginning level to a developing level after the intervention. A significant difference in the pre-test and post-test between the experimental group and the control group is in favor of the experimental group. Therefore, the alternative hypotheses of this study are accepted. Evaluated by the Science experts, the instructional tool passed the curricular validity criteria. The researchers recommend the use of the Eureka Role Playing Game since it significantly increased the proficiency level of the students from the beginning to the developing level based on the findings.

1. INTRODUCTION

A positive engagement in acquiring the necessary competencies in different fields allows individuals to grow toward being progressive. Likewise, the capability to incorporate Science into everyday demands is crucial to one's life. As one of the branches of Pure Science, "for many students, Chemistry is seen as a difficult, complex and an abstract subject that requires special intellectual talent and a too much effort to be understood" (Ben-Zvi, Eylon & Silberstein 1987; Gabel, 1999; Johnstone, 1991; Nakhleh, 1992). Due to its complexity, it cannot be handled easily through simple discussion. The teacher's personality attributes, teaching methods, techniques, classroom management, teaching materials, the learning environment,

and administrative support were the main influences on how students perceived their scientific literacy (Palines, K. M. E., & Ortega-Dela Cruz, R. A. 2021). As seen in 21st-century learning, Science teachers have always sought ways to make the teaching and learning of science very easy to understand with the use of technology. Rapid technological advancement, specifically in game applications, provides immense opportunities in the field of education to help teachers integrate innovative, more diverse, and effective teaching strategies. As COVID-19 hits the world, most people's perceptions of technology have shifted significantly, as it has evolved into a channel and mode for learning continuity.

The Program for International Student Assessment (PISA) shows a relatively low number of Science literacy in both male and female average 15-year-old Filipino students. Filipino learners can use basic Science knowledge to recognize or identify explanations of scientific phenomena. According to the PISA National Report of the Philippines (2018), Region V has the lowest proficiency level at which students can only use basic or everyday scientific knowledge to recognize aspects of familiar or simple scientific phenomena. Meanwhile, the PISA National Report of the Philippines (2022), revealed that the Philippines ranked 77th out of 81 countries in science with an average score of 356 compared to the 485 points in the OECD countries. At a minimum, these students can recognize the correct explanation for familiar scientific phenomena and can use such knowledge to identify, in simple cases, whether a conclusion is valid based on the data provided. Based on the results, there is no significant difference between the 2022 PISA and the 2018 PISA wherein the Philippines ranks second to lowest in mathematics and science. As evidenced by the fact, that there is a need to address learners' deterioration in Science literacy. This fact alone served as an impetus for the researchers to design, develop, and provide game-based learning instructional material aided by technology.

Keeping in mind, that instructional materials play crucial roles in the teaching and learning process (Vlachopoulos, D & Makri, A, 2017). The first role is to be more interesting, practical, realistic, and meaningful learning (Olayinka, 2016; Zhang et al., 2013). Onyia (2013) said that instructional materials make simple learning, practical, effective, and understandable to students. The second role is to develop the knowledge, skills, attitudes, and values of students in the learning process (Saglam, 2011). The third role is to make learning easy and help memorize the things needed (Akpan et al., 2017). The fourth role is to let teachers and students participate actively and effectively in learning. The fifth role is to enhance the learning outcomes, save time, increase students' interest, and facilitate retention of students' memory (Awolaju, 2016).

One of the Sustainable Development Goals formulated by the United Nations is to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. One of the targets of this goal is that by 2030, significant growth in the proportion of youth and

adults with skills necessary for employment, decent careers, and entrepreneurship, including technical and vocational skills. The indicator for this target is the percentage of adults and children who are skilled in information and communications technology (ICT), subdivided by skill. To improve the learners' learning performance, teachers should incorporate innovative instructional tools that will grasp the students' cognitive skills, such as game intervention in the learning process. According to the study by Perez, et al. (2018) utilizing a Game-based learning methodology enhances the skills and abilities of the students and caters the multiple intelligences. With the advancement of technology, educators and policymakers are interested in introducing innovative technological tools such as video games, virtual worlds, and role-playing games (RPG) (Buckless, 2014; Gomez 2014).

Role Playing Games (RPGs) brings players together in a large virtual community. This can be used for entertainment, social interaction, information exchange, and education, hence becoming an important part of people's lives, particularly among the younger generation. According to a survey conducted by Rakuten Insight in the Philippines, 32 percent of the respondents played role-playing genre of games as of April 2022. Meanwhile, 2020 statistics posited that 43 million gamers drove the unprecedented rise in the Philippine gaming industry and across Southeast Asia, with 74 percent of the Philippine online gaming population playing on their mobile devices, 65 percent on PC games, and 45 percent on classic console games (The Manila Times, 2022). With that data, the Department of Education through the enhanced K-12 program always plays an integral part in improving the basic education curriculum as they combine modern technology with education to create a variety of tools and approaches that are susceptible to different modalities and occasions.

Despite the threat of the COVID-19 virus in the Philippines, there is a need to have face-to-face classes all over the archipelago to ensure the efficacy of the knowledge acquired and to address the learning gaps. Given the lack of learners' motivation and engagement in classroom discussion and participation as the effect of the pandemic, the Department of Education issues DO No. 034 s. 2022 or the School Calendar and Activities, the school year 2022-2023 by its commitment to the resumption of 5-day in-person classes despite the health crisis brought on by the COVID-19 pandemic hence the resumption of face-to-face classes has been implemented.

The growing popularity of computer games and their potential impact on students' Science skills prompted the researchers to design the Eureka Role Playing Game (E-RPG) - a game-based instructional tool for learning Science concepts, specifically in Chemistry 7 at Zeferino Arroyo High School. The respondents of this study were the two sections of Grade 7 (sections A and B), each with the same number of learners (36), a total of 72 respondents under the Special Science Class (SCC). Evaluators were clustered into Classroom-based Science teachers, Master teachers, and Headteachers to validate the E-RPG.

The E-RPG allows the learners to navigate the character through the different maps, and discover items and problems that need to be accomplished while experiencing a fun, exciting, and enjoyable way of learning Science concepts.

This study intends to probe the effectiveness of E-RPG in improving the performance of the learners in Chemistry 7. Specifically, it aims to answer the following questions: 1) What is the mean pre-test and post-test result of the two groups of respondents; 2) Is there a significant difference between the mean pre-test and post-test results of the two groups of respondents; and 3) What is the curricular validity of the instructional tool?

Having mentioned the problem, this served as the impetus towards conducting this action research that would be beneficial to the learners, entitled "Eureka Role Playing Game: An Instructional Tool in Improving Proficiency Level in Chemistry 7".

2. METHODS

This study used the Quantitative Method to measure the gathered data and test the hypothesis. The quantitative method is the mathematical method of measuring and describing the observation of the materials or characteristics. The researchers utilized this method to observe objective data that are communicated through statistics and numerical data.

2.1. Research Design

This study utilized the quasi-experimental pretest-posttest research design with a validated questionnaire and Eureka Role-Playing Game (E-RPG) as the primary data-gathering instrument to evaluate students' proficiency level improvement as the intervention applied to the experimental group. According to Harris, et. Al (2006) the quasi-experimental design is often used to evaluate the benefits of specific interventions. Quasi-experimental is a study that aims to evaluate interventions but does not use randomization. Similar to randomized trials, quasi-experiments aim to demonstrate causality between an intervention and an outcome. This involves the comparison of pre-tests and post-tests that were administered in controlled and experimental groups to determine the proficiency level of the students.

2.2. Sampling and Participants

The purposive Sampling Method was employed to obtain the number of respondents. This type of sampling method refers to a group of non-probability sampling that chooses the respondents based on the characteristics of the population and the purpose of the study. The respondents of the study were the Grade 7 Special Science Class (SSC) A and B students of Zeferino Arroyo High School with a total number of 72 students for the school year 2022-2023, 36 students enrolled in Grade 7-SSC A and 36 students in Grade-7 SSC B.

2.3 Instrument

The research instruments of the study were the Eureka Role-Playing Game (E-RPG), the evaluation rating sheet for non-print materials developed by DepEd, and the pre-test and

post-test questionnaires that were formulated by the researchers. These instruments were utilized to gather the desired findings.

In this study, the researchers designed a role-playing game named Eureka, an instructional tool to determine the improvement of the proficiency level of the Grade-7 students. The RPG Maker MV engine was used to design the content of the game due to its versatility, low-level programming skills, and graphics. This RPG maker is an offline application wherein it has no specs requirement as it can be used on Android phones. The researchers conducted a dry-run of the E-RPG with an ICT expert and Science teachers to determine and validate the game's content, design, technicality, and instruction. To validate the game, the evaluation rating sheet for non-print materials developed by the Department of Education was used. The learning, instructional activities, and gaming take place as the students manipulate the ERPG.

Furthermore, there are 5 quests in the game that each player must accomplish each quest will allow the students to gain knowledge and information about the content to complete the task. The content of the game is interrelated with the concepts from the Science Grade 7 Learner's Material and is anchored on the Most Essential Learning Competencies (MELCs) in Science. The game was incorporated into the learning of the students to create a better understanding of the topic, increase students' engagement, and establish a fun learning environment that will build motivation for the students to learn.

Moreover, the researchers formulated 15-item pre-test questionnaires to determine the prior knowledge of the students and 15-item post-test questionnaires which were evaluated by Science teachers for validity. An evaluation rating sheet for non-print materials was also utilized to ensure the effectiveness of the Eureka game in terms of content quality, instructional quality, technical quality, and other findings such as errors.

Eureka Role Playing Game

In the E-RPG, the objectives, general instructions, and the Non-Playable Character (NPC) were presented in the game. The mechanics of each quest were introduced by the NPC alongside commands to guide the player/s to ensure a seamless and orderly delivery of the discussion. The E-RPG has a storyline that is connected with the game's activities and objectives to make the game more interesting and motivating to play. The game includes immediate feedback from the NPCs to the players to provide knowledge, skills, and response. In the E-RPG, the students can freely navigate the game by using a mouse and/or the keyboard keys such as; the arrow keys, space bar, ENTER button, and ESC button to control the game. The material's quest contains questions that follow systematic leveling to ensure effective learning acquisition. Each question is patterned on the topic Concentrations of Solutions expressed in two terms: qualitatively (Concentrated Solutions and Dilute Solutions) and quantitatively (Percent by Volume and Percent by Mass). Through the game, the players

can earn points, gain levels, and accumulate items that can be used in each quest. Eureka Role-Playing Game (E-RPG) can also save the progress of the players which can be used by the teacher to check the learning of the students in the given task in each quest.

Game Flow

Each player must register their characters first by typing their names. After the user's successful registration, the game is now ready to be accessed. The game is divided into five quests and each one of them contains a mission that each player must surpass. Using the map, the player must first go to the Einstein Village for quest 1. The mission for the first level is to accumulate examples of solutions in the science laboratory. Players should talk to the non-player character (NPC) to acquire the instructions for the mission of the level as well as relevant information about Solutions. Players must complete all the given tasks to advance to the next quest. Quest 2 will be held in Edison Village and Curie Village for Quest 3. In mission 3 for the next quest, players will solve for the percentage by volume and compute for the percentage by mass in mission 4 to unlock the code for the next level. There are houses in the Edison Village wherein they will look into to search for the portion. After comprehending the instructions of the quest, players will analyze the task, acquire the materials needed, and start to accomplish the game. Immediate feedback will be made after the players answer the quest. Players will be informed about the correctness of their answers and will receive rewards and instantly upgrade their level once they accomplish the task correctly. As the game progresses, the level of difficulty for the succeeding levels will also increase. In case of incorrect answers, players will not be able to move forward to the next level. To end the game, players must defeat the evil scientist by using examples of solutions as special powers. This will enable them to be free from the evil scientist and this marks that they have successfully finished the game.

2.4 Data Gathering Procedures

In gathering the data, a letter of request to conduct the study was given to the administrators of Zeferino Arroyo High School. The study was conducted in two (2) groups, the controlled and experimental groups. As soon as the letter was approved, the two groups were pre-tested to assess the existing knowledge of the respondents. Two (2) lesson plans were prepared by the researchers, one (1) for the control group and one (1) for the experimental group. The lesson plans revolved around the topic of the least mastered competencies in Chemistry 7, Concentration of Solutions based on the result in the First Quarterly Examination dated October 24-25, 2022. The specific competency from Most Essential Learning Competencies (MELCs) used by the researchers to formulate the content of the game and the questionnaires is the K to 12 Curriculum Guide (CG) Code S7MT-Id-3 "Express concentrations of solutions quantitatively by preparing different concentrations of mixtures according to uses and availability of materials." Subsequently, in the control group, the researchers conducted the traditional method of teaching to discuss the concentration of

solutions. On the contrary, the experimental group utilized the E-RPG during the discussion as an instructional tool. In particular, having mentioned the least mastered competency of the learners, the researchers focused on the concept of "Solutions" specifically on the topic "Concentration of Solutions" to design the game. Furthermore, the post-test was utilized in both groups to determine the learning outcomes of the respondents after the tool was administered. The data gathered were tallied, tabulated, and analyzed for interpretation of the results. The researchers also utilized published studies and articles to support the results of this study.

2.5 Data Analysis

The data in this study were arranged according to the order of the questions in the statement of the problem. The results and outcomes were gathered and presented in a tabular form.

The test results of the pre-test and post-test were computed using the weighted mean to get the average of the results. The researchers utilized the Paired Sample Z-Test specifically two-tailed to determine if the two paired groups were significantly different from each other. It also compared the means of the respondents' pre-test and post-tests with an intervention administered in the experimental group and traditional teaching methods in controlled groups. In addition, the Standard Deviation was used in computing the Z-Test, and the Percentage Technique was utilized to calculate the given percentage of the score to determine the proficiency level of the respondents. Moreover, the level of proficiency was employed to determine the proficiency level of the student in the pre-test and post-test. The level of proficiency was based on the mean test results of the students. Table 1 shows the numerical value with corresponding verbal interpretation to determine the proficiency level developed by the Department of Education (DepEd).

Table 1. Enclosure No. 1 of DepEd Order No. 73 s. 2012 "General Guidelines on the Assessment and Rating of Learning Outcomes Under the K to 12 Basic Education Curriculum"

Scale	Verbal Interpretation
90 and above	Advanced
85-89	Proficient
80-84	Approaching Proficiency
75-79	Developing
74 and below	Beginning

3. RESULTS AND DISCUSSION

This section presents statistical analyses, interpretations, and discussions of the results obtained from the researchers' instruments. The data gathered were presented in tabular form with verbal explanations to further provide a concise understanding of the data.

Table 2. Mean Pre-test Result of the Respondents in the Controlled

Controlled Group	Mean	Percentage	Level of Proficiency
Pre-test	5.00	33%	Beginning
Post-test	5.11	34%	Beginning

Table 2 presents the mean results of the respondents obtained from the administered pre-test and post-test. It also shows the corresponding percentage score of the mean and the level of proficiency. Based on the gathered data, the respondents in this group obtained a mean pre-test result of 5.00 with a percentage score of 33%, which denotes that the students are at the Beginning level. In addition, the table reveals that their mean post-test result is 5.11 with a percentage score of 34%, which denotes that the students are at the Beginning level.

This implies that the mean result of the respondents in the post-test is higher compared to their mean pre-test result, yet they are still in the Beginning level of proficiency.

Table 3. Mean Pre-test Result of the Respondents in the Experimental Group

Experimental Group	Mean	Percentage	Level of Proficiency
Pre-test	7.44	50%	Beginning
Post-test	11.75	78%	Developing

Table 3 presents the mean pre-test and post-test results of the respondent in the experimental group. It reveals that during the pre-test, the respondents obtained a mean result of 7.44 with a percentage score of 50%, which denotes that the students are at the Beginning level. Meanwhile, the respondents obtained an 11.75 mean result in the post-test with a percentage score of 78%, which denotes a Developing level of proficiency.

This implies that the mean post-test result of the respondents is higher compared to the mean pre-test result. The level of proficiency of the experimental group has improved from the Beginning level to the Developing level after the intervention.

Moreover, the findings of Cezar (2022) also showed similarities with the results of this study. The experimental group achieved higher mean post-test scores after the intervention and positively increased the respondents' academic performance from Did not Meet expectations to Outstanding.

Table 4. The Significant Difference Between the Mean Pre-Test and Post-Test in the Controlled Group

Measures/Attributes	Pre-Test	Post-Test
Mean	5.00	5.11
Sample Size	36	36
Standard Deviation	1.82	1.81
Level of Significance	0.05 (two-tailed)	
$Z_{computed}$	-0.26	
$Z_{critical}$	±1.96	
Decision	Reject H_a	
Conclusion	There is no significant difference between the pre-test and post-test results of the respondents in the controlled group.	

Table 4 presents the analysis of the z-test, which revealed the significant difference between the pre-test and post-test results of the respondents in the controlled group. The mean pre-test score is 5.00, the mean post-test score is 5.11, and the pre-test standard deviation is 1.82, while the post-test standard deviation is 1.81. The z-critical is set to be ±1.96, as the researchers used an alpha of 0.05. From the table, it can be seen that at -0.26 the value of the z-test was outside the z-critical value of ±1.96, which concludes that the result was not significant. Thus, the alternative hypothesis was rejected. The findings support the conclusion that there was no significant difference in the control group's pre-and post-test scores.

Table 5. The Significant Difference between the Mean Pre-Test and Post-Test of the Respondents in the Experimental Group

Measures/Attributes	**Pre-Test**	**Post-Test**
Mean	7.44	11.75
Sample Size	36	36
Standard Deviation	2.15	1.91
Level of Significance	0.05 (two-tailed)	
$Z_{computed}$	-8.98	
$Z_{critical}$	±1.96	
Decision	Accept H_a	
Conclusion	There is a significant difference between the pre-test and post-test results of the respondents in the experimental group.	

Table 5 presents the analysis of the z-test, which revealed the significant difference between the pre-test and post-test results of the respondents in the controlled group. The mean pre-test score is 7.44, while the mean post-test score is 11.75. Before the intervention, the pre-test standard deviation was 2.15, while after the intervention was implemented, the post-test standard deviation was 1.91. The z-critical value is set to be ±1.96, as the researchers used an alpha of 0.05. From the table, the value of the z-test, which is -8.98 is inside the z-critical of ±1.96, which concludes that the result is significant. Thus, the alternative hypothesis is accepted. Therefore, the findings support the conclusion that there is a significant difference between the pre-test and post-test results of the respondents in the experimental group.

The findings of this study corroborated with Cezar (2022) that the academic performance in Science between students taught using the DGBL and the students using the Modular Approach significantly differed. Since the results of the statistics presented a justification, the study rejected the null hypothesis. The research null hypothesis, which stated there is no significant difference in the academic performance of Grade 9 learners taught with digital game-based learning and the learners taught with K-12 learner's modular method, is rejected. Therefore, it was disclosed that there was a significant difference between the two groups in favor of the experimental group. Similar to the study by Wang, M., Zheng, X. (2021), no significant difference was found between the digital and non-digital game groups when considering science learning performance, but students of the digital game group showed significantly higher self-efficacy than those of the non-digital game group.

Table 6. The Curricular Validity of E-RPG in terms of Content Quality

Indicator	Evaluator				Mean	Verbal Interpretation	Validity
	A	B	C	D			
Content Quality	40	40	36	39	38.75	Very Satisfactory	Passed

Note: Resource must score at least 30 points out of a maximum of 40 points to pass this criterion.

Table 6 presents the curricular validity of the material in terms of Content Quality. Evaluators A and B accorded the highest total mean score of 40, which yields the verbal interpretation of Very Satisfactory. The average weighted mean of the validity in Content is 38.75 which passed the criterion based on the rating. This implies that the contents of the Eureka Role-Playing Game achieved its goal on the material and contains relevant information needed by the students. In a study by Karakasis and Xinogalos (2020), one of the indicators of the evaluation is Perceived Learning wherein the results suggest that the BlocklyScript RPG showed positive feedback that the game helps the students to easily comprehend the basic concepts of Computational Thinking Skills.

Table 7. The Curricular Validity of E-RPG in terms of Instructional Quality

Indicator	Evaluator				Mean	Verbal Interpretation	Validity
	A	B	C	D			
Instructional Quality	36	40	36	40	38	Very Satisfactory	Passed

Note: Resource must score at least 30 points out of a maximum of 40 points to pass this criterion.

Table 7 reveals the validity of the material in terms of Instructional Quality. Evaluators B and D accorded the highest total mean score of 40, while evaluators A and C accorded 36 as the total mean score. The weighted average mean score is 38, which is treated as Very Satisfactory. This implies that the material meets the student's learning needs, learning styles, and interests and is aligned to the instructional materials standards. Previous research indicates that RPG has a positive effect on increasing student interest in class and is appropriate for students to initiate learning. It also revealed that 80% of the evaluators agreed that the game enhances teaching effectiveness. (Lai, A. & Wen, 2012) On the contrary, a study by Giannakoulas and Xinogalos (2018) revealed that the game was unable to raise the student's interests which might be due to the lack of typical game mechanics.

Table 8. The Curricular Validity of E-RPG in terms of Technical Quality

Indicator	Evaluator				Mean	Verbal Interpretation	Validity
	A	B	C	D			
Technical Quality	52	36	42	47	44.25	Very Satisfactory	Passed

Note: Resource must score at least 39 points out of a maximum of 52 points to pass this criterion.

Table 8 shows the validity of the material in terms of Technical Quality. Evaluator A accorded the highest total mean score of 52, while Evaluator B accorded the lowest total mean score of 36. The Technical Quality indicator obtained an average weighted mean score

of 44.25, reflecting a rating of Very Satisfactory. This implies that the material meets the operations, functionality, design, and maintenance specification standards. In a study conducted by Lai, A. & Wen (2012), 90% of the teachers who evaluated the online E-RPG material agreed on the easiness of operating the game. Students do not spend more time learning to manipulate the game as it is efficient to use.

Table 9. The Curricular Validity of E-RPG in terms of Other Findings (Error)

Indicator	Evaluator				Mean	Verbal Interpretation	Validity
	A	B	C	D			
Other Findings Error	16	16	16	16	16	Very Satisfactory	Passed

Note: Resource must score at least 16 points out of a maximum of 16 points to pass this criterion.

Table 9 reveals the validity of the material in terms of Other Findings (Error). The evaluators accorded 16 as the total mean score. The weighted average mean score is 16, which is treated as Very Satisfactory. This indicator passes the criterion rating, which implies that the material does not contain errors in terms of concept, typographic error, factual error, and computational errors. A study by Karakasis and Xinagalos (2020), revealed the evaluation of the material where all the respondents highly agreed that the BlocklyScript does not have a conceptual error which allows the students to be confident that they will learn by playing the material.

4. CONCLUSION

In light of the findings, the following conclusions were drawn: (1) The mean pre-test and post-test results of the experimental group are higher in comparison to the controlled group, which implies that the level of proficiency of the experimental group has improved from a beginning level to developing level after the E-RPG were integrated to the learners; (2) There is a significant difference between the pre-test and post-test results of the respondents in the experimental group; thus, in the controlled group, there is no significant difference in the results between the pre-and post-test; (3) the E-RPG passed the curricular validity criteria in terms of Content Quality, Instructional Quality, Technical Quality, and Other Findings (Error). Therefore, the learners will be able to acquire knowledge by playing with the material. Overall, the study probed the effectiveness of E-RPG as an instructional tool in improving the proficiency level of the learners in Chemistry 7. This implies that the experimental group acquired positive outcomes that improved their proficiency level in Chemistry after using the E-RPG. Furthermore, as the E-RPG has been evaluated by the science experts, the findings concluded that the instructional tool passed the curricular validity criteria.

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