International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 11s, 2025
https://theaspd.com/index.php

Simulations And Games Integration In Teaching Selected Topics In Astronomy

Pino, Benito Prince Megan[1], Briones, Lourdelen[1], Amador, Noemi[1], Berador, Jessa Mae[1], Royo, Jenyl[1], Matillano, Bryan Joseph[1]
Secondary Education Department,Leyte Normal University,Tacloban City, Philippines\
Corresponding author: Bryan Joseph Matillano (bryan.matillano@lnu.edu.ph)

Abstract
Misconceptions in astronomy hinder students' understanding of natural phenomena. Addressing these misconceptions in preservice teacher training enhances scientific literacy. Common misunderstandings about the Moon's structure, phases, and eclipses exist among students and teachers. This study compared traditional lectures with simulations and games in teaching lunar concepts. Eighty-one participants were divided into two groups. Posttest results showed significant improvement, with no notable difference between methods. Simulations and games proved as effective as lectures. Gender and age influenced achievement, but educational background did not. Student interviews revealed that simulations and games were engaging and supported learning. However, kinesthetic and spatial challenges were identified. The findings highlight the potential of interactive methods to make learning more engaging and suitable for diverse learning styles.
Keywords: student-centered learning, diverse learning, misconceptions, preservice teaching training, science education

INTRODUCTION

Over the past decades, research shows that students have difficulties understanding basic astronomical phenomena and hold alternate conceptions (Atwood and Atwood, 1996; Trumper, 2001). Students have pre-existing concepts coming from their cultural beliefs or from the ideas they developed about their own astronomical experiences. Misconceptions from alternative formats, mental images, and visualizations may result in challenges in the curriculum (Villarino, 2018) or referred to as alternative concepts (Canlas and Magtolis, 2008), and preconceptions (Matillano,n.d).Misconceptions may arise from pedagogical sources and may be cemented in the consciousness of students. Astronomy topics in teacher pre-service training are basically intangible subjects or unavailable to witness directly. Pedagogies demand night observations, telescopes, models, or videos and simulations in order to establish correct concepts. Lunar misconceptions, particularly moon structure, phases, and eclipses, are widespread and resistant to change, even among adults (Kavanagh, 2000). In the most prevalent misconceptions, explanations for lunar phases and eclipses occur when the Moon enters the Earth's shadow (Kavanagh, 2005). Others misconceptions include the Moon only being seen at night; the Moon makes its light instead of reflecting sunlight; the Earth's shadow causes the Moon's phases; the clouds cause the Moon's phases; Earth's rotation on its axis causes the Moon's phases; Moon's rotation causes the Moon's phases; the Moon takes one day to orbit Earth; and the Moon orbits the sun instead of the Earth (Kavanagh, 2005).Students possess a variety of alternative concepts and can hardly explain the occurrences of eclipses and the phases of the Moon even after they have undergone formal instruction in elementary science (Canlas, 2013). These may suggest that students had a poor understanding of the Moon, its phases, and eclipses, and that their former teachers did not correctly instruct them in this field, leading to low student achievements.Reconceptualization and rectifying misconceptions are referred to as "scaffolding" as the metaphor of knowledge development through learning (Buck et al., 2010). Scaffolding is characterized by co-construction through shared interactions among teachers and students in an active structure. Learning experiences that are fun, engaging, first-hand, and interactive are enjoyed by students (Tal and Dallashe, 2021), compared to lectures-discussions, which wane retention and focus (Schwerdt and Wuppermann, 2011). Scaffolding in this paper is the integration of games and simulations as alternative strategies in teaching lunar concepts. Simulations bridge the gap between the classroom and the real world by providing experience, revealing student misconceptions and understanding about the content, and providing information about students' problem-solving strategies (Gredler, 2004). On the other hand, games may refine previously acquired knowledge and skills, which may identify gaps or weaknesses in developing concepts and principles (Gredler, 2004). Using games, students not only become smarter and intellectually engaged but also realize their desire for hard fun, delayed gratification, rewards, making the right decisions, participation, depth of understanding, pattern recognition, and problem-solving skills (Johnson, 2005). Game-based learning may present an excellent opportunity to engage students in activities that can enhance learning and educational benefits (Groff et al., 2010). Teachers, however, are consistently found to be critical components in effective game-based learning, and preservice training institutions must integrate them into the curriculum. This study explores the instructional effectiveness of simulations and games in teaching lunar concepts compared to the traditional lecture method, thereby; finding (1) differences of the achievements between the controlled and experimental groups, (2) relationships among the demographic profiles and their achievements, and (3) document experiences of the implementations from both groups.

METHODOLOGY

The participants of this study were first-year preservice teaching students who took up the subject Physical Sciences at a local state university in the Philippines. In determining the sample for the study, two classes were chosen out of twelve classes using the fishbowl technique (Som, 1995). Researcher-made test underwent validation through pilot testing for its comprehensibility and consultation with the science faculty. The test had two parts. The first part required the demographics, which contained three factors: age, gender, and educational background. The second part was a 30-item multiple-choice test that was good for 20 minutes with questions relating to the topic. The same test questions were used for the pretest and posttest, but were arranged in a different order. Researchers also conducted a pre-lesson interview, with 5% of the students who gained a low score and 5% of the students who gained a high score in the pretest.The intervention was also conducted for both groups. The approach used for the control group was a traditional lecture, while the experimental group used games and simulations. Both classes had the same topic: the Moon, its structure, phases, and eclipses. The researchers administered a posttest for both classes separately and gathered the test results. They also conducted a post-lesson interview with 5% of the students who gained a low score and 5% of the students who gained a high score in the posttest.T-test and analysis of covariance (ANCOVA) were used to compare the means of the pretest and posttest of the control and experimental groups. Latent content analysis (Neuendorf and Kumar, 2015) was also utilized to analyze responses in the pre-lesson and post-lesson interviews. Texts of the interviews were read and re-read while the researchers took down notes on the words and the meanings given by the participants. This helped the researchers determine the differences in the students' responses between the pre-lesson and post-lesson interview in terms of difficulty, importance, and strategies in learning about the Moon: its surface, phases, and eclipses.

RESULTS AND DISCUSSION

There were 81 students who participated in the study, taking up Physical Sciences from different programs. Independent sample t-test and analysis of covariance test were computed using a 0.05 alpha level.

Table 1. Pretest Comparison of Control and Experimental Groups

Predictor Variable	N	Mean	Std. Deviation	Mean Difference	*t*- value	*p*-value	Interpretation ($p<0.05$)
Control	39	9.61	3.57	.62	0.74	0.45	Not Significant
Experimental	42	10.26	3.87				

*p<0.05=significant **p<0.01=highly significant

As shown in Table 1, the control group was composed of 39 students (N=39), and the experimental group was composed of 42 students (N=42). The following were the mean scores of the two groups in the pretest: control group (9.61) with a standard deviation of 3.57, and experimental group (10.26) with a standard deviation (3.87). Their mean difference is .62 with a t-value of 0.74 and a p-value of 0.45. These results show that the two groups can be equally treated and compared.

Before the implementation of the study, both groups had very low knowledge about the Moon's structure, phases, and eclipses (experimental group M=10.26, and control group M=9.61). Both groups were considered to have low knowledge about the Moon, barely reaching 25% of the 45-item test.

Table 2. Pretest and Posttest in the Control Group and Experimental Group

Predictor Variable	Paired T-test (*t*-value)	*p*-value	Interpretation
PreTest and PostTest in the Control Group	-8.89	0.000**	Highly Significant
PreTest and PostTest in the Experimental Group	-12.30	0.000**	Highly Significant

*p<0.05=significant **p<0.01=highly significant

As shown in Table 2, the Pretest and Posttest of the Control Group and Experimental Group had the t-value: control group (-8.89) and experimental group (-12.30). There was a highly significant difference in the pretest and posttest scores of both groups. Both groups significantly increased in their posttest. Subsequently, both the integration of simulations and games and the traditional lecture method delivered improved achievement in the topic.

Table 3. ANCOVA Result of Posttest with Pretest as Covariate

Value Label			N	Mean	Std. Deviation	Mean Difference
Groupings	1.00	Control	39	19.67	4.84	.89
	2.00	Experimental	42	20.57	4.79	
Total			81	20.12	4.82	

Table 4. Tests of Between-Subjects Effects

Dependent Variable: Posttest Score						
Source	Type III Sum of Squares	Df	Mean Square	*f*	Sig.	Interpretation
Corrected Model	61.82	2	30.91	1.35	.26	Not significant
Intercept	2878.35	1	2878.35	125.92	.00	Significant
PreTest Score	47.56	1	47.56	2.08	.15	Not Significant
Groupings	13.36	1	13.36	.58	.44*	Not significant
Error	1599.99	70	22.85			
Total	31424.50	73				
Corrected Total	1661.8	72				

*p<0.05=significant **p<0.01=highly significant

As shown in Tables 3 and 4, the ANCOVA results of the control group (19.67) and the experimental group (20.57). Their mean difference is .89, indicating there was no significant difference in the posttest mean scores of the control and experimental groups. This suggests further that both simulations, games, and the traditional lecture method are equally effective in helping students understand concepts about the Moon.

Table 5. Demographic Factors that Affect Achievement of Simulations and Games Integration in Experimental Group (Difference between Pretest-Posttest Results)

		N	Test Statistic	*t*-value	*P*-value	Interpretation
Educational Background	Private Schools	8	Eta Coefficient	-0.14	0.21	Not Significant
	Public Schools	33				
Program	Elementary Education		Eta Coefficient	-0.05	0.64	Not Significant
	Secondary Science					
	Secondary Social Science					
	Secondary English					
Sex	Female	35	Eta Coefficient	0.30	0.00	Significant
	Male	7				
Age			Pearson r	0.27	0.01	Significant

As shown in Table 4, the study considered three factors: educational background (graduated from private and public high schools and courses), sex (male and female), and age. There were eight students from private high schools (20% of the class of 42) and 33 students from public high schools (80% of the class of 42). A p-value of 0.21 revealed that there is no significant difference between the achievement of students who graduated from public and private schools. It suggested that students who graduated from public and private high schools performed equally. The program of the students had a p-value of 0.64; thus, there is no significant difference between participating students and the program they were enrolled in.The p-values of females and males were less than the alpha level of 0.05. Thus, there was a significant difference between the achievement of the female and male students, where females performed better using this method. Another interactive method in the use of music in teaching mitosis indicated that both male and female students have similar achievement (Matillano et al., n.d.) and behavior towards homework (Fernández-Alonso et al., 2015). This entails distinctiveness of learning experiences established alongside learner demographics and strategies in teaching. Also, the age of the respondents showed a significant difference in the experimental group (t=0.27 and p=0.01). Age was an essential factor that may influence an adult learner's achievement (Delialioglu et. al, 2010).

Latent Content Analysis

This study also used an individual interview to explore the experiences of students exposed to simulations and games integration and the traditional lecture method. The interview aims to discern the feedback of the students before and after the intervention. The names of the participants included in this study are pseudonyms used to maintain confidentiality. In the study, the researchers got 10% of the students from each group (experimental & control) for the pre-lesson interview and another 10% of the students from each group for the post-lesson interview. The interviewees were selected based on their scores in the pretest and posttest. Scores are grouped into an upper group (high scores) and a lower group (low scores). 5% of the students were chosen from the upper group, and 5% of the students were selected from the lower group. Using the latent content analysis, the following border themes emerged from the students' responses: difficulty, importance, strength, and weakness. For the experimental group, the pre-lesson interview results are: three (3) out of four (4) interviewees perceive the topic as average difficulty, and one (1) as difficult. All four interviewees in the post-lesson interview found the topic easy to integrate with simulations and games. For the control group, the pre-lesson interview results showed two (2) with an average difficulty and two (2) as difficult. In the post-lesson interview, one (1) found the topic easy, while three (3) found it with an average difficulty.Both groups of students' responses in the pre-lesson interview suggest the importance of learning the topic. They said that they should learn the topic because the Moon is a part of our daily lives and greatly affects us. Also, in the post-lesson interview, the students' responses suggested the importance of learning about the Moon because they discovered the significance of this topic in eliminating misconceptions about the Moon.On the other hand, the responses of the students in the pre-lesson interview from the experimental group indicated a strength toward simulations and games even before the intervention was done. They said that simulations and games were interactive, and they promoted teamwork. Their responses in the post-lesson interview signal a creative, challenging, and fun learning experience with first-hand experiences that encourage high retention of the lesson. Response from the same group also indicated the weakness of the simulations and games. It showed that not all students were capable of doing kinesthetic activities like games and did not have the spatial intelligence to be able to manipulate the model well, resulting in low participation during the activities. The students' responses in both groups revealed that students tend to perform better in class when the teaching strategy used is interactive and fun, making the topics enjoyable.

CONCLUSION

There was no significant difference between the achievements of student participants in both the experimental and control groups, as indicated in the means and ANCOVA results of the pretest and posttest, with the pretest as the covariate in both groups. Demographic factors, specifically sex and age, significantly affect the students' learning on the topic. A more structured pedagogical approach and analysis of academic performance in Astronomy among preservice teacher training, among sex and age intersections, may offer curricular perspectives in science education.

REFERENCES

1. Atwood, R.K., & Atwood, V.A. (1996). Pre-service elementary teachers' conceptions of the causes of seasons. *Journal of Research in Science Teaching*, 33(5), 553-563.
2. Buck Bracey, Z. E. (2017). Students from non-dominant linguistic backgrounds making sense of cosmology visualizations. *Journal of Research in Science Teaching*, *54*(1), 29-57.
3. Canlas, I. (2013). University students' understanding on selected astronomy concepts. Sanghiran Multidisciplinary Journal, 1(1), 71-76
4. Canlas, I. P., & Molino-Magtolis, J. (2024). Reflecting on the relevance of drawing as a tool in eliciting pre-service teachers' preconceptions of human organs and organ systems. *Journal of Biological Education*, *58*(4), 951-971.
5. Delialioglu, O., Cakir, H., Bichelmayer, B., Dennis, A., Duffy, T. (2010). Factors impacting adult learner achievements in a technology certificate program on computer networks. *The Turkish Online Journal of Educational Technology*, 9(2), 97-107.
6. Fernández-Alonso, R., Suárez-Álvarez, J., & Muñiz, J. (2015). Adolescents' homework performance in mathematics and science: Personal factors and teaching practices. *Journal of educational psychology*, *107*(4), 1075.
7. Gredler, M., (2004). Games and simulations and their relationships to learning. Retrieved from http://www.coulthard.com/library/Files/gredler_2004_gamesandsimsandrelationtolearning.pdf
8. Groff, J., Howells, C., & Cranmer, S. (2010). The impact of console games in the classroom: Evidence from schools in Scotland. Retrieved from http://www2.futurelab.org.uk/resources/documents/project_reports/Console_Games_report.pdf
9. Johnson, S. (2006). Everything bad is good for you. New York: Riverhead Books.
10. Kavanagh, C., Agan, L., & Sneider, C. (2005). Learning about phases of the Moon and eclipses: A guide for teachers and curriculum developers. *The Astronomy Education Review*, 4(1), 19–52.
11. Matillano, B. J. E. Preconceptions from Media Influenced Disaster Preparedness During Super Typhoon Haiyan.

12. Matillano, B. J. E., Asis, T. G., Idlisan, J. A. C. R. A., & Sudario, M. Q. Demographic Aspects In The Use Of Music-Action Integration In Teaching Mitosis.
13. Neuendorf, K. A., & Kumar, A. (2015). Content analysis. *The international encyclopedia of political communication*, 1-10.
14. Schwerdt, G., & Wuppermann, A. C. (2011). Is traditional teaching really all that bad? A within-student between-subject approach. *Economics of Education Review*, *30*(2), 365-379.
15. Som, R. K. (1995). *Practical sampling techniques*. CRC press.
16. Tal, T., & Dallashe, S. (2021). Engaging the hands, heads, and hearts in a medical simulation informal learning environment. *Journal of Research in Science Teaching*, *58*(6), 759-789.
17. Trumper, R. (2001). A cross-age study of junior high school students' conceptions of basic astronomy concepts. *International Journal of Science Education*, 23(11), 1111-1123.
18. Villarino, G. N. (2023). Assessing Junior High School Science Teachers' Conceptual Understanding of Force and Motion: Implications for Science Education: Assessing Junior High School Science Teachers'... *International Journal of Science Education and Teaching*, *2*(2), 106-113.