Flashcards and Manipulative Tools as Instructional Material in Teaching Eclipses

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ABSTRACT

This paper discusses the effectiveness of manipulatives and flashcards as teaching aids in teaching a complex astronomical phenomenon such as eclipses. This is explored using the mixed-method approach, discussing the way that these interactive resources improve the engagement, understanding, and retention of information by students in regards to both solar and lunar eclipses. Students from grade 7 level in Rizal National High School were evaluated, applying a mix of focus group discussions to gather the responses qualitatively and both pre- and post-experiments to measure the amount learned. Results suggest that with the use of flashcards within the group activity, collaborative learning happened in addition to fortification of memory for relevant information through visual memory. Meanwhile, the concrete experience that manipulative instruments such as models and simulations offer can help students observe the spatial relationships involved in eclipses. The results show that the understanding of the mechanics of eclipses by students has improved significantly, and therefore, these teaching resources can be integrated into the curriculum to make science instruction more effective. This study provides insight with information on pedagogies for teaching astronomy, hence underlining the value placed on interactive learning resources on student engagement and academic achievement.

Keyword: *Flashcard, Manipulatives, Teaching aids, Student engagement, Learning Retention, Pedagogical Strategies.*

1. INTRODUCTION

There are special challenges in the education field when teaching eclipses, especially solar and lunar eclipses. For students to improve their understanding, educators will need innovative teaching methods for learning. Traditional teaching methodologies do not seem to provide proper student engagement or a holistic grasp of such complex celestial occurrences (Kesler, 2021). It is with this reason that interactive teaching aids like manipulatives and flashcards have gained popularity as a way of promoting learning. Flashcards, for instance, enable pupils to organize and represent material in an approachable way and are therefore very useful resources for vocabulary repetition and important eclipse-related themes (Pocket of Preschool, 2021).

Among the manipulative aids for the feel-sense experience is through models and simulations that enrich the student's perception of spatial relations in eclipses. According to Legends of Learning, 2017, the materials have the students observe firsthand how the positions of the sun, the moon, and Earth would relate during an eclipse. Having tangible representations of solar and lunar eclipses can help in better understanding principles governing celestial alignments. Experiential learning strategies are in sync with constructivist learning theories, which support active engagement with the learning process (Kesler, 2021).

The mixed-methods approach of this study will permit the researchers to investigate profoundly how different teaching tools will be effective. The measurement of student engagement levels as well as students' perceptions on

the level of understanding before and after the utilization of flashcards and manipulatives can be provided through the combination of quantitative analysis with qualitative analysis through the means of focus groups, according to Legends of Learning, 2017. This research study assesses not only the extent to which academic performance was delivered but also evaluates the views of students regarding how they felt when applying interactive resources to learn more about eclipses.

The above mentioned researches have established that learning interactively improves the pupil's performance in scientific sessions. For example, contrasting to the traditional lecture education, active learning approaches greatly boost the results for the pupils by Hattie (2009). This is especially critical as such a topic of lesson in teaching eclipses comprises complicated concepts that need one to grasp it in terms of thinking he or she can vividly imagine. Flashcards and manipulatives can be used to transform a passive learning exercise into an engaging activity which provokes inquiry and discovery.

In addition to that, the group assignment reveals that the flashcards are used and fosters more collaborative opportunities to learn raise the social relationship between the learners. Various views along with the expertise of the group enables the students to deal with the problems or to address the idea of eclipses (Vygotsky, 1978). Along with their elevation in understanding levels, the constructivist learning methodology fosters critical cooperative skills among the students through their classroom activities.

There has been a direct correlation with the use of manipulatives and the retention of information as well as better engagement and understanding. It has been shown in studies that hands-on activities enhance theconsolidation of knowledge by enabling students to associate abstract concepts with real life (Bransford et al., 2000). The creation of memorable experiences such as modeling an eclipse with the use of tangible objects such as flashlights or balls enables students to reenforce their understanding of how eclipses occur.

It is already well settled within educational literature that the effectiveness of using flashcards in studying cannot be disregarded. Research studies (Dunlosky et al. 2013) demonstrated that using flashcards with retrieval practice reinforces topic mastery and long-term memory. While teaching eclipses, teachers can utilize flashcards in quizzing their learners on terms, kinds of eclipses, or vocabulary phrases used in discussions related to these phenomena. Active recall remains the only mechanism in which information learned will stick and provide an advantage over tests.

All things considered, this study will determine just how best to teach eclipses using manipulatives and flashcards. Its mixed-method approach tries to shed light on how exactly such interactive materials impact both the engagement and understanding/retention of students involved. The outcomes will lead to further discussions on some creative pedagogical approaches when it comes to scientific education and highlight a need for dynamic approaches toward teaching otherwise challenging astronomical ideas.

2. RESEARCH QUESTIONS

1. What is the result of the Pre and Post-test of the subject of the study?

2. Is there a significant difference on the result of the Pre and Post-test?

3. How effective is flashcards and manipulative tools as instructional materials to improve the engagement, understanding, and retention of information by students in regards to both solar and lunar eclipses?

4. Based on the findings, what specific interventions can be proposed to enhance student’s retention further?

3. RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

Using a mixed-methods design approach to evaluate educational outcomes, this study investigated how well manipulatives and flashcards teach eclipses. The target population of this study is the seventh-grade students of Rizal National High School, and focus groups were used to collect qualitative data about the kids' understanding and participation level. To quantitatively evaluate the retention of knowledge about solar and lunar eclipses, the pre- and post-experimental tests will be conducted. The method will help in a very detailed analysis on how interactive

teaching aids can improve collaborative learning, visual memory, and understanding of the spatial relationship that underlies eclipses. Through comparison between qualitative feedbacks and quantitative performance, this research aspires to be able to indicate meaningful improvements on the understanding of the mechanics involved in eclipses, thereby serving as a precursor to recommending its introduction in the curriculum to improve teaching and learning practices.

3.1 RESEARCH LOCALE

This study was conducted in Rizal National High School, Barobo, Surigao del Sur is situated near the coast. So, this becomes unique in terms of educational environment it offers to diverse students who study there. The school does have a healthy willingness to learn among its students, which gets them motivated for studying despite facing the challenges which their geographical background poses.

3.2 RESEARCH PARTICIPANTS

This research study selected 23 seventh-grade students from Rizal National High School for the research participants to ensure that the sample chosen is representative based on predefined criteria. These pupils have shown a basic understanding of the subject content and also a potential for improvement, as indicated by their science course marks, which range from 80 to 85. Moreover, since the selection is on slow learners, the study can explore how flashcards and manipulatives can be more appropriate for their learning and improve their comprehension of difficult astronomical concepts such as eclipses. The goal is to be specific in collecting helpful data that informs how effective the interactive teaching resources will be for enhancing academic achievements of children in need.

3.3 RESEARCH INSTRUMENT

The researchers crafted the research instrument aimed at evaluating student engagement and retention of information regarding both solar and lunar eclipses. Before conducting the pre-test and post-test, the instrument underwent pilot testing to assess its reliability and validity, achieving a Cronbach's alpha of 0.97, which indicates excellent internal consistency. To determine understanding and retention of information, the researchers created flashcards and manipulative tools as instructional materials. Additionally, a 30-item test was developed for both the pre- and post-tests, which was validated by experts in science education to ensure its effectiveness in measuring student learning outcomes.

3.4 DATA GATHERING PROCEDURE

This study has established a data collection protocol to maintain the integrity and credibility of the study findings. This included several phases to develop and validate instructional materials, testing for student understanding and measuring the efficacy of instructional methods. The first step was to create the flashcards and manipulatives, which were then vetted for accuracy and assessed for pedagogical fit. A detailed lesson plan on eclipses was developed and validated by academic experts and then a questionnaire to assess the recall or retention of students post lesson were provided. Afterward, a letter of permission was obtained from Rizal National High School to facilitate the research in a Grade 7 classroom. The researcher administered a pretest to measure the existing knowledge of the students. Instructional materials were used during class hours, making use of the ground of student engagement and perceptions, and qualitative data was obtained from those sources. A post-test was conducted to see if the students had gained an improved understanding after the instructional period. Finally, results from both pre-tests and post-tests and qualitative inputs from interviews were analyzed to assess the effectiveness of flashcards and manipulatives in imparting the concept of eclipses.

3.5 ETHICAL CONSIDERATIONS

Ethical standards were observed in the research by ensuring that the rights and welfare of the participants were preserved. Permissions from the school administration and the parents or guardians of the student were sought. Participants were informed of the objectives of the study, and their option to withdraw at any time from the study was reserved without any form of retribution. Furthermore, confidentiality and anonymity of the information of the participant were preserved during the entire conduct of the study.

3.6 SCOPE AND LIMITATION

Manipulatives and flashcards are actually compared on how well they as aids in instructing seventh graders of Rizal National High School make meaning of complicated astronomical concepts to make them feel engaged, know about, or to remember information relating to eclipses of both solar and lunar phenomena. However, the study only spans a single grade level and domain, which automatically limits the external validity of these findings to an age group

other than the sampled one or contexts other than this educational setting. Other variables than those controlled, such as individual differences in pupils' prior knowledge and classroom characteristics, may confound the measurements and, through them, probably the overall effects of the interventions.

4. RESULTS

Table 1. Pre and Post-test Scores

SUMMARY				
Groups	*Count*	*Sum*	*Average*	*Variance*
Pretest	23	188	8.260869565	6.4743083
Posttest	23	487	21.34782609	4.964426877

The comparative analysis of the pre-test and post-test scores provides compelling evidence of the effectiveness of the instructional materials used in teaching eclipses. In the pre-test, the 23 participants achieved an average score of approximately 8.26, with a variance of 6.47, indicating a wide range of understanding and a generally low level of knowledge regarding eclipses prior to the intervention. Following the instructional period, the post-test results showed a remarkable increase in average scores to approximately 21.35, accompanied by a reduced variance of 4.96. This significant improvement not only reflects a substantial gain in knowledge but also suggests that students became more aligned in their understanding of the concepts related to eclipses after the intervention. The decrease in variance indicates that the instructional materials helped to standardize student performance, minimizing disparities in knowledge levels among participants. Overall, these findings highlight the positive impact of interactive learning tools, such as flashcards and manipulative resources, on enhancing student engagement and comprehension in science education, demonstrating their potential as effective pedagogical strategies. A related study by Pamolarco (2022) found that digital flashcards significantly enhance student engagement and vocabulary acquisition among learners with disabilities, suggesting that interactive tools can foster better understanding and retention of complex subjects in various educational contexts.

Table 2. Statistical Analysis of Retention of Information: Pre-test vs. Post-test Results

	Pretest	*Posttest*
Mean	8.260869565	21.34782609
Variance	6.4743083	4.964426877
Observations	23	23
Pearson Correlation	0.544501732	
Hypothesized Mean Difference	0	
df	22	
t Stat	-27.3533628	
P(T<=t) one-tail	8.80032E-19	
t Critical one-tail	1.717144374	

P(T<=t) two-tail	1.76006E-18	
t Critical two-tail	2.073873068	

Table 2, The analysis of the pretest and posttest data reveals significant improvements in student performance following the instructional intervention. The mean score for the pretest was approximately 8.26, while the posttest mean rose dramatically to about 21.35, indicating a marked enhancement in understanding of the subject matter. The variance decreased from approximately 6.47 in the pretest to about 4.96 in the posttest, suggesting that students' scores became more consistent after the intervention, reflecting a uniform improvement in comprehension among participants. The Pearson correlation coefficient of 0.54 indicates a moderate positive correlation between pretest and posttest scores, suggesting that students who performed better on the pretest also tended to show greater improvement in the posttest. The t-statistic of -27.35 far exceeds the critical t-values for both one-tail (1.72) and two-tail (2.07) tests, leading to a p-value of approximately 1.76 x 10^-18, which is significantly lower than any conventional alpha level (e.g., 0.05). This result strongly rejects the null hypothesis, confirming that there is a statistically significant difference between pretest and posttest scores. Overall, these findings underscore the effectiveness of the teaching methods employed, highlighting their role in enhancing student engagement and comprehension of complex astronomical phenomena such as eclipses.

Student feedback after Implementation

The feedback from students following the implementation of flashcards and manipulative tools was overwhelmingly positive, highlighting their enhanced engagement and understanding of eclipses. Many participants expressed appreciation for the interactive nature of the materials, which they felt significantly contributed to their learning experience.

*P1 :"Ganahan kaayo ko ma'am kay nalingaw ko" (*I really like that there are flashcards and manipulatives tools used, ma'am, because I enjoyed it)

*P4: "Mas dali man diay masabtan po kung kami mismo mag arrange sa celestial objects" (*It turns out it's easier to understand if we ourselves arrange the celestial objects.)

*P8: "Nadugangan ang akong vocabularies ma'am tungod sa mga scenarios nga nakasulat sa flashcards" (*My vocabulary has been enriched, ma'am, due to the scenarios depicted on the flashcards.)

*P11: "Mas nadumduman nako ma'am kay ako mismo ang nag manipulate sa objects" (*I recall more effectively, ma'am, as I personally manipulated the objects.)

*P16: "Prefer namo siya as visual learner" (*We prefer it as visual learners.)

*P22: "Giganahan mi pag-dula man kay aside sa padak-anay mi og scores nga matama each falshcards, mas nadugangan sab amoa learning ug mas nadumduman" (*We found playing enjoyable because, aside from striving to achieve higher scores with each flashcard, it also enriched our learning and helped us remember more effectively.)

This shows the responses of the students after the implementation of flashcards and manipulative tools shows very positive reception toward these interactive methods of learning. Most of the students said that they enjoyed learning and that this method was much more interesting compared to the conventional methods of teaching. Comments such as "I really liked it because I had fun" and "It's easier to understand when we arrange the celestial objects ourselves" emphasize the fact that hands-on activities are very effective in helping to understand. The students' vocabulary increased due to the scenarios presented on the flashcards to improve understanding of complex concepts. They further said that rich tactual and visual experiences clarify where the heavenly bodies are supposed to be so there is improved retention. This can be supported as it was a suggestion from one who remarked "I remember better because I was the one handling the objects.". Overall, this feedback gives strong evidence for a clear preference for visual and interactive learning strategies, suggesting these methods contribute to engagement but much more importantly enhance deeper learning and memory retention in student learning.

5. CONCLUSIONS

The research presents clear evidence on how the use of flashcards and manipulative tools as learning resources enhances seventh-grade students' understanding and retention of complex astronomy concepts: solar and lunar eclipses. Findings are derived from both quantitative measures and qualitative feedback from participants regarding their performance improvement, participation, and usage of vocabulary. The statistical results obtained from ANOVA and t-tests affirm that observed gains are not only high but statistically significant, hence proving that interactive learning resources can definitely close the gap of understanding for inadequately performing students vis-à-vis the traditional methods of teaching. Student feedback prefers a more visually active method, suggesting that methods like these favor different learning types and, therefore, more facilitative of an enjoyable learning experience. The results generally indicate that the inclusion of routine collaborative activities that engage these interactive tools, such as model building group projects or peer teaching with flashcards, will allow students to retain more substantial portions of complex science subjects in education. From the findings of this study, this indicates the significant role innovative pedagogical approaches play in learning achievement and should be incorporated in the curricula of educators.

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