Boosting Science Learning through Individualized Interactive Weather Work Booklets

Jezyl A. Teves[1], Erwin B. Berry [2]

[1] Teacher I, Dahican Elementary School, Dahican, Carrascal, Surigao del Sur, Philippines
[2] Graduate School Faculty, North Eastern Mindanao State University-Main Campus, Philippines

ABSTRACT

This study explores the implementation of an individualized interactive weather work booklet designed to enhance Grade 4 pupils' understanding of science concepts, particularly targeting students with below-average scores (below 80). During a designated lesson period, students engaged in a series of activities utilizing the work booklet, which incorporated various interactive elements aimed at fostering interest and comprehension. Initially, many students expressed doubts about their ability to complete the activities due to their unfamiliarity with this format. However, the structured and engaging nature of the workbook led to significant improvements in their grasp of scientific concepts, as evidenced by a notable increase in post-test scores compared to pre-test scores. Statistical analysis revealed a mean difference of -514.286 between pretest and post test scores, with a standard deviation of 186.445 and a t-value of -7.298, indicating statistical significance ($p < 0.001$). These findings suggest that the implementation of the individualized interactive weather work booklets positively impacted students' understanding and engagement with science content, highlighting the effectiveness of such educational interventions for enhancing learning outcomes among struggling.

Keyword: *Weather Education, Student Engagement, Interactive Workbook, Individualized Learning, Academic Improvement*

---

1. INTRODUCTION

Weather is a fundamental topic in elementary science education, as it forms the basis for understanding broader concepts related to the environment, climate, and Earth sciences. Traditional methods of teaching weather concepts in elementary classrooms often rely on static textbooks or passive learning methods, which may fail to engage students fully. To address this challenge, there has been growing interest in incorporating interactive and personalized learning tools, such as individualized workbooks, to enhance student engagement and comprehension (Kelley & Mielke, 2020). An individualized interactive weather work booklet for elementary science students aims to enhance engagement and understanding of meteorological concepts among young learners. Research has shown that interactive learning tools can significantly improve students' comprehension and retention of scientific material (Hattie, 2009). These work booklets can be customized to meet the diverse learning needs of students, providing opportunities for hands-on learning, reflection, and inquiry. Research indicates that personalized learning materials, when paired with interactive

activities, promote deeper understanding and retention of scientific concepts (Hattie, 2009). Specifically, the use of workbooks that incorporate hands-on activities and real-world applications allows students to connect theoretical knowledge with practical experiences, fostering a deeper understanding of complex topics such as weather patterns and phenomena (Miller et al., 2019).Elementary education is a critical stage for developing foundational scientific literacy, yet many students struggle with abstract concepts in science, particularly those related to environmental science (National Research Council, 2012). The individualized approach of the work booklet is designed to cater to diverse learning styles and paces, enabling students with below-average performance in science to engage more effectively with the content. This personalized method not only addresses individual learning needs but also promotes self-directed learning, which is essential for academic success (Schunk & Zimmerman, 2012). Furthermore, incorporating local weather phenomena into the work booklet can enhance relevance and interest, as students are more likely to engage with material that reflects their lived experiences (UCAR, 2020). By integrating interactive elements such as data collection and analysis, the work booklet encourages students to become active participants in their learning process. This study seeks to evaluate the effectiveness of the individualized interactive weather work booklet in improving science concept mastery among elementary students, ultimately contributing to better educational outcomes in science education.

2. RESEARCH QUESTIONS

This action research investigated the effectiveness of an individualized interactive weather work booklet in enhancing elementary science students' understanding of weather concepts. Specifically, this study aimed to:

1. Describe the students' engagement and performance in the activities provided within the work booklet.
2. Determine the significance of the differences between students' pre-test and post-test scores to assess learning outcomes.
3. Document the students' feelings and reflections experienced during the workbook activities, as well as their thoughts on learning the weather concepts after completing these activities.

3. RESEARCH METHODOLOGY

This research utilized both quantitative and qualitative methods to collect extensive data. The study involved (n=7) Grade 4 students from an intact class at Dahican Elementary School in Carrascal District, who were identified as having below-average performance in science. The primary objective was to investigate the effectiveness of an individualized interactive weather workbook as an educational resource. This action research specifically aimed to evaluate how the workbook could enhance the students' learning experiences and deepen their comprehension of scientific concepts, especially those related to weather.

3.1 RESEARCH INSTRUMENT

To assess the effectiveness of the instructional intervention on students' understanding of weather concepts, a validated teacher-prepared multiple-choice pre- and post-test was utilized. This instrument consisted of 30 items designed to evaluate various aspects of weather knowledge.

3.2 DATA COLLECTION

The study followed a structured methodology consisting of three key phases: pre-intervention, intervention, and post-intervention, along with a detailed data collection process to assess the effectiveness of the individualized interactive weather workbook.

1. Pre-Intervention Phase:

In this phase, the participants were selected based on their below-average grades in science. Prior to the intervention, a pre-assessment was conducted to evaluate the students' current understanding of basic weather concepts. The pre-test consisted of multiple-choice questions designed to assess the participants' initial knowledge and skills. Additionally,

individual interviews were conducted with each participant to gauge their attitudes and experiences towards learning science, particularly in relation to weather topics.

2. Intervention Phase:
During this phase, the individualized interactive weather workbook was introduced as a learning tool. Each student received a copy of the workbook, which included various activities such as weather observation exercises, interactive quizzes, diagrams, and experimental tasks related to weather patterns. The students worked through the workbook over a period of a week, with one session per day lasting approximately 45 minutes. Throughout the intervention, the researcher provided guidance and support to ensure students' engagement and understanding. Interactive discussions and individual activities were incorporated to enhance collaborative learning. The students' progress was closely tracked through daily check-ins.

3. Post-Intervention Phase:
Following the intervention, a post-assessment was conducted to measure any improvements in the students' understanding of weather concepts. The post-test was similar to the pre-test. A follow-up interview with each participant was also conducted to capture their reflections on the workbook's effectiveness, their personal learning experiences, and their perceived improvements in their science skills.

3.3 ETHICAL CONSIDERATIONS

To protect everyone's rights and well-being, the study followed strict rules about ethics. The parents or guardians of the students and the school administration gave permission for the study to take place. The purpose of the study was explained clearly to everyone involved, and they were assured that they could leave at any time without any pressure. Additionally, the privacy of all participants was carefully kept safe throughout the entire study.

3.4 DATA ANALYSIS

Means and standard deviations were calculated to characterize the students' performances in the pre- and post-tests. A t-test for dependent samples was utilized to assess the significance of the differences in student performance across these assessments. Additionally, dominant themes were identified from the qualitative data.

4. RESULTS AND DISCUSSIONS

Table 1 displays the performance of the fourth graders in the 30-item pre- and post-tests.

Table 1. Pre- and Post-Test Performance of the Students

N = 7	Highest Score Obtained	Lowest Score Obtained	Mean	Standard Deviation	Mean Difference
Pre-test	14	7	9.857	2.15	
Post-test	21	12	15	3.46	5.14

The results presented in Table 3 indicated that fourth graders demonstrated notable improvements in their learning outcomes after using the individualized interactive weather work booklet. Initially, the pre-test mean score was 9.857, with a standard deviation of 2.15, reflecting relatively low proficiency among students, whose scores ranged from 7 to 14. In contrast, the post-test mean score increased to 15, with a standard deviation of 3.46, demonstrating a notable enhancement in student performance. The mean difference of 5.14 points highlights the positive impact of the booklet, suggesting it effectively engaged students and improved their understanding of the material. While the increase in standard deviation points to greater variability in individual student gains—implying that some students benefitted more than others—the overall trend is promising. This suggests that while the booklet was successful in promoting

learning, there may be opportunities for further refinement to better assist students who need additional support. The use of individualized interactive work booklets aligns with findings from various educational research studies that emphasize the effectiveness of interactive and personalized learning approaches. For example, Hwang and Chang (2011) demonstrated that interactive learning environments significantly enhance student engagement and performance, reinforcing the idea that personalized resources can lead to improved educational outcomes. Similarly, McGowan and Beattie (2016) found that individualized instruction positively influences student achievement, indicating that tailored educational interventions can enhance understanding and retention of material. Additionally, research from Iowa State University highlighted how interactive activities related to severe weather not only motivate students but also deepen their comprehension of complex meteorological concepts (ResearchGate, 2024). Collectively, these findings suggest that utilizing individualized interactive work booklets for teaching weather concepts can effectively enhance learning outcomes, as evidenced by the pretest and post test results indicating potential improvements in student performance.

Table 2. Test of Normality for Pretest and Post-test Scores

	Shapiro-Wilk		
	Statistic	df	Sig.
pretest	.949	7	.722
post test	.890	7	.274

The results of the Shapiro-Wilk test presented in Table 2 revealed varying levels of normality for the pretest and post-test data. For the pretest, the statistic was 0.949 with a p-value of 0.722, indicating that we cannot reject the null hypothesis of normality; thus, the pretest data appears to conform to a normal distribution. In contrast, the post-test yielded a lower statistic of 0.890 and a p-value of 0.274, which also does not provide sufficient evidence to reject the null hypothesis. This suggests that while both datasets do not significantly deviate from normality, the post test data exhibits a slight decline in normality compared to the pretest. These findings are critical as they precede the t-test analysis, implying that the assumptions necessary for conducting parametric tests, such as the t-test, are likely satisfied for both datasets. However, the minor decrease in normality observed in the post test data should be considered in subsequent analyses. This study investigates the impact of interactive learning environments on student engagement and performance. The results suggest that interactive materials significantly enhance learning outcomes when compared to traditional teaching methods. Supporting this perspective, Hwang and Chang (2011) highlight the effectiveness of interactive learning environments in fostering student engagement. Furthermore, research by Hsu and Chen (2016) investigates the role of structured workbooks as a teaching tool in science education, demonstrating that their use can lead to improved understanding and retention of scientific concepts among students. These findings collectively underscore the value of innovative educational strategies in enhancing student learning experiences.

4.1Significant Difference in the Performance of the Students in the Pre- and Post- Tests

Table 3. Paired Sample test

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pair 1 pretest – post test	-5.14286	1.86445	.70470	-6.86719	-3.41852	-7.298	6	.000

The analysis of the individualized interactive weather work booklets presented in Table 3 revealed a significant improvement in science scores for students with averages below 80. This was evidenced by a mean difference of -514.286 between pretest and post test scores, a standard deviation of 186.445, and a t-value of -7.298, with a p-value of 0, indicating strong statistical significance. This suggests that the implementation of these work booklets effectively enhanced student understanding and engagement in science. Supporting this finding, Hattie (2009) emphasizes the positive impact of personalized learning strategies on student achievement, while Brusilovsky and Millán (2007) highlight the benefits of interactive learning environments tailored to individual needs. Additionally, Kulik and Kulik (1992) found that computer-assisted instruction significantly boosts learning outcomes for low-achieving students, further corroborating the effectiveness of individualized educational materials in improving academic performance.

4.2 Students Reflection

Table 4 presents a selection of students' journal responses reflecting their thoughts on the individualized interactive weather work booklet. The students were guided by a specific question, and their responses revealed a variety of emotions concerning the activities. Initially, they expressed excitement mixed with some doubts about their ability to complete the tasks. Notably, many students indicated that the activities helped them grasp the concepts more effectively, as evidenced by their improved scores on the post-test. This feedback underscores the positive impact of the weather work booklet in enhancing their learning experience and understanding of the material.

Table 4. Sample Responses of the Students in the Reflection Part of the Material

Instructional Material	Question:	Responses
Individualized Interactive Weather Work Booklet	Write your thoughts about this work booklet.	"It is a happy, it is a strong, it is a sad about the book'. ("*The book makes me feel happy, strong, and sad*".)
		"My favorite is to design girl and boy clothes of the weather."
		"It is very important to us knowing about weather so that we can make prepared important things if there's problems we encounter".
		"My attitude toward of this booklet I am very happy because some page are easy to answer and I learned some of this booklet."
		"Be healthy and take care of yourself but be happy with the beautiful things that make you be so happy."
		"Happy ako ko man nag answer amo ansiranan mo Mam." *("I'm happy that I answered your questions, Ma'am.")*
		"Thank you Ma'am sa booklet. I learned so much about weather." *("Thank you, Ma'am, for the booklet. I learned so much about the weather.")*

5. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the implementation of the individualized interactive weather work booklet significantly improved student engagement and performance in the activities provided. Students actively participated in hands-on tasks, which cultivated a sense of curiosity and excitement about weather concepts. Observations revealed that students were more inclined to collaborate with peers and share their findings, reflecting increased motivation and interest in the subject matter. The differences between pre-test and post-test scores highlight the effectiveness of these activities, suggesting that the workbook not only engaged students but also led to meaningful improvements in their understanding of weather concepts. Students reported positive feelings and reflections during the workbook activities, noting that the interactive elements made learning enjoyable and accessible. Many expressed greater confidences in their ability to understand complex meteorological concepts after completing the activities. They valued how the workbook facilitated exploration of real-world applications of weather phenomena, contributing to a deeper comprehension of the material. This feedback indicates that the workbook activities resonated well with students, enhancing their overall learning experience.

The findings from this implementation demonstrate that individualized interactive work booklets can significantly enhance student engagement and learning outcomes in science education. It is recommended that educators continue to utilize such personalized resources while considering further enhancements to meet diverse student needs. Additional support mechanisms could be integrated for those who may still struggle with certain concepts, ensuring that all students benefit from this innovative approach to learning about weather.

6. ACKNOWLEDGEMENT

The researchers wish to express their heartfelt gratitude to all those who contributed to the creation of the Individualized Interactive Weather Work Booklet. Special thanks are given to Dr. Jeshrel B. Plaza, MT-II of Madrid National High School, for his invaluable technical support with the instructional materials, and to Maricel R. Jimenez, MAED, MT-I of Dahican Elementary School, for her assistance in developing the questionnaire. They also extend their appreciation to Peter B. Castante, School Head of Dahican Elementary School, for facilitating the research process, and to Jun Alvarvo A. Arnaldo, T-I of Dahican Elementary School, for permitting his selected students to participate in the study. Additional gratitude is directed to co-researcher Dr. Erwin B. Berry of North Eastern Mindanao State University for his guidance in refining the research paper. The researchers also wish to express their love and appreciation to family and friends for their unwavering support throughout this journey, along with sincere thanks to Almighty God for His blessings and guidance. Each contribution has been essential to the successful completion of this project.

7. REFERENCES

Abou El Seoud, S., & El-Sayed, A. (2022). The effectiveness of using interactive science notebook to develop sixth grade (EFL) pupils' creative thinking skills and their achievement in science. Journal of Educational Sciences, 10(3), 1-22.

Alshahrani, A., & Alshahrani, S. (2024). The effectiveness of interactive e-books in the development of scientific concepts among students: A focus on cognitive styles and learning outcomes. Journal of Educational Technology, 15(1), 45-60.

Bacarrisas, G., & Castro, H. (2019). The effects of interactive science notebook on student teachers' achievement, study habits, test anxiety, and attitudes towards physics. Journal of Turkish Science Education, 16(1), 62-76.
Black, P., & Wiliam, D. (1998). Assessment and classroom learning. Assessment in Education: Principles, Policy & Practice, 5(1), 7-74.

Black, P., & Wiliam, D. (2009). Developing the theory of formative assessment. Educational Assessment, 14(1), 1–21.

Brusilovsky, P., & Millán, E. (2007). "User Modeling 2.0: New Opportunities for Personalized Learning."

Faber, M., Quintus, R., & De Jong, O. (2024). The effects of interactive science notebook on student teachers' achievement and engagement in science education. International Journal of Science Education, 46(2), 123-145.

Hattie, J. (2009). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement. Routledge.

Hsu, Y. S., & Chen, C. H. (2016). The effects of using workbooks on students' science learning in elementary school. Journal of Science Education and Technology, 25(3), 405-417.

Kelley, J. F., & Mielke, P. W. (2020). Interactive learning strategies for elementary education: Enhancing student engagement through technology. Journal of Educational Technology, 35(2), 75–89.

Krachenfels, J. T. (2019). Interactive Science Notebooks: Exploring the Extent Which Integrating a New Learning Tool Influences Self-Efficacy in Expressing Science Content Knowledge and Interest in Pursuing a STEM Related Career. Virginia Tech.

Kulik, J. A., & Kulik, C.-L. C. (1992). "Effectiveness of Computer-Based Instruction: An Updated Analysis."

Lentz, K. (2015). The impact of interactive science notebooks on middle school students. California State University.

McDonald, J. (2023). The effects of interactive notebooks on student content knowledge and achievement in science classrooms. Montana State University.

McGowan, M., & Beattie, J. (2016). The impact of individualized instruction on student achievement: A meta-analysis. Educational Psychology Review, 28(2), 307-332.

Miller, D. J., et al. (2019). The Impact of Interactive Learning on Student Engagement in Science Education. Journal of Science Education and Technology.

National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. The National Academies Press.

Piaget, J. (1976). Piaget's theory. In P. Mussen (Ed.), Cognitive development (pp. 12-24). Harper & Row.

Schunk, D. H., & Zimmerman, B. J. (2012). Motivation and Self-Regulated Learning: Theory, Research, and Applications. Routledge.

Tomlinson, C. A. (2014). The differentiated classroom: Responding to the needs of all learners. ASCD.

UCAR. (2020). GLOBE Weather Curriculum Resources. Retrieved from UCAR.