



## RESEARCH ARTICLE

## Science Comics as Educational Materials and its Impact on Elementary Students' Science Academic Performance

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ARTICLE INFO	ABSTRACT
<p>Received: May 22, 2024 Accepted: Jul 4, 2024</p>	<p>Science comics are one of the innovative educational trends utilized in classrooms, combining images and texts, making them visually attractive and engaging. It is helpful in science education to visualize abstract scientific concepts. This study explored the impact of using science comics as educational materials in science education among the selected elementary students. It also aimed to determine students' academic performance in science before and after integrating science comics and their significant differences using pre-and post-test assessments. The contents of the science comics covered weather and weather instruments learning competencies and lessons based on the grade level curriculum. The study utilized classroom action research (CAR) design by integrating science comics as an innovative approach to science lessons. Standardized test items were adapted from the Grade 4 science teaching module, and the results were analyzed quantitatively. Using purposive sampling and total enumeration, the participants involved 18 Grade 4 students at Palabayan Elementary School (PES), Tinoc, Ifugao, Philippines. Results indicated that the students attained a low mean percent score during the pre-test, suggesting that most have low academic performance in science. However, in the post-test, there was an observed increase in the students' attained mean percent score, signifying higher academic performance after integrating science comics. It was found that there was a significant difference between the pre-and post-test mean percent scores, implying the significant impact of science comics as educational materials on the Grade 4 students' science academic performance. Aside from this, the results imply the effective use of science comics in science lessons, attaining learning competencies, and enhancing the Grade 4 students' scientific literacy and critical thinking. It is recommended that further research be conducted to broaden the impact and academic benefits of science comics in elementary science education.</p>
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### INTRODUCTION

Teaching approaches, instructional methods and strategies, and educational materials and resources that are amusing, inspiring, and engaging are generally seen to positively impact students' ability to learn efficiently and effectively. This underpins the teachers' competencies as it directly impacts the quality of education and students' learning outcomes (Libiado & Canuto, 2023). As a competent teacher, it is vital to utilize visually engaging educational materials to help foster and enhance students' skills in the rapidly evolving educational landscape of the 21st

century. It is noted that there is a relevance between the presence of visuals or images and increased learning. This is why comics have the power to pique an individual's curiosity and, more importantly, the curiosity of the students (Yang, 2003). Students' visual and learning perspectives and abilities are altered when exposed to comics that combine visuals and texts (Astuti et al., 2014). This results in students finding classroom instruction more appealing, motivating, and engaging. The utilization of comics as educational materials will have a favorable impact on both the teaching and learning processes (Yang, 2003).

*Comics*, a shorter word for *comic strip*, is a medium that communicates ideas through visuals, frequently in conjunction with text or other visual information. More often than not, it is presented as a series of panels of images (Akaygun, 2016; Kunzle, 2023). It is a series of discrete visuals juxtaposed to form a narrative (Hayman & Pratt, 2005; Lazarinis et al., 2015). It is a sequence of separate images with a preponderance of image over text that appears in a mass medium and tells a moral and topical story (Kunzle, 2023). With this, comics that address students' interests can be used as alternative resources in science education (Koutníková, 2017).

Comics can be used in all subjects (Koutníková, 2017), all phases of teaching (Cheesman, 2006), and in all levels of education, from primary to tertiary (Green, 2013; Koutníková, 2017). Regarding incorporating comics into science education, *science comics* is the most frequently used term (Maulidah & Wulandari, 2021; Muzumdar, 2016). Teachers may also use *sciencetoons* (Badeo et al., 2021) to define science comic strips. Because comics logically communicate information structures (Akaygun, 2016; Kunzle, 2023), they may be valuable scientific tools that assist students more efficiently following scientific procedures and concepts. Through the provision of a visual scientific concept, science comics have the potential to bridge the gap between academic knowledge and applications in the actual world.

With comics, interdisciplinary learning can be integrated, and science can be related to other disciplines (Matuk et al., 2019). This undertaking can highly reinforce science, technology, engineering, arts, and mathematics (STEAM) education, supporting students' curiosity about the natural world and scientific thought. STEAM education supports the development of students' scientific literacy (Koutníková, 2017), enabling them to become lifelong learners in science and technology and preparing them to become productive members of society.

Comics have emerged as one of the most widely available and valuable writing materials in recent years (Roswati et al., 2019). Since science education is described mainly by its conceptual and theoretical nature (Canuto et al., 2024), comics can be an effective supplementary teaching aid for concretizing abstract concepts in science classes (Akcanca, 2020). It has the potential to produce an environment that is conducive to learning and fosters excitement for both education and cognition. Students are motivated to maintain critical thinking on optimal learning strategies and active engagement (Bolton-Gary, 2012), substantiating teaching science strategies (Aulia & Hidayati, 2023). This is one of the reasons why the use of comics in science education has become an innovative educational trend.

In addition, comics used for science concepts to eliminate complexity and abstraction can provide the permanence of knowledge and eliminate forgetting caused by rote learning since they are visually attractive to students (Şengül & Dereli, 2010). In a concise, appropriate, and efficient manner, it can explain a world composed of abstract scientific concepts (Morel et al., 2019). Additionally, it can prevent students from misconceptions and encourage them to engage in scientific thinking, which may be utilized to explain scientific knowledge (Orçan & Kandil İngeç, 2016).

It can also be noted that using science comics supports the achievement of Quality Education as one of the Sustainable Development Goals (SDGs) or Global Goals adopted by the United Nations

in 2015. Ensuring equitable and inclusive quality education among learners (United Nations, 2024) can be achieved through the science comics' visual engagement and accessibility. Although some educators have expressed concern regarding the possible advantages of comics (Locke, 2005; Thompson, 2007), their use in educational settings is nevertheless growing in popularity (Lazarinis et al., 2015; Topkaya, 2016). Over the past years, there has been a massive surge in the production of educational comics, with a significant number focusing on scientific topics. This rapid increase in science comics far outstrips the understanding of how comics impact students' beliefs and interests in science (Anggoro & Jee, 2012).

### **Research gap**

Despite the acknowledged potential of science comics to enhance students' engagement, scientific literacy, and critical thinking skills, some educators still expressed tension between the potential benefits of comics for engaging students with science and its risk of providing low-level entertainment without commensurate learning (Locke, 2005; Thompson, 2007). There are relatively few studies that have been found regarding their use in the classroom and as science educational material (Tribull, 2017). Similarly, a knowledge gap exists in the locality due to the lack of related researchers about science comics conducted in Tinoc, Ifugao, Philippines.

### **Research aim and questions**

This study aimed to explore the potential impact of using science comics as educational materials at the elementary level. It also aimed to determine the effect of using science comics on the Grade 4 students' academic performance. The conduct of the study was guided by the following:

1. What is the academic performance of the elementary students in science during the pre-test and post-test assessments?
2. Is there a significant difference in the students' pre-and post-test results after integrating science comics as educational materials?

### **Research significance**

Using science comics as educational materials in elementary science education may become a compelling and engaging medium that aligns with young students' cognitive and imaginative capacities. With this, the researchers have high hopes that the study will shed light on the innovative application of science comics in science education. It may serve the purpose of recognizing the necessity for school administrators to adequately equip their teachers with educational materials that are both current and appropriate for school instruction. The researchers hope the study will be used as a reference source in the academe and among educators interested in performing similar studies.

## **LITERATURE REVIEW**

### **Theoretical framework**

One theory supporting the use of comics in the classroom is visualization, which is the process of creating a visual image in one's mind (American Psychological Association, 2023; Kolodii et al., 2017). Visualization may be static, as in paper drawings, pictures, or comic strips, and dynamic, as in animations and simulations (Akaygun, 2016). Research has shown that using visualization tools in the classroom helps students better understand the concepts being taught (Williamson, 2015). It can also potentially hone students' metacognitive skills (Kelly, 2014). Likewise, it enables students to divide their ideas into phases, structuring their thoughts (Jouni & Piia, 2021).

Constructivism is another theory that is connected to the incorporation of comics into education. It has been demonstrated that a constructivist view of teaching and learning (Fensham et al., 1994) is an effective model for expressing how a conceptual shift in students can be

encouraged. A significant number of science teachers have utilized this view. Its fundamental idea is that the students can only make sense of new circumstances by referring to what they already know and how they have previously understood them. Learning is an active process in which students generate meaning by associating new concepts with their existing knowledge while simultaneously acquiring new information.

Associating constructivism as a learning theory and in science comics emphasizes that students actively build their understanding of the world by engaging with information and experiences. Science comics, through their combination of visual and textual elements, provide a dynamic platform that aligns with the constructivist approach. It may encourage students to actively interpret and construct meaning from the information by presenting visually rich and sequentially content. The narrative structure of comics facilitates the organization of knowledge into a cohesive framework, allowing students to connect new information with their existing understanding. Additionally, the interactive nature of comics, where students visually engage with characters and scenarios, promotes a participatory learning experience (Jones & Brader-Araje, 2002; Kumar Shah, 2019; Singh & Yaduvanshi, 2015). This serves as a tool for students to construct their understanding, connect concepts, and actively engage in learning.

### **Comics in elementary science education**

Comics present a highly effective approach to imparting scientific knowledge in elementary education (Fianto et al., 2023; Tribull, 2017). Since they are appealing to children, the use of comics in education is reasonable (Phoon et al., 2020; Spiegel et al., 2013). Students find it more comfortable to read comics than standard textbooks since comics contain brief messages, although they are relevant (Affeldt et al., 2018). Therefore, using science comics as an educational material in science is essential for achieving the required competencies (Paco & Linaugo, 2023). Most students consider comics a fun learning tool (Ilhan et al., 2021). It can potentially be precious in terms of introducing scientific topics in a manner that is both fascinating and easily understandable (Koutníková, 2017). It can enhance students' academic performance and scientific literacy (Bolton-Gary, 2012; Fitria et al., 2023; Listianingsih et al., 2021).

Teachers can integrate comics into their instruction to support and meet the curriculum standards. It is a valuable medium for connecting scientific concepts and the student's personal experiences (Matuk et al., 2019). This can be attributed to the comic's capacity to communicate concepts aesthetically pleasing effectively (Phoon et al., 2020), making abstract science concepts concrete and visually appealing to the students. Science comics can potentially engage students in scientific thinking by presenting visually appealing and enjoyable scientific concepts through pictures (Listianingsih et al., 2021). It is distinguished that students were excited to learn when comics were involved due to their colors (Syarah et al., 2019; Fitria et al., 2023). The pictures and colors can clarify ideas they may struggle to grasp through text alone. This visualization can build a more concrete understanding of science concepts, significantly increasing the students' conceptual understanding of science topics (Badeo et al., 2021; Fitria et al., 2023; Maulidah & Wulandari, 2021).

Science education necessitates teachers to be abreast of innovative educational materials, enabling them to support students' scientific literacy (Canuto, 2023). With its integration, studies indicate the positive impact of using science comics as educational materials in elementary classrooms. For instance, Samosa (2021) determined that it effectively improves students' critical thinking ability, developing their character, especially discipline and complex work traits. Casumpang and Enteria (2019) found that student participants positively perceived the self-developed science comics. The students' inference and science communication skills were enhanced. The students had better motivation and appreciation of the lesson where the science comics were integrated. Syarah et al. (2019) uncovered that using comics in science classrooms

increased the students' knowledge, comprehension, and awareness of marine conservation. Students became aware of issues regarding marine life, such as the effects of trash on marine animals and the roles of coral reefs and mangroves.

Istiqomah et al. (2021) found that comics focused on the environment can improve students' higher-order thinking skills (HOTS). This indicates that students have increased their creative ways to find and solve problems, creative, future-oriented thinking skills, and scientific inquiry. Further, Damopolii et al. (2022) determined that comics improved students' critical thinking when partnered with augmented reality (AR). Students claimed that they quickly understood lessons on human organs. The images maintained their reading attention and helped them to study diligently. The students could compare, determine cause and effect, and arrange science concepts in sequence.

## **METHODOLOGY**

### **Research design**

The research was conducted using a classroom action research (CAR) design, which involved one of the researchers engaging in action and teaching while the student participants were learning about science. One of the purposes of this design is to integrate innovative approaches to the current education, inhibiting transformation and change among the affected students (Khasinah, 2013). In this study, the innovative approach involved the utilization of science comics as educational materials. The CAR consists of four stages: planning for an action, implementation of the plan as an action, observation of the action, and reflection to analyze the results of the action (Khasinah, 2013). However, CAR is usually conducted in cyclical order, expanding to seven steps: identifying a problem, seeking information, planning an action, implementing the action, observing the action, reflecting the observations, and revising the plan (Strickland, 1988). In this endeavor, the researchers utilized these seven CAR steps as they were best suited to the study's structure.

### **Participants**

Using total enumeration, 18 Grade 4 students at Palabayan Elementary School (PES), Tinoc, Ifugao, Philippines, were involved in the study. The students were selected through purposive sampling as suggested by the School Head and based on the grade section where one of the researchers was teaching. Specifically, there were 55.56% ( $N = 10$ ) males and 44.44% females ( $N = 8$ ). This small number of student participants is due to the low population of PES. The study was conducted during April, fourth quarter of the academic year 2023 - 2024.

### **Materials and instrument**

Since the study was conducted during the last quarter of the academic year, the coverage of the learning competencies and science lessons to which the science comics were integrated as educational materials consisted of topics related to weather and weather instruments. This includes the construction and use of simple wind vanes and anemometers, the reading and use of thermometers to measure relative temperatures, and the factors affecting the day's temperature. These topics were based on the standardized Grade 4 science curriculum to be delivered in a week. The researchers developed four science comics using varied online, editable comic templates based on these topics. It was downloaded, printed in full colors, reproduced, and distributed individually among the Grade 4 students during each lesson. Using printed copies of the science comics as educational materials during the lesson proper was most feasible. Using online comics, smartphones, and projectors in the classroom was not concrete due to a lack of school resources.

In measuring the science academic performance of the Grade 4 students, the researchers adapted the test items from the Grade 4 level science teaching modules. It consists of ten questions covering the learning competencies and lessons on weather and weather instruments. Adapting the questions ensures that the test items were accurate, valid, and reliable. The same set of test questions were used for the pre-and post-test assessments. The pre-test was given before the start of the lesson at the beginning of the week. On the other hand, the post-test was given at the end of the week after the science lessons were delivered.

### **Procedures**

The seven steps of CAR were utilized for more specific procedures reflecting the study's context. First, the study identified problems based on observing the Grade 4 students' academic performance and the teaching strategies used in the science lessons, including the probable impact of science comics as educational materials. Second, supplementary information was gathered using scholarly-related works of literature. Third, a research proposal was formulated for the planning stage, including integrating science comics into the lesson plans and the statistical tests based on the problems. This stage also involved conducting the pre-test assessment at the beginning of the week and before the main lesson to gauge the students' prior knowledge of weather and weather instruments and to determine their initial academic performance.

Fourth, integrating science comics as educational materials covering learning competencies and lessons on weather and weather instruments were implemented. Four interrelated science comics were utilized separately during lessons within four executed science lesson plans covered. Fifth, after covering the learning competencies and lessons, the post-test assessment was administered at the end of the week to determine any significant improvements in the students' acquired knowledge and academic performance. Sixth, pre-and post-test results were organized, tabulated, and analyzed to determine the impact of science comics as educational materials on the academic performance of the Grade 4 students. Lastly, the revision stage involved modifying and creating additional science comics. The revised science comics were given to the Grade 4 Class Adviser for future purposes. In the end, presenting the study's results was undertaken.

Before the study, the researchers sought approval from their institution's ethics review committee. Permission letters were sent to the PES School Head and the Class Adviser for the participation of the selected Grade 4 students. Once approved, consent letters were solicited from students' parents or guardians. The lessons and the pre-test and post-test assessments were done during class hours and facilitated by one of the researchers. The students' test papers for both the pre-test and post-test assessments were checked and securely recorded. The students' scored test papers were returned promptly at the end of the study.

### **Data analysis and management**

The researchers were responsible for the data acquisition, gathering, and management. After each test, the researchers personally checked and scored the students' papers. The scores were then recorded using a secured and updated spreadsheet program. For anonymity and confidentiality, the names of the Grade 4 students were presented in codes. Only the raw scores were collected. The test papers were kept in two separate labeled envelopes, one for the pre-test and the other for the post-test results. The study made use of both descriptive and inferential statistics. Means ( $M$ ), standard deviation ( $SD$ ), and percentages were used to determine the students' average percent score and describe their academic performances. A  $t$ -test determined the significant difference between students' pre-test and post-test scores.

## Ethical considerations

Strict ethical principles were followed throughout the study to protect the rights and well-being of the researchers and the Grade 4 student participants. Ethical evaluation and authorization from the researchers' institution were sought. The student participants were duly informed of the study's characteristics and objectives and their explicit voluntary involvement. Informed consent was sought from students' parents or guardians to allow their child or ward to participate in the study. Respect was extended to all the student participants, and their autonomy was maintained. The researchers prioritized the welfare of the Grade 4 students while attempting to mitigate any potential hazards. Data was anonymized to ensure the confidentiality of the students' identities. The collected data was only accessible exclusively among the researchers. The study's outcomes were evaluated and documented with integrity.

## RESULTS

As gleaned in Table 1, the mean percent scores result shows a notable increase in the student participants' science academic performance after utilizing science comic strips as educational materials in teaching lessons about weather and weather instruments. Considering the mean score of 22.22% in the pre-test, the academic performance of the Grade 4 students increased to 78.89% after the post-test assessment.

**Table 1: Pre-and Post-test academic achievement results of the grade 4 students**

Students	Pre-test		Post-test	
	Score	%	Score	%
S1	0	0	6	60
S2	2	20	10	100
S3	0	0	8	80
S4	0	0	10	100
S5	4	40	4	40
S6	2	20	6	60
S7	4	40	10	100
S8	4	40	8	80
S9	0	0	8	80
S10	0	0	8	80
S11	6	60	10	100
S12	2	20	10	100
S13	4	40	10	100
S14	0	0	4	40
S15	6	60	10	100
S16	0	0	6	60
S17	0	0	4	40
S18	6	60	10	100
Mean		22.22		78.89

Eight students, specifically S1, S3, S4, S9, S10, S14, S16, and S17, acquired 0% scores during the pre-test. Three students, S2, S6, and S12, got 20% correct items. Four students particularly S5, S7, S8, and S13, garnered 40%. Only three students, S11, S15, and S18, attained the minimum passing rate of 60% based on the accepted passing score and grade used at the elementary level. This indicates that the pre-test results show very low academic performance in science for the Grade 4 students.

On the other hand, the post-test result shows an overall increase in students' academic performance. Eight out of 18 students had 100% perfect scores, notably S2, S4, S7, S11, S12, S13, S15, and S18. Seven students including S1, S3, S6, S8, S9, S10, and S16, achieved above minimum passing rate of 60% to 80% correct scores. However, the remaining three students, S5, S14, and S17, attained 40%, which is still below the minimum passing rate of 60%. In general, the post-test results show increased academic performance in science for the Grade 4 students after integrating science comics.

As seen in Table 2, the students' t-test results revealed a significant difference between the pre- and post-test results [ $t(17) = -10.013, p = .001$ ]. The post-test ( $M = 78.89, SD = 539.87$ ) is significantly higher than the pre-test ( $M = 22.22, SD = 559.48$ ). It indicates that science comics were effective, impacting the Grade 4 student's academic performance in science.

**Table 2: Comparison between the pre-and post-test academic achievement results**

Tests	<i>M</i>	<i>N</i>	<i>SD</i>	<i>d</i> <i>f</i>	<i>t</i> - value	<i>p</i> - value
Pre- test	22. 22	18	559. 48	1	-	.001
Post- test	78. 89	18	539. 87	7	10.01 3*	

Note: \* = significant ( $p < .05$ ); ns = not significant ( $p > .05$ )

**DISCUSSION**

Based on the mean percent scores, the science academic performance of the selected Grade 4 students increased after integrating the science comics as educational materials in science lessons on weather and weather instruments. The mean percent scores attained during the pre- and post-tests divulge that the science comics positively affected students' academic achievement. This is in line with the findings of Casumpang and Enteria (2019), Istiqomah et al. (2021), and Samosa (2021), which indicated that the utilization of comics as educational material has a favorable impact on the performance of students. It is possible that the utilization of science comics that included both images and texts was able to successfully capture the interest of the students, as Astuti et al. (2014) indicated. As Syarah et al. (2019) and Fitria et al. (2023) suggested, the colors used may also have contributed to the students' excitement. It may have made complex science concepts more engaging among the students by presenting information in visually appealing and entertaining panels.

The science comics may have sustained the Grade 4 students' critical thinking and active engagement, as Bolton-Gary (2012) indicated. It may have helped the students visualize the science lessons' abstract concepts, making them easier to understand or remember. This is especially true since young students tend to learn and understand more visually, as Williamson (2015), Kelly (2014), and Jouni and Piia (2021) supported. As for active engagement, the students may have enjoyable learning experiences with increased motivation. They may be more inclined to actively participate in the lessons and put forth effort to understand scientific concepts as presented in the science comics used, as the constructivist view supports.

It can be noted that the science comics' storytelling helped the Grade 4 students contextualize concepts and see how they relate to real-world situations. Its panels created narrations that conveyed scientific information, which may have enhanced their understanding and critical thinking skills, as Kelly (2014) and Bolton-Gary (2012) described. The students may have developed a deeper understanding and interest in the lesson by connecting the scientific concepts to relatable characters and storylines. In turn, it may have helped the students to have better retention of the science lessons and better academic performances, as posited by Bolton-Gary



(2012), Fitria et al. (2023), and Listianingsih et al. (2021). Similar to the findings of Şengül and Dereli (2010), it signifies that the science comics helped to enhance students' knowledge, including scientific literacy.

The positive increase in the Grade 4 students' science academic performance strengthened the proof that science comics as educational materials impact students' academic performance. It can be used as a supplementary tool for teaching science, as Aulia and Hidayati (2023) claimed. The results contribute to and support science comics' effectiveness in elementary science education. It conforms with the increasing popularity of the utilization of science comics in classrooms, as Lazarinis et al. (2015) and Topkaya (2016) identified. This is despite the circumstances surrounding the academic benefits of comics, as Locke (2005) and Thompson (2007) posited.

As determined, the science comics significantly impacted the Grade 4 students' academic performance after its integration. This suggests that science comics effectively enhance learning competencies and lessons as educational materials, supporting Paco and Linaugo (2023). The academic improvement may indicate that the science comics engaged the Grade 4 students more interactively and enjoyably, fostering deeper comprehension and retention of scientific concepts. The visual and narrative elements of the science comics likely appeal to various learning styles, accommodating diverse students' needs and promoting a more inclusive science learning environment for the Grade 4 level. This underscores the potential of innovative teaching methods, such as utilizing science comics, to positively impact attaining science learning competencies and cultivate scientific learning among the students. Overall, the increase in academic performance suggests that using science comics in science education has effectively enhanced the Grade 4 students' academic experiences, leading to improved comprehension, retention, and application of scientific concepts.

## **CONCLUSIONS, IMPLICATIONS, AND LIMITATIONS**

Science comics are considered supplemental educational materials for teaching science lessons. It is favorable among teachers due to its combination of images and texts, helping the students gain scientific knowledge and sustain critical thinking and scientific literacy. The study aimed to explore the potential impact of science comics on the academic performance of the selected Grade 4 students. Conclusively, using science comics as educational materials positively affected students' academic performance in science. This outcome suggests that the integrated science comics effectively engaged the students, enhancing their understanding and retention of scientific concepts. The science comics most likely stimulated students' motivation, encouraged active learning, and promoted a better understanding of the science concepts presented. Overall, the positive impact of the science comics on Grade 4 students' academic performance underpins their potential as effective educational materials fostering both engagement and enhancement of science literacy.

One of the limitations of this study is the inclusion of only a small group of participants in a class section at an elementary school. Thus, the study's findings are limited to the participants involved rather than the general student population. The illustrations and texts used in science comics were limited and directly related to a specific science topic and concept of weather and weather instruments, covering only the specific learning competencies during the study based on the science curriculum. However, the researchers still recommend integrating science comics as educational materials in science classrooms. Designing science comics' visuals and text relevant to the lesson to suit students' learning needs is also suggested. Using a variety of related comics is also recommended. Lastly, conducting related researches involving a more significant number of participants is encouraged.

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