



RESEARCH ARTICLE

Pre-Service Teachers' Experiences in Developing and Using Science Comics as Educational Materials for Elementary Science Education

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ARTICLE INFO	ABSTRACT
Received: Aug 18, 2024 Accepted: Oct 7, 2024	<p>Pre-service teachers are increasingly adopting science comics as innovative educational materials for their teaching internship in science education. As science comics combine visual art with scientific concepts, they are gaining traction as dynamic approaches to enhancing science learning. Correspondingly, this study aimed to explore the pre-service teachers' experiences developing and using science comics for elementary science education. It further aimed to determine the benefits they have gained and problems encountered while integrating it as educational materials. The study utilized descriptive phenomenology, where the data were gathered through semi-structured interviews and then analyzed thematically. Participants involved three pre-service teachers at Ifugao State University (IFSU) – Tinoc Campus, Ifugao, Philippines. They were deployed at Palabayan Elementary School (PES), Tinoc, Ifugao, Philippines, for their teaching internship. Findings determined four major themes: student benefits from learning through science comics, teaching benefits of utilizing science comics, teaching skills enhancement in developing and using science comics, and challenges experienced in developing and utilizing science comics. As determined, the pre-service teachers were capable of developing engaging and creative science comics and used them during their teaching internship. They were able to integrate them as educational materials in teaching science lessons. They successfully extended scientific concepts, teaching practices, and professional training and development. The science comics provided them with excellent ways to elucidate and convey scientific concepts. It facilitated the development of crucial abilities in content simplification and scientific narrative construction, enhancing their competence in crafting compelling science lessons. By incorporating science comics into their teaching internship, the pre-service teachers develop a more dynamic and innovative educational approach, preparing them to inspire curiosity and enthusiasm among their future students.</p>
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INTRODUCTION

Comics have surpassed their traditional role as entertainment and emerged as dynamic and effective educational resources, seamlessly blending art and text to create a dynamic learning experience. When integrated into science education, teachers can use it as an innovative tool, providing visually engaging platforms to present complex scientific concepts. This can reflect the teachers' competence

and quality of instruction, directly affecting student learning, engagement, and overall educational outcomes (Libiado & Canuto, 2023). Comics present information that is structured and logically arranged (Kunzle, 2024), helping students follow scientific processes and concepts more effectively (Phoon et al., 2020). With these characteristics, educators can use comics to bridge the gap between theoretical knowledge and real-world applications, offering visual narratives for a deeper understanding of the interconnectedness of scientific principles. It fosters enthusiasm for scientific inquiry, making comics valuable resources for pre-service teachers seeking to cultivate curiosity and engagement among their students for science education during teaching internships.

Comics engage readers through a unique interplay of images and words, allowing for innovative storytelling techniques and artistic expressions. Comics, shorthand of comic strips, is a set of related drawn images presenting a story or a timeline, including words or phrases within or next to each image, or they may not be used at all (Kunzle, 2024). Usually, the sequence of pictures is employed to depict sequential processes (Akcanca, 2020) or to present a story (Lazarinis et al., 2015). When used in instruction, it is most proper to call it educational comics (Akcanca, 2020). In particular, scientoons (Badeo et al., 2021) and science comics are the most common terms used when comics are integrated into science education (Maulidah & Wulandari, 2021; Tatalovic, 2009). Specifically, science comics seek to convey scientific information or inform readers regarding certain non-fictional scientific ideas or themes (Tatalovic, 2009).

A positive learning environment and excitement for pedagogy and cognition can be fostered through the use of comics. It encourages students to think critically about active engagement and ideal learning strategies (Bolton-Gary, 2012). For this reason, the integration of comics into science education has emerged as an innovative educational trend. It can substantiate teaching science strategy (Aulia & Hidayati, 2023; Fabillar et al., 2024). Since most science lessons are conceptual and difficult to portray (Canuto, 2023), comics can serve as an effective pedagogical instrument for translating abstract scientific topics into visual representations, all while engaging students (Akcanca, 2020; Lazarinis et al., 2015; Topkaya, 2016). Several studies determined that comics have practical benefits in instruction, including serving as motivation, supporting concentration, and allowing exploration and acquisition of scientific concepts (Cheesman, 2006; Fabillar et al., 2024; Koutníková, 2017). Generally, it can be discerned that comics can potentially enhance students' scientific literacy (Bolton-Gary, 2012; Fitria et al., 2023; Listianingsih et al., 2021).

Science teachers can integrate comics as one of the educational material resources into their instruction. Using varied resources in science education creates a more inclusive and effective learning environment (Canuto, Choycawen, et al., 2024). Teachers can establish a connection between scientific concepts and students' personal experiences through the use of science comics (Matuk et al., 2019). This can be ascribed to the comic's ability to effectively communicate aesthetically pleasing concepts (Phoon et al., 2020), rendering abstract scientific concepts concrete and visually appealing to the students.

In teacher education programs, the incorporation of science comics into the training of pre-service teachers supports their skills enhancement, application, and integration of educational technology (EdTech) and information and communications technology (ICT) resources. It contributes to their training as an engaging pedagogical tool that enhances their understanding and teaching of complex scientific concepts. Some pre-service teachers recognized comics as valuable educational materials because they stimulate their creative thinking and enable the elucidation of ideas (Senturk & Cicek Senturk, 2023). Pre-service teachers use digital platforms to create and design science comics to enhance their understanding of scientific content and develop essential technological skills (Akcanca, 2021; Craciun & Bunoiiu, 2017), including 21st-century skills. This practice promotes creativity and innovation, enabling them to design visually engaging materials that effectively communicate ideas in their future classrooms. Furthermore, it cultivates their ability to integrate technology into their

teaching methodologies, preparing them to engage, captivate, and inspire their future students for a more dynamic learning environment.

The pre-service teachers' training on the use of science comics can play a significant role in promoting the Sustainable Development Goals (SDGs) adopted by the United Nations in 2015 (United Nations Development Programme [UNDP], 2024). It can significantly contribute to achieving multiple SDGs by enhancing educational engagement and inclusivity. For instance, in SDG 3: Good Health and Well-Being, pre-service teachers can integrate science comics to educate students about health issues and preventative measures, making complex medical information more understandable and relatable (Green, 2013; Muzumdar, 2016). The pre-service teachers' use of science comics supports SDG 4: Quality Education by making complex concepts accessible and relatable (Matuk et al., 2019), catering to diverse learning styles. When pre-service teachers feature diverse characters and themes in science comics, it can promote SDG 5: Gender Equality and SDG 10: Reduced Inequalities, fostering discussions that encourage critical thinking about gendered social norms and biases (Bando et al., 2024; Canuto & Espique, 2023; Lumidao, Bando, et al., 2024; Lumidao, Espique, et al., 2024). Pre-service teachers can also extensively educate students and address issues such as in SDG 13: Climate Action, SDG 14: Life Below Water, and SDG 15: Life on Land and Life on Land by illustrating environmental challenges and solutions. This supports students' immersion with scientific issues and enhances their scientific literacy (Bolton-Gary, 2012; Farinella, 2018; Fianto et al., 2023; Fitria et al., 2023; Koutníková, 2017; Listianingsih et al., 2021; Maulidah & Wulandari, 2021; Tribull, 2017) and motivation for environmental protection (Syarah et al., 2019; Istiqomah et al., 2021). Generally, in support of the SDGs, science comics can create an interactive learning environment that deepens understanding of global issues and empowers students to become informed and proactive citizens, inspiring them to take action toward a more sustainable and equitable future.

1.1. Research Gap

As academic institutions increasingly seek innovative ways to engage students, science comics have emerged as an innovative trend and a valuable educational tool for promoting scientific literacy, encouraging exploration, and making learning fun and impactful. While there has been a fair number of studies exploring how comics can enhance students' engagement and literacy and the advantages of teachers in using them, there are only a few identified studies (Akcanca, 2021; Craciun & Bunoiu, 2017; Senturk & Cicek Senturk, 2023) assessing the experiences among pre-service teachers regarding their use of science comics. Most studies dwell on the impact of comics on students' academic performance and teacher benefits. There is a knowledge gap concerning exploring the pre-service teachers' experiences integrating science comics as educational materials in their delivery of science lessons and teaching practices, especially in the locality. Addressing this gap could provide deeper insights into the long-term implications of using science comics as pedagogical tools and teacher education curricula that effectively prepare future teachers for diverse classroom environments.

1.2. Research Aim and Research Questions

This study aimed to explore the pre-service teachers' experiences integrating science comics into elementary science education. It also aimed to determine the benefits they have gained and problems encountered in developing and using science comics as educational materials. The conduct of the study was guided by the following:

1. What benefits or advantages did the pre-service teachers acquire in integrating science comics into elementary science education?
2. What are the challenges they experienced in developing and using science comics as educational materials?

1.3. Research Significance

Studying pre-service teachers' experiences developing and using science comics is significant because it provides valuable insights into how they perceive and implement innovative teaching strategies in their future classrooms. By exploring their experiences, the benefits and challenges associated with integrating science comics into science instruction can be identified, helping to refine future pedagogical practices. Understanding how pre-service teachers engage with science comics can also reveal their impact on student engagement, comprehension, critical thinking, and scientific literacy, contributing to the broader discourse on effective science education. These insights can inform teacher training programs, equipping future teachers with the tools and confidence to utilize diverse educational materials and fostering a more dynamic and inclusive learning environment for students.

2. LITERATURE REVIEW

2.1. Learning Theories Supporting Science Comics

Science comics are based on visualization, a cognitive process of generating a mental representation of a visual image (Kolodii et al., 2017; Veřmiřovský, 2013). Pre-service teachers' visualization tools increase students' conceptual understanding of the lessons. With science comics, students can interpret and create visual messages. It helps to break down abstract or intricate ideas into more understandable and memorable components. It provides a platform for developing visual literacy skills by requiring the students to understand visual elements, interpret symbolism, and make connections between images and text. Pre-service teachers can use images in science comics to contextualize information within a narrative or story. Their contextualization helps students see academic content's real-world applications and relevance. Visualizations in science comics make learning more engaging and applicable by placing information in a meaningful context.

Educational science comics are also grounded in constructivism's fundamental principles of active learning and knowledge construction. Constructivism asserts that learners actively construct their comprehension of the world via engagement with knowledge and experiences (Jones & Brader-Araje, 2002; Singh & Yaduvanshi, 2015). Science comics and constructivism are inherently linked through their emphasis on active engagement and meaning-making in learning. Science comics among pre-service teachers align well with constructivist principles, as these visual narratives dynamically engage learners, encouraging them to interpret information, make connections, and explore complex scientific concepts through storytelling. By integrating comics into their teaching internship, pre-service teachers can develop critical thinking and creativity, fostering a deeper understanding of scientific ideas while gaining insight into effective pedagogical strategies they can employ later in their instructions.

Integrating science comics into teacher education can be a creative and effective way for pre-service teachers to apply Mishra and Koehler's (2006) technological pedagogical content knowledge (TPACK) framework. TPACK describes the knowledge that teachers need to effectively integrate technology into their teaching practices (Koehler et al., 2013). It emphasizes the intersection of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). TPACK provides a framework that empowers pre-service teachers to thoughtfully integrate science comics into their teaching practice while considering the unique demands of science content and pedagogy. It encourages pre-service teachers to consider how science comics can effectively convey scientific concepts to reflect their CK. This requires a deep understanding of the content being taught and how science comics can be used to communicate complex ideas in an engaging and accessible manner. Science comics can be powerful visual learning tools, and pre-service teachers should understand how to leverage their visual nature to enhance their PK. This involves designing it to align with effective teaching strategies, such as storytelling and sequencing. For TK, pre-service teachers need

a basic understanding of digital science comics creation tools. This includes knowing how to use graphic tools, software, or online platforms that allow them to design and create science comics. TPACK guides them in selecting and integrating these tools effectively into their teaching. Transcending technological, pedagogical, and content, pre-service teachers with technological pedagogical knowledge (TPK) expound their understanding of how to use science comics to support effective teaching strategies. They must know how to integrate it seamlessly into their science instruction methods. Technological content knowledge (TCK) requires the pre-service teachers' knowledge of how science comics can be applied to enhance the teaching of specific science lessons. They could use it to help students visualize complex science concepts. Pedagogical content knowledge (PCK) involves understanding how to teach specific content using effective pedagogical strategies. Pre-service teachers should know how to integrate science comics that align with the curriculum and enhance students' understanding of the science lessons. As pre-service teachers explore and refine their use of science comics in the classroom, TPACK ensures a balanced and purposeful technology integration into their teaching practices (Bilici et al., 2013; Bwalya & Rutegwa, 2023; Kiray, 2016).

2.2. Science Comics in Elementary Science Education

Teachers' integration of comics in instruction is reasonable as they appeal to children (Phoon et al., 2020; Spiegel et al., 2013). Students find it more comfortable to read comics compared to traditional textbooks due to their short but meaningful messages (Affeldt et al., 2018). It caters to the student's interests and effectively presents condensed and concise information (Matuk et al., 2019). Most students describe comics as a fun learning tool as they can improve reading enjoyment by humorously presenting science concepts (Roswati et al., 2019; Tatalovic, 2009). Comics portray significant characteristics, such as humor in relieving the tension inside the classroom (Özdemir, 2017) and visualizing and contextualizing learning (Lin et al., 2015). Through comics, students can view the learning process as fun and exciting (Astuti et al., 2014). Comics effectively visualize narratives and enable teachers to connect scientific tasks with genuine scenarios from students' experiences.

For these reasons, using comics as educational materials at the elementary level (Fianto et al., 2023; Maulidah & Wulandari, 2021; Tribull, 2017) is an excellent method for conveying scientific knowledge. Aside from educational resources, this embodies the effective use of academic intervention (Canuto, Lumidao, et al., 2024) to support students' learning. Using comics as resources in science education can help students achieve learning competencies. In a concise, relevant, and effective manner, comics are particularly useful tools for teaching complex science lessons, thereby facilitating students' comprehension of abstract scientific concepts (Morel et al., 2019). It has the potential to substantially enhance the conceptual comprehension of scientific subjects among students (Badeo et al., 2021; Fabillar et al., 2024; Fitria et al., 2023; Maulidah & Wulandari, 2021).

Science comics can reinforce learning of fundamental concepts in areas such as biology, physics, chemistry, and earth and space science. It supports acquiring scientific knowledge, enhancing problem-solving skills, and correcting misconceptions (Bolton-Gary, 2012). It can effectively engage students in scientific reasoning by illustrating scientific principles in a visually captivating and engaging format through imagery (Listianingsih et al., 2021). Students exhibited heightened enthusiasm for learning when comics, characterized by their vibrant colors, were incorporated (Fitria et al., 2023; Syarah et al., 2019). Images and colors can elucidate concepts that may be difficult for children to comprehend through text alone. This visualization can enhance comprehension of scientific subjects. Science comics can enhance the accessibility and engagement of scientific issues (Farinella, 2018), where the students can be encouraged to ask questions, make predictions, and conduct investigations to discover answers to relevant issues.

Comics can simplify science concepts (Roswati et al., 2019). Its sequential information allows for the gradual introduction of concepts, making it easier for students to follow the logical progression of scientific ideas. This aids in building a foundation of understanding before moving on to more complex aspects. The simplification of ideas can also be related to the comic's use of concise and clear language. This avoids unnecessary and complex terms, contributing to better comprehension. This enforces the comic's appeal to students for increased science learning engagement compared to science textbooks (Aulia & Hidayati, 2023; Phoon et al., 2020). Comics allow the highlighting of key points visually and textually. Comics guide students to the most critical aspects of a concept by emphasizing crucial information through visual cues and bold text. This makes comics effective for supporting independent science learning among students (Ntobuo et al., 2023).

2.3. Science Comics and Pre-service Teachers

Senturk and Cicek Senturk (2023) determined that some science pre-service teachers perceived creative comics as alternate educational resources in environmental education. Through technology, they regarded comics as a potent tool since they could personalize characters, such as superheroes. The pre-service teachers recognized that the comics facilitated their thought expressions, affected their learning pace, and supported their establishment of a fun learning environment, narrative writing and visual skills, creative thinking, and humorous learning. Senturk and Cicek Senturk (2023) also determined that the comics caused active participation and engagement, captured attention, and enhanced the empathy of the pre-service teachers. They further found that the pre-service teachers used the comics as assessment tools, enabling their observation of students' behaviors and perspectives. However, they determined that the pre-service teachers found using of comics time-consuming and made classroom management difficult since their students were having fun reading them. The pre-service teachers also lacked resources in designing comics, were challenged due to the comics' inherently limited information, affecting detailed explanation of information, and needed more creative skills, technology training, and instructor guidance.

Akcanca (2021) found that prospective teachers experienced difficulty in designing their digital educational comics. They had trouble with background design and drawing. They also struggled to identify the most appropriate characters and subjects and write dialogues. Some comics creating programs were also not free, affecting their sufficiency of technological resources. Additionally, the prospective teachers conveyed their need to be mindful of the subject integrity, design process, integration of scientific knowledge, students' ages, visual and text coordination, visual attractiveness, dialogue contents, real-life applications, and target development competencies. On the other hand, Akcanca (2021) determined several benefits acquired by the prospective teachers. These include facilitating learning, permanent learning, and fun learning. The prospective teachers claimed the comics were effective educational materials and could concretize science concepts. They also mentioned that the comics made their students attentive and enhanced their imagination, creative skills, and multiple senses. It could also improve students' visual memory and was beneficial through modeling.

Craciun and Bunoiu (2017) found that web-based comics were beneficial among future physics teachers. In their teaching activities, the comics were advantageous for determining and rectifying science misconceptions. It was also beneficial for elucidating and evaluating concepts in the classroom. Furthermore, Craciun and Bunoiu (2017) determined that future physics teachers have developed TPACK through selected training activities based on web-based comics and concept maps. This was due to the effective amalgamation of comics and mind maps, which presupposed a deeper comprehension of the interplay among the science concepts, pedagogical knowledge, and technology, resulting in the enhanced TPACK of future physics teachers.

2.4. Elementary Pre-service Teachers in the Philippines

Pre-service teaching concerns students' educational training before becoming a licensed professional teacher (LPT) in the Philippines. Elementary pre-service teaching is directed toward individuals to learn about educational theories, teaching methods, classroom management, and other essential skills and knowledge needed to be effective teachers at the elementary level. Elementary pre-service teaching is reflected in the country's Bachelor of Elementary Education (BEEd) program (Commission on Higher Education, 2017). Near the end of their training, the pre-service teachers undergo teaching internship, sometimes called teaching practicum, practice teaching, or on-the-job training (OJT) for pre-service teachers, where they gain hands-on experience in natural classroom settings. During this immersive period, pre-service teachers apply theoretical knowledge acquired in professional education (ProfEd) courses to practical situations, honing their teaching skills and developing effective instructional techniques. Under the guidance of experienced mentor teachers, pre-service teachers engage in classroom management, lesson planning, and student interaction, receiving valuable feedback for continuous improvement. This practical experience is essential for building confidence, refining teaching methods, and fostering cultural competence as individuals prepare to enter the teaching profession (Commission on Higher Education, 2017).

In the local institution, Ifugao State University (IFSU), legal agreements are sought from nearby elementary schools to serve as collaborating institutions where the BEEd pre-service teachers will be deployed for their teaching internship. These elementary schools are commonly called cooperating schools. Common and similar to most higher education institutions (HEIs) in the Philippines, pre-service teachers are deployed during the second semester of each academic year. They must undergo teaching internships in the cooperating schools for at least 360 hours, covering the entire semester. Since this is the case, most of the pre-service teachers' practical training and lesson contents often cover the fourth or last quarter of the elementary schools. The pre-service teachers will be grouped according to their current addresses and nearness to the cooperating schools. Each group will be assigned a faculty member to serve as supervising instructors and monitor them. Once in the cooperating schools, the school head mainly must assign which grade level and class the pre-service teachers will handle. The main teacher of the class will then serve as their cooperating teacher and professional mentor. The duration of instruction and lessons to be taught by each pre-service teacher is determined primarily by their mentor. In most cases, the pre-service teachers will undergo two or more shifting of grade levels that they will handle. This allows them to be exposed to diverse subject areas, lessons, lesson planning, pedagogies, classroom management, and student interaction to further their teaching skills.

3. METHODOLOGY

3.1. Research Design

The study used a qualitative approach, specifically the descriptive phenomenology design. It focused on exploring and understanding (Neubauer et al., 2019) the pre-service teachers' experiences developing and using science comics for elementary science education. The researchers engaged the participants in semi-structured interviews using guide questions regarding their encounters with planning, creating, designing, integrating, and utilizing science comics in their science instruction during their teaching internship. The interviews were transcribed and extensively analyzed using thematic analysis (Lochmiller, 2021), allowing the researchers to identify common themes and patterns for results presentation. This allowed the researchers to capture the meanings and interpretations the pre-service teachers assigned to their experiences. Further, using this design emphasizes the importance of context and the researchers' bracketing of preconceived notions to minimize bias.

3.2. Participants

The participants involved three BEd pre-service teachers at IFSU – Tinoc Campus. They underwent their practice teaching during the second semester of the academic year 2023 – 2024. They were deployed at the Palabayan Elementary School (PES), a cooperating school of the campus. Among all the students, these three pre-service teachers were purposely selected because they were the only ones who extensively integrated science comics in their lesson plans and utilized them as educational materials in their science instructions, from planning, design, lesson delivery, and utilization. The small number of pre-service teacher participants was reflected in the campus' small BEd student population, considering that the campus has a small overall student population. The selection process was also characterized by the BEd program's emphasis on preparing individuals to teach at the elementary level. Through their training, the pre-service teachers were expected to possess proficiency in both subject matter and teaching methods and the confidence to employ various teaching techniques and utilize technology to enhance the quality and relevance of science education. Furthermore, it reflects the course's outcomes, equipping prospective science teachers with the necessary knowledge, abilities, and comprehension to become technologically proficient elementary science teachers. This will be achieved by incorporating educational technology and digital resources into their science teaching.

3.3. Procedures

The researchers solicited approval and collaborated with the campus officials and pre-service teachers' supervising instructor, who directly managed their deployment and teaching internship. Consent and approval were sought from each pre-service teacher detailing the study's scope and structure and their freedom to withdraw without repercussions. As of practice in the university, the pre-service teachers submitted copies of their lesson plans and weekly schedules of planned academic activities to their supervising instructor for monitoring. This allowed the researchers to determine when the pre-service teachers developed their science comics and employed them in their teaching. The specific topics for the science comics were dependent on the science lessons programmed based on the elementary science curriculum that the pre-service teachers handled. The pre-service teachers developed the science comics using a graphics design tool already used in one of their previous subject courses. In order to avoid potential risks and content errors in the science comics, they were submitted first to the cooperating teachers for content and quality checking. The pre-service teachers employed science comics within one week of their teaching. Each pre-service teacher utilized four to five science comics related to elementary Earth Science and Space Science lessons.

After the pre-service teachers employed science comics, the researchers conducted the interview personally. This allowed the researchers to engage directly and explore the pre-service teachers' experiences in detail, uncovering underlying issues and gaining a richer understanding of the context surrounding their responses. It also allowed in-depth data that captured their personal insights and perspectives in utilizing science comics in their teaching. Additionally, the researchers were able to probe deeper into their responses, leading to nuanced findings that enhanced the overall quality and relevance of their employment of science comics for elementary science education. Afterward, the recorded interviews were transcribed and translated into the English language. Thematic analysis of the translated responses followed through. The presentation of the findings concluded the study.

3.4. Data Gathering and Analysis

The researchers were solely responsible for conducting the interviews, transcription, and thematic analysis. To observe anonymity and confidentiality, the pre-service teachers and their responses were assigned codes P1, P2, and P3. Individual scheduled interviews were done using guide questions and recorded using smartphones as audio recording devices. To ensure the accuracy of the

English-translated responses, validations were requested from an English language specialist fluent in the local dialect used by the pre-service teachers in their responses. Findings were determined through thematic analysis, providing a systematic approach to identifying, analyzing, and interpreting patterns or themes. This allowed the researchers to distill complex and rich information into coherent insights, making understanding the pre-service teachers' experiences and perspectives easier. This resulted in a refined understanding of their employment of science comics in their teaching. Data from the audio recordings, transcriptions, and translations were organized and stored appropriately, limiting access to the researchers only.

4. FINDINGS

Analyzing the pre-service teachers' responses led to four major themes. These include 1) student benefits from learning through science comics, 2) teaching benefits of utilizing science comics, 3) teaching skills enhancement in developing and using science comics, and 4) challenges experienced in developing and utilizing science comics.

4.1. Student Benefits from Learning Through Science Comics

This first theme relates to the pre-service teachers' observed benefits of using science comics among the students they have taught. Overall, the pre-service teachers concluded that the science comics have positively affected their students in terms of cognitive and affective domains. These allowed the students to understand better scientific concepts in elementary Earth Science and Space Science lessons. The benefits discerned among their students include 1) enhanced learning, 2) heightened curiosity, 3) elevated engagement, 3) motivated reading, 4) made learning fun and enjoyable, and 4) active participation.

4.1.1. Enhanced Learning

The pre-service teachers, P1, P2, and P3, observed that their students' learning abilities were enhanced using science comics. They indicated that it helped the students to understand the science concepts easily and affected their imagination and learning retention. This is due to the science comics' concise dialogues and related visuals. As the pre-service teachers shared:

P1: *"It helped to enhance the ability of students to learn because it was easy to understand."*

P2: *"It helped students understand the lesson content. The students understood the lesson using science comics since retaining the information they had read was easy. Because of its graphics, the learners can enhance their imagination and easily understand the concept."*

P3: *"Students understand the lesson deeper due to its visuals and brief dialogues."*

4.1.2. Heightened Curiosity

The science comics piqued and deepened students' curiosity, as shared by P2. This caused the students to question the lessons and the contents of the science comics. P1 also specified that science comics sparked students' curiosity. They have become peculiar about its contents, such as the characters and design. This stimulated the students to skim all its pages before even reading it. They cited:

P2: *"It deepens the students' curiosity. They were more likely to ask questions about its contents and what they saw and read."*

P1: *"The characters and graphics caused them to be more curious."*

4.1.3. Elevated Engagement

P2 indicated that the science comics were a dynamic tool in elevating student engagement. P2 observed that the more appealing the designs, backgrounds, and characters used, the more the students were engrossed in the science comics. Likewise, P3 pointed out that the graphics used captured students' attention. As they mentioned:

P2: *"The students were more engaged due to the graphics and designs I used."*

P3: *"While using the science comics, I saw that the students were visually attracted to the graphics, and their attentions were captured."*

4.1.4. Motivated Reading

Due to the brief dialogues and short stories presented in the science comics, P2 described that students were more likely to read the science comics. The concise sentences made students' reading feel less daunting, particularly for reluctant readers or those who struggled with traditional texts. P2 shared:

P2: *"Those with difficulty reading were willing to read the comics because it was only brief."*

4.1.5. Made Learning Fun and Enjoyable

P2 observed that the science comics influenced students' affective domain. They were emotionally engaged in reading the dialogues and immensely invested in the characters and narratives. Students were observed to be entertained, emotionally uplifted, and enjoyed the stories, making the learning fun. P2 described:

P2: *"Students found it enjoyable because it tells short stories with illustrations, making the learners enjoy the lesson. It motivated the students to read with emotion because they enjoyed the story and immersed themselves in it."*

4.1.6. Fostered Active Participation

As the students were engaged in the science comics, they became more participative in the learning process, as P3 and P1 observed. P3 cited that the students were actively participating and eager during discussions. P1 indicated that the students were empowered to respond to questions since the concepts were directly given in the science comics. It is easy for the students to pinpoint and identify the correct answers. P3 and P1 indicated:

P3: *"Once the students were engaged in the science comics, they became attentive and actively participated during the discussion."*

P1: *"The students became more active and dared to answer correctly because of the graphics in science comics. It encouraged them, especially those who lack self-confidence, to answer questions since the concepts were already presented in the science comics."*

4.2. Teaching Benefits of Using Science Comics

The teaching benefits earned by the pre-service teachers are presented in this second theme. It presents the myriads of advantages they have gained in incorporating science comics into their instruction. It includes 1) enhanced content knowledge, 2) encouraged teaching innovation, 3) effective lesson planning, 4) better classroom management, 5) convenient, and 6) economical. These cover the benefits they gained from classroom management, pedagogy, and teaching development.

4.2.1. Enhanced Content Knowledge

By interacting with science comics, P3 perceived enhanced content knowledge. It provided P3 with a fresh and engaging way to make science lessons concise due to the short narrative of science comics. P3 found ways to simplify complex science concepts, presenting them as clearly as possible through the characters, dialogue, and related graphics. As P3 declared:

P3: *"I became more knowledgeable about the lessons, enabling me to make the content of science comics clear and concise."*

4.2.2. Encouraged Teaching Innovation

P1 stated that the use of science comics boosted innovation. P1 adopted it as an opportune supplementary teaching resource to support students' learning. It encouraged P1 to be innovative, allowing resonance between instruction and students. As P1 claimed:

P1: *"It helped and encouraged me to be more innovative in developing and using alternative, timely, and effective teaching tools for enhanced learning capacity of students."*

4.2.3. Effective Lesson Planning

P3 and P2 affirmed that integrating science comics made lesson planning more effective. It provided a versatile, engaging, supportive framework for P3 and P2 to plan their lessons. Incorporating it allowed P3 and P2 to integrate visual storytelling into their lessons, making science concepts more accessible and relatable to students. By leveraging the dynamic nature of science comics, P3 and P2 could tailor lessons to accommodate students' learning styles and abilities. As P3 and P2 shared:

P3: *"It enriched my lesson plan, making it more student-centered to suit the student's learning styles and abilities."*

P2: *"Using science comics helped my lesson planning to become effective. I could relate the concepts to the student's everyday lives."*

4.2.4. Better Classroom Management

A better classroom management was experienced by P2 in using science comics. P2 described that it was easier to handle the class since the students maintained minimal noise as they were focused on reading the science comics. It captured their attention and interest, minimizing off-task behaviors. It helped to manage students' behavior and promote a positive learning environment. P2 claimed:

P2: *"I managed the classroom better using science comics. Students were quiet because they enjoyed reading it. Even the students who had difficulty reading enjoyed it because of the pictures they saw."*

4.2.5. Thorough Discussions

The science comics enriched classroom discussions, as explained by P1. As a pre-service teacher undergoing a teaching internship, P1 indicated that it made the discussions more understandable and delivered more apparent lessons. P1 used it as an attractive springboard for thorough discussions due to the characteristics of science comics. P1 explained:

P1: *"Science comics were essential, especially for a novice teacher like me...it had helped me to teach the lesson more effectively, clearer, easier, and more consistently without or with little wasted time in the discussion...it helped make my discussions more understandable to the students because it is detailed, short to read, and has colorful and attractive graphics that aroused their interests."*

4.2.6. Convenient

P2 and P1 described science comics as very convenient to use. P2 said that it can be used standalone without other resources. P1 indicated that it is easily accessible and can be directly shared with students in several copies. Additionally, since it was printed on a few pages due to its concise contents, P1 shared that it was easy to carry and not cumbersome. As they mentioned:

P2: *"It can be used independently and does not need other materials or tools heavily."*

P1: *"It was easily accessible and can be given to each student during discussions. It was lightweight and easy to carry."*

4.2.7. Economical

P3, P1, and P2 found that using science comics was less expensive and economical. Without buying costly materials, P3, P1, and P2 saved significant money using science comics as educational materials. By just using laptops and printers to create science comics, P3, P1, and P2 were able to avoid higher expenses. As they asserted:

P3: *"I was able to save my allowance since I do not need to buy more school supplies to create it."*

P1: *"It was economical and faster than more expensive traditional educational materials... It only required bond papers, a computer, a printer, and no other costly materials."*

P2: *"It was less expensive since I did not need to buy other materials."*

4.3. Enhanced Teaching Skills in Developing and Using Science Comics

This third theme recounts the specific teaching skills the pre-service teachers enhanced or improved while developing science comics and using them as educational materials. As they affirmed, their enhanced teaching includes 1) creativity and artistry, 2) technological literacy, 3) instructional time management, and 4) storytelling skills. The science comics provided dynamic support among the pre-service teachers, evolving their pedagogical approach. This is aside from the other previously presented benefits they have gained in using science comics.

4.3.1. Creativity and Artistry

Improving creative and artistic skills was one of the significantly enhanced teaching skills experienced by the pre-service teachers. P2, P3, and P1 divulge that they became more creative and artistic in designing science comics. P3 indicated that considering the science comics' design, such as colors, characters, font styles, and symmetry, positively affected creative thinking. The same was valid with P1, where selecting vibrance, attractive colors, and graphics expanded designing knowledge. The pre-service teachers attested:

P2: *"I became creative in making science comics, especially when the students enjoyed reading them."*

P3: *"It enhanced my creative thinking in designing science comics. It brought out varied ideas when I was designing it. I must consider the colors, symmetry, pictures, characters, font styles, and other graphics I must include in the science comics designs."*

P1: *"I have learned and extended my knowledge of science comics by using appropriate, vibrant, and attractive colors and graphics that I have effectively used to teach science lessons."*

4.3.2. Technological Literacy

Technological literacy was another enhanced teaching skill experienced by the pre-service teachers in developing and using science comics. P2, P3, and P1 could use online resources and comics and graphic tools in designing science comics. They explored, demonstrated, and utilized digital tools and online comic generators for development and presentation. Through science comics, P2, P3, and P1 were additionally equipped with technological knowledge and skills. They have become more comfortable with technology, boosting their integration of diverse technologies.

P2: *"I created complex designs for my science comics with several graphics tools on my laptop and downloading from the internet."*

P3: *"I was able to explore several comic applications and software that I was not knowledgeable about."*

P1: *"In making science comics using my laptop, my computer knowledge was enhanced. I was also able to increasingly use online platforms in designing."*

4.3.3. Instructional Time Management

P1 had better time management when using science comics and ended the lesson promptly. P1 indicated that the science comics were used as teaching guides, optimizing instruction timetables. Since science comics were integrated into lesson planning, lesson delivery was easy to follow. Thus, it saved time allocation. P1 mentioned:

P1: *"Using the science comics strip in teaching, I can use the teaching time more appropriately because this material becomes my guide in teaching the lesson. I can easily follow the lesson's flow and save time allocated to each science lesson. I can teach and finish the lesson at the right time."*

4.3.4. Storytelling

The pre-service teachers improved their storytelling skills through the narrative structures of the science comics. P3, P1, and P2 acknowledged that the science comics provided a structured yet flexible medium for narrative development. They have to think critically about plot structure, character development, and pacing, allowing them to refine their ability to convey information compellingly. The visual aspect of the science comics also allowed them to use imagery effectively, enhancing complementary narratives. P2 mentioned the importance of using entertaining stories for prolonged capture of students' attention.

P3: *"It enhanced my storytelling skills."*

P1: *"Using the science comics strip, I have developed and improved my teaching narratively. This way, the student better understood the science lessons."*

P2: *"I enhanced my storytelling by using science comics. Since the students were young, the comics must have an entertaining story because if they do not, they will surely make noise and become out of focus."*

4.4. Challenges Experienced in Developing and Using Science Comics

This last theme presents the challenges experienced by the pre-service teachers in developing and using science comics. Amidst the benefits gained, the pre-service revealed their struggles regarding science comics. These challenges include: 1) lack of knowledge in using computer and digital platforms, 2) lack of knowledge in designing, 3) weak internet connection and signal interruption, 4) power interruption, 5) time-consuming, and 6) concise content.

4.4.1. Lack of Knowledge in Using Computer and Digital Platforms

The pre-service teachers expressed that they lack knowledge, familiarity, and experience in creating science comics. P1 struggled to design and select appropriate graphics due to inexperience using computers and online digital platforms. Likewise, P2 lacked familiarity, while P3 lacked experience in using designing tools and online comic generators. P1, P2, and P3 expressed that this affected the initial science comics they developed and used. As they declared:

P1: *"Due to my lack of knowledge of laptop usage and online digital platforms, I have trouble making science comic strips, especially in designing and selecting suitable graphics."*

P2: *"I was unfamiliar with using online comic generators and designing tools. This affected the first science comics that I made."*

P3: *"I lacked experience designing science comics. The same was true when using graphic tools and online generators. In a way, this affected the way I designed the science comics."*

4.4.2. Lack of Knowledge in Designing

P3 and P1 conveyed that a lack of knowledge and design affected their development of science comics. P3 reiterated the difficulty in finding a design that fits the lessons. P3 added that selecting comic templates for the design took much work. Similarly, the science comics' vibrance was affected due to mediocre design knowledge, as shared by P1. P3 and P1 cited:

P3: *"Finding a design appropriate to the lesson was hard. It was not easy to select designs and graphics that fit each topic. It was challenging to choose templates that were most properly suited based on each lesson."*

P1: *"An issue I have had with making science comic strips was poor design knowledge, affecting its vibrance."*

4.4.3. Weak Internet Connection and Signal Interruption

Having a weak internet connection in the locality significantly affected P1 and P2. Sometimes, P1 could not create science comics, while P2 experienced difficulty in downloading related visuals. Besides, P1 and P2 encountered troubles using online comic generators and graphic tools. P1 and P2 pointed out:

P1: *"Sometimes, I could not make science comics for my discussions because sometimes there was no signal or internet connection."*

P2: *"I needed a strong internet connection to download all the necessary files to create science comics. However, because I have a weak internet connection, it was hard to download, which makes it more difficult."*

4.4.4. Power Interruption

The frequent electrical power outages in the locality affected P1 and P3 in creating science comics. Since most power outages were abrupt and unannounced, P1 and P3 experienced recurring problems regarding downloading designs and templates and printing science comics. P1 could not continuously design science comics. It ensued P3 to use alternative educational materials due to inaccessible printing of copies.

P1: *"There have been many power interruptions affecting my laptop charging. So, I was not able to continuously design science comics."*

P3: *"Due to power interruptions, I could not print copies of the science comics I needed for the lessons. I had to resort to using other educational materials. Once I can print copies, I will still use the science comics in another lesson and relate to the past lessons."*

4.4.5. Time-consuming

P2 and P1 agreed that developing science comics is time-consuming. As a beginner, P2 specified that it took a longer time to design the science comics. P1 had to be patient, and it took longer to select relevant science visuals, graphic tools, and comic generators. P2 and P1 expressed:

P2: *"Since I was a novice at developing comics, it took much time to create the designs and dialogues."*

P1: *"It took a longer time to work with the designs. It required my patience to find suitable graphics and characters, especially since I needed to improve using graphic tools and comics generators."*

4.4.6. Concise Content

P3 and P2 argued that it was difficult to summarize and make concise lesson contents in science comics. P3 and P2 must consider developing brief stories and shortening the dialogues without sacrificing the science lessons. Since science comics consist of a few panels, P2 has to modify how the lessons are presented periodically. P3 and P2 declared:

P3: *"I struggled to make the science content concise in the science comics strip."*

P2: *"It is difficult to summarize and make brief stories and dialogues in the science comics. I had to adjust and modify the lessons to fit it in the few panels of the science comics."*

5. DISCUSSION

In using science comics as educational materials, the pre-service teachers observed significant advantages in their students' cognition and affection. It enhanced students' learning by combining visuals and narratives to make complex science concepts simpler, more engaging, and imaginative, leading to students' better understanding. As such, it substantially enhanced students' conceptual comprehension of scientific concepts, supporting Badeo et al. (2021), Fabillar et al. (2024), Fitria et al. (2023), Maulidah and Wulandari (2021). It effectively concretized abstract ideas using vivid visuals and relatable narratives, transforming science concepts into tangible representations. It contemplates that of Akcanca (2020), Bolton-Gary (2012), Lazarinis et al. (2015), Morel et al. (2019), and Topkaya (2016). The science comics could represent scientific principles through characters, scenarios, and visuals. This visualization helped bridge the gap between theoretical knowledge and real-world applications, making it easier for learners to grasp abstract concepts. This corresponds with Kolodii et al. (2017) and Veřmiřovský (2013). The designs, characters, backgrounds, and graphics simplified intricate scientific ideas, while the dialogues and storytelling created emotional connections that aid learning retention. As students connect emotionally with the characters and stories, they become more invested in the science lessons, leading to a richer educational experience.

The science comics heightened curiosity and elevated engagement by presenting scientific concepts in a visually appealing and entertaining format that engrossed and captured students' attention. Students were engaged with its vibrant illustrations and creative designs, mirroring Fitria et al. (2023), Listianingsih et al. (2021), Phoon et al. (2020), Spiegel et al. (2013), and Syarah et al. (2019). This prompted the students to inquire and explore the science lessons further, supporting Cheesman (2006), Fabillar et al. (2024), and Koutníková (2017). The blend of vibrant illustrations and relatable narratives of the science comics motivated students' reading to explore the science lessons more deeply, fostering a love for reading. The combination of visuals and concise content helped break

down complex scientific concepts, encouraging reluctant students to actively read and reducing their feelings of intimidation often associated with traditional science texts. This reading motivation is associated with Affeldt et al. (2018). This approach made students' learning fun and enjoyable and helped demystify science, making it more approachable and inspiring a desire to understand the world better. The fun and enjoyable learning depicts Astuti et al. (2014), Roswati et al. (2019), and Tatalovic (2009).

Using science comics encouraged students' active involvement, making learning more participatory during discussions. It created an interactive learning environment, empowering students to ask questions and express their opinions, fostering a sense of ownership over their learning. Students were able to discuss and share their thoughts on the science lessons. The students' active involvement echoes Bolton-Gary (2012). These students' benefits clearly show that the science comics contributed to students' scientific literacy. It encouraged critical thinking, prompting the students to analyze information and make connections, highlighting real-world applications and current scientific issues, and fostering a deeper awareness of scientific inquiry and its relevance in everyday life. The students' comprehension of scientific issues bespeaks Bolton-Gary (2012), Farinella (2018), Fitria et al. (2023), and Listianingsih et al. (2021). Overall, it cultivated more informed students, ultimately contributing to greater scientific literacy.

The teaching benefits acquired by the pre-service teachers in developing and utilizing science comics were diverse. They enhanced their content knowledge, enabling them to present complex scientific concepts in science comics concisely. They could simplify intricate scientific ideas in a visually engaging and easily digestible manner. They could look for ways to easily convey scientific information through the science comics' characters, background, dialogues, and overall design, promoting students' better understanding. This accentuates Senturk and Cicek Senturk's (2023) observation of pre-service teachers' thought expressions and their permanent learning as determined by Akcanca (2021). Using science comics encouraged teaching innovation by inspiring the pre-service teachers to adopt creative and diverse educational materials. The alternative use of science comics underpins Senturk and Cicek Senturk (2023). Its visuals and narrative aspects prompted them to think outside traditional teaching methods, integrating multimedia resources and storytelling techniques to engage their students. As the pre-service teachers explored science comics, they discovered new ways to aid their students' students' enriching professional development.

Incorporating science comics into lesson planning significantly impacted the design and delivery of lessons, encouraging the pre-service teachers to think creatively about science content presentation. It served as a lesson framework, guide, and engaging entry points to complex science topics, allowing them to structure science lessons around visual storytelling. This makes science comics an effective educational strategy in agreement with Aulia and Hidayati (2023), Fabillar et al. (2024), Fianto et al. (2023), Maulidah and Wulandari (2021), and Tribull (2017). It facilitated the integration of interdisciplinary approaches, blending art, literacy, and science, which led to more dynamic and interactive lesson plans. Moreover, it provided differentiated resources to meet varied students' learning styles, making it easier for the pre-service teachers to create inclusive lessons that resonate with all their students.

Science comics significantly improved the pre-service teachers' classroom management by providing an engaging and interactive educational tool that captured students' attention and lessened disruptive behaviors. The stories and visuals of the science comics kept their students focused and understanding the material, creating more meaningful discussions. This approach supports the observations of pre-service teachers among their students in relation to Akcanca (2021). Through the science comics, their students were encouraged students to express their thoughts and ask questions, supporting students' constructivist approach to learning as described by Jones and Brader-Araje (2002) and Singh and Yaduvanshi (2015). It fostered more interactive dialogues, as

their students could easily reference specific panels or storylines to support their points. It served as a springboard for exploring diverse perspectives and real-world applications of science, promoting their students' critical thinking and deeper understanding. By integrating science comics into their discussions, the pre-service teachers created a more dynamic and inclusive learning environment where their student feels empowered to contribute.

Using science comics in the classroom was very convenient among the pre-service teachers. Due to its condensed characteristics, they could reproduce several copies and distribute them among their students individually. Since it also consisted of a few pages, it was very practical. Consequently, science comics are versatile teaching tools that can be incorporated across various subjects and grade levels, making them adaptable to different curricula. They can serve as icebreakers, discussion starters, or supplementary materials, saving time in lesson preparation. It was economical for the pre-service teachers because it is a cost-effective resource that can convey scientific ideas without expensive materials or school supplies. Many templates, designs, and visuals related to science comics are free, making them readily accessible. Some online comics generators offer free access. Additionally, their reusable nature allows the incorporation of the same comics across multiple lessons and grade levels, maximizing their investment. It can also reduce the time and resources spent on re-teaching complex concepts. The science comics' convenience and affordability supplement the observations of Akcanca (2021), Craciun and Bunoiu (2017), and Senturk and Cicek Senturk (2023). Generally, the affordability and convenience of science comics make them a smart choice for budget-conscious teachers.

The pre-service teachers have also gained enhanced teaching skills. Similar to teaching innovation, using science comics enhanced the pre-service teachers' creative and artistic skills, consolidating Senturk and Cicek Senturk (2023). It encouraged them to think outside the box and use a variety of designs, graphics, and other visuals to make the science comics catchier and more vibrant. The inherent visuals prompted them to consider how illustrations, layouts, and dialogues can complement the science concepts, inspiring them to develop unique lessons that incorporate various artistic elements. The pre-service teachers' technological literacies were also enhanced. They explored online resources, comics generator, graphic tools, and other platforms. They gained hands-on experience with technology, which helped them become more comfortable and proficient in using digital media for comics. It encompasses enhanced TPACK in correspondence with Bilici et al. (2013), Bwalya and Rutegwa (2023), Craciun and Bunoiu (2017), Kiray (2016), Mishra and Koehler (2006), and Koehler et al. (2013). Furthermore, by leveraging technology to create engaging science comics, pre-service teachers can model digital literacy skills, preparing them for a future where technology plays an increasingly vital role in education and beyond.

The science comics positively affected the pre-service teachers' instructional time management by serving as a guide and streamlining lesson delivery. It helped them to maximize time allocation while maintaining an engaging learning environment. The narratives of science comics sequentially outlined vital ideas and processes, helping the pre-service teachers and their students follow along and understand the flow of scientific information. This is due to the comics' logical format in general, as described by Akcanca (2020) and Kunzle (2024). The science comics enhanced pre-service teachers' storytelling skills, encouraging them to craft narratives embodying engaging story plots. The blend of visual elements and text in comics challenged the pre-service teachers to think creatively about how to present information compellingly, helping them develop a more dynamic storytelling approach. It manifests the narrative structure of comics as described by Kunzle (2024) and Lazarinis et al. (2015). This practice allowed teachers to experiment with tone, pacing, and character development, making scientific content more relatable and memorable for students.

Conversely, the pre-service teachers have encountered challenges in developing and using science comics. One problem was their lack of knowledge of computer and digital platforms. It is similar to

the observations of Senturk and Cicek Senturk (2023). Their inexperience caused hindrances in the way they designed the science comics. It limited their ability to leverage computers and digital tools that streamline the science comic-making process. Initially, they struggled to produce visually appealing science comics but significantly improved once they became familiar. The lack of knowledge in designing science comics also impacted the pre-service teachers' creation of science comics. This is comparable to the findings of Akcanca (2021). At first, they could have been more profound in selecting suitable visuals related to the science topics. With a lack of understanding of design principles such as layout, color combinations, and character selection, they have struggled to create visually appealing comics, which may hinder student engagement. However, after familiarizing themselves with graphic tools and online resources, the pre-service teachers were able to develop better science comics.

The pre-service teacher found creating science comics time-consuming, supporting Senturk and Cicek Senturk (2023). They found it labor-intensive due to the multifaceted process involved, including researching content, developing narratives, and creating visuals that accurately represent scientific concepts. This was especially for those who had yet to gain experience with designing or creating science comics. The pre-service teachers experienced challenges in making the science comics' content concise. They have trouble making short narratives and using only a few panels, considering that scientific concepts can be inherently complex and multifaceted, making it difficult to distill essential information into brief, impactful visuals and text. With the succinct structure and characteristics of comics described by Kunzle (2024), presenting nuanced explanations to convey scientific meaning fully is relatively difficult.

A weak internet connection significantly obstructed the pre-service teachers' creation of science comics. It limited their access to essential online resources and tools facilitating the design process. They have struggled to download visuals and use graphic design software, which stalled their progress. Frequent, unannounced power outages in the locality significantly affected the creation of science comics. It interrupted the use of computers and printers for design and production. The interruption halted their creative process in relation to weak internet connections, forcing them to pause and delay their work and potentially use alternative educational materials. Experiencing weak internet connection, signal interruption, and power outages is inherent in the locality, as reflected in Bawingan et al. (2024) and the report of the Department of Energy (2024). It is likely affected by a lack of electrical resources, weather conditions, equipment failures, and maintenance works.

6. CONCLUSION, LIMITATIONS, AND RECOMMENDATIONS

Science comics are unique and innovative educational materials that combine visual art with scientific concepts, making complex ideas more accessible and engaging. It has gained popularity as a teaching resource, sparking students' curiosity about scientific phenomena. They are increasingly being embraced by pre-service teachers as a versatile tool for their teaching internship to enhance their instruction and pedagogy. As established in this study, the pre-service teacher participants' use of science comics offered a glimpse of the advantages and inconveniences they experienced. They shared observations regarding the benefits of using science comics in teaching their students. Their students were engaged and enjoyed learning, leading to better learning and scientific literacy. The study uncovered that the pre-service teachers perceived science comics as affordable and favorable, valuable in lesson planning, classroom management, and discussions, and beneficial for their knowledge and teaching innovation. Further, the pre-service teachers enhanced their teaching skills regarding technological literacy, instructional time management, storytelling, creativity, and artistry. On the other hand, they have expressed that they found creating science comics time-consuming and had difficulty making concise content. They also struggled due to their lack of knowledge of computers and design skills. Their creation of science comics was further hindered by weak internet connection and power interruption.

Despite the problems, the pre-service teachers have positively integrated science comics as educational materials. They were able to extend scientific concepts, effective teaching practices, pedagogical skills, and professional training and development. The science comics equipped them with effective strategies to simplify and communicate scientific ideas. It helped them develop essential skills in content simplification and narrative construction, making them more adept at creating engaging science lessons. Comprehensively, by integrating science comics into their teaching internship, the pre-service teachers cultivate a more dynamic and inclusive approach to education to create dynamic learning environments, preparing them to inspire curiosity and enthusiasm among future students.

Although, it must be noted that the results of this study only reflect those of the pre-service teacher participants. The study's findings do not directly relate to the experiences of other pre-service teachers, particularly those who used or will use science comics in their teaching internship. The study also involved a very small number of participants. It does not contemplate and generalize a larger pre-service teacher population. The construct of the practice teaching must also be considered. Though it might be similar to other academic institutions, the unique structures and conditions of the local university and the cooperating school where the pre-service teachers were deployed must be taken into consideration. Nonetheless, the researchers recommended that teacher education programs actively incorporate science comics into their curriculum and training as innovative tools to enhance pre-service teachers' understanding of scientific concepts and improve their science instructional practices. Lastly, further research regarding the development and use of science comics among pre-service teachers is suggested.

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