A comparative analysis of video and book-mode comics in enhancing science classroom learning attainments

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Abstract
This study was aimed at assessing and comparing the effectiveness of integrating book- and video-mode comics as instructional tools in a resource-constrained English Second Language (ESL) primary science classrooms. In the context of a true experimental design, the research conducted pre-tests and post-tests on a control group and two experimental groups in each participating school. This investigation spanned four schools in Namibia's Omusati region, involving a total of 178 Grade 4 learners. The quantitative analysis of the data employed Mixed Model ANOVA Type III. The investigation was examined within the theoretical framework of Social Learning Theory because the video and book comics at the core of this study were shaped by Bandura's symbolic model of observational learning. The findings of the study uncovered a statistically significant difference in Grade 4 Science learning outcomes between learners exposed to video-mode and book-mode comic instruction compared to those taught through traditional methods. Despite resource constraints, the implementation of both comic modes proved advantageous in enhancing science education. Intriguingly, there was no statistically significant difference between the two comic modes, even though the mean score for the video-mode comic group surpassed that of the book-mode comic group. This suggested that both book-mode and video-mode comics were equally effective in improving science learning outcomes among the grade 4 learners. These results emphasised the potential of leveraging comics as instructional tools in ESL science education, particularly in settings with limited resources. The implications of these findings extend beyond the local context, offering guidance for educators and policymakers seeking innovative and accessible approaches to science education. The participants in this study recommend that universities should integrate comic courses into their curriculum, partnering with international experts. The Ministry of Education should allocate resources for comic materials and technology. In-service training and regional workshops are needed to equip teachers, with senior education officers leading local training. Community awareness programs can also promote involvement in the comic industry.

Keywords: *efficacy, video-mode comics, book-mode comics, symbolic modelling, instruction, science education, traditional methods*

Background

The academic performance of Grade 4 learners in the Omusati region, particularly in science, has been consistently below average in regional examinations between 2018 and 2021 (Omusati Regional Advisory Services, 2018, 2019, 2020, 2021). This grade assumes significance as it marks the transition to English as the medium language of instruction, presenting unique challenges in adapting to new cognitive demands and linguistic shifts (Evans & Nthulana, 2018). Boateng (2019) suggests delaying the language transition to alleviate potential negative impacts on learning achievements. Teaching science in Grade 4 is intricate due to the abstract nature of scientific concepts (Evagorou et al., 2015). The brain's cognitive processes involved in conceptual change are crucial, where existing cognitive abilities are repurposed to comprehend novel scientific ideas (Chi et al., 1994). However, the shift from the mother tongue to English as the medium of instruction poses challenges, impacting reading comprehension and hindering the understanding of abstract scientific content (Hazari, 2012). Williams et al. (2018) emphasise the importance of diverse forms of written discourse in Science, Technology, Engineering, Arts and Mathematics (STEAM) disciplines, necessitating effective reading and listening comprehension strategies. To address these challenges, innovative teaching strategies, especially utilising visual aids, are essential (Lee & Kim, 2015). The implementation of comic-based instructions proves promising, as comics have shown to improve learning outcomes, foster creativity, and motivate learners (Marianthi et al., 2008). However, there is a gap in comprehensive studies on comics in the African context, including challenges in

poorly resourced classrooms and disparities between video- and book-mode comics.

This study aimed to investigate the impacts of video-mode and book-mode comic instruction on learning outcomes in Grade 4 science classrooms, addressing the need for a thorough examination of the integration of comics into Bandura's Social Learning Theory. It emphasised the importance of government and regional support for comic-based methods in Namibian schools, particularly in under-resourced science education settings, to enhance English proficiency and academic performance in Science at the Grade 4 level. The study also highlighted the necessity for further research to bridge existing gaps and comprehensively understand the potential of comic-based instructions in ESL science classrooms.

Research questions

The study was based on the following questions:

1. What are the effects of video-mode comics on the learning attainment of Grade 4 Science learners?
2. What are the effects of book-mode comics on the learning attainment of Grade 4 Science learners?
3. What are the differences in the effects of video-mode and book-mode comics on the learning attainment of Grade 4 Science learners?

Hypothesis

The study tested the following hypothesis:

- Teaching that uses video- and book-mode comics has a greater effect in an urban primary school with an English medium of instruction than in an urban primary school with a mother tongue medium of instruction.

Theoretical framework

Albert Bandura, a prominent Canadian-born American Psychologist (1925-2021), significantly impacted global perspectives on teaching and learning through his pioneering work, especially in the realm of Social Cognitive Theory. Bandura is acclaimed as the originator of this theory, with his influential "bobo-doll" experiment showcasing how children learn by observing adults (Nolen, 2022). In this experiment, children imitated violent behaviour after witnessing an adult subject an inflatable toy to physical and verbal abuse. Beyond the “Bobo doll” studies, Bandura's contributions extend to observational learning, self-efficacy, and social learning theory (Kendra, 2020). This study is rooted in Bandura's Social Learning Theory, emphasising observational learning and self-efficacy. According to Bandura, learning occurs through direct social interaction or indirect means, including learning through social networks.

This study delves into teaching and learning with comics within the context of Bandura's theory. It suggests that teachers, instead of relying solely on scaffolding and drilling techniques, should act as facilitators while learners and comic characters lead the learning process. Bandura's work outlines three fundamental models of observational learning: the live model, verbal instructional model, and symbolic model, with the latter involving instances where characters within various media exhibit behaviours (Kendra, 2019). In the context of comics in education, the symbolic model becomes significant, indicating that observational learning isn't strictly dependent on direct witnessing; individuals can acquire knowledge through reading, hearing, or watching characters' actions in books and films (Kendra, 2019). Symbolic modelling is exemplified through cases where individuals display accurate actions in activities, they haven't directly experienced but have observed in media, emphasising the influential role of observational learning in acquiring knowledge and skills (Kurt, 2019).

Bandura's Social Learning Theory, distinct from theories based on direct conditioning, reinforcement, and punishment, finds its niche in explaining how individuals learn and acquire skills. The study aims to explore the synergistic potential of the Social Learning Theory (SLT) along with elements of cognitive development theory, emphasising the value of this partnership within the research context.

Literature Review

Different types and elements of comics

Comic literacy is crucial for educators and learners involved in educational activities that use comics. It requires a comprehensive understanding of the structural composition of comics, the differences between book and video comics, and familiarity with their key elements. (Poai, 2018; DifferenceEngine, 2018). IvyPanda (2020) clarifies that both books and motion pictures function as storytelling mediums, captivating readers and viewers with

the utilisation of characters. Nevertheless, the fundamental difference lies in the degree of effort involved in their creation (Wijaya et al., 2021). The author's meticulous endeavours to create a thoroughly detailed book exceed the comparatively effortless manner in which an actor communicates the message in a movie. The current study centres around a comic book comprising nine comic strips addressing specific sub-topics within Natural Science. These strips, categorised into picture and text-picture comics, took one week for book-mode comics and two days for video-mode comics to create.

Picture comics predominantly rely on visuals, while text-picture comics incorporate words and images within speech balloons to effectively present information (Zhao & Mahrt, 2018). Novice readers find text-picture comics more accessible than purely picture-based comics, which demand a higher level of graphical literacy (DifferenceEngine, 2018). Educators utilising comic instruction should familiarise themselves with comic mechanics to enhance their comprehension of comics and contribute to improved academic outcomes among learners.

The essential elements of comic strips, as highlighted by Poai (2018) and further elaborated by DifferenceEngine (2018), include pictures, panels, lettering, balloons, and borders. Pictures convey characters' appearances, actions, and facial expressions, while panels provide the structural framework for presenting all other elements within the comic strip. Lettering or captioning is crucial in setting the stage and guiding the reader's understanding of forthcoming events (Wijaya et al., 2021). In dialogue, speech bubbles with straight-pointed edges are employed for verbal communication, while those with bubble-edged contours convey characters' thoughts. Borders, comprising the lines that enclose panels, balloons, and dialogues, define the boundaries and organisation of the comic strip (DifferenceEngine, 2018; Wijaya et al., 2021). These elements collectively create a cohesive comic strip, effectively communicating messages and information to readers.

The study integrated Bandura's Social Learning Theory, emphasising the significance of observation, imitation, and modelling as effective learning modes (Kendra, 2022). Overall, the study aimed to explore the synergistic potential of the Social Learning Theory along with elements of cognitive development theory, elucidating the value of this partnership within the research context. In contrast to existing frameworks by Wijaya et al. (2021) and DifferenceEngine (2018), Akcanca (2020) introduces a distinct set of five elements for book-mode comics: language, time, theme, graphics, and characters. Characters in book-mode comics encompass central and secondary figures, embodying diverse identities (Tuncer, 1993; Avarogullari & Mutlu, 2019). The language used in book-mode comics aligns with everyday vernacular, positively impacting learners' learning experiences (Krashen, 1993). Speech bubbles convey different vocal qualities, reinforcing the language element. Time in book-mode comics allows readers to navigate the narrative temporally, discerned through visual cues like clothing styles (Akcanca, 2020). The theme represents the contextual backdrop corresponding to a specific educational level (Lazarinis et al., 2015).

In video-mode comics, two formats, live-action and animated videos, are described explicitly (Champoux, 2005; Smith et al., 2012; Hooks, 2019; Suto, 2022). Live-action videos feature real individuals, grounded in tangible locations, while animated videos employ static images or programmed sequences (Hooks, 2019). Animated videos are further categorised into 2D or 3D with text-to-speech or human voices (Hooks, 2019; Suto, 2022). Stop-motion animation records object movement frame by frame, creating the illusion of motion (MasterClass, 2021). Live-action videos, chosen for this study, involved two characters in mascot costumes, providing a humorous and engaging learning experience (Hooks, 2019). Clarifying the distinction between comics and cartoons, the term "video-mode comics" is employed for live-action videos (Khan, 2021). While the terms are sometimes used interchangeably, a distinction is made, considering a cartoon as an animated visual with sound and a comic as a written, printed format (Khan, 2021). "Video-mode comics" are justified by these videos being amusing and educational, aligning with the humorous and entertaining aspects of comics (Harcourt, 2010).

Educators' solid understanding of comics and their elements, including the distinct characteristics introduced by Akcanca (2020), enhance their ability to use comics as a teaching medium and develop comic literacy. This knowledge allows educators to navigate the effectiveness and limitations of comics, fostering a clearer grasp of the subject matter. The subsequent section delves into the considerations for creating comics in science

education.

Characteristics of comics in science education

As highlighted by Akcanca (2020), three crucial attributes—humour, visualisation, and contextualised learning—play a significant role in the realm of science education through comics. Humour, according to Ozdemir (2017), creates a relaxed learning environment, alleviating stress associated with complex scientific concepts. While Gorham and Christophel (1990) indicate no direct correlation between humour and retention, Ozdemir (2017) suggests that heightened attention resulting from humour may indirectly enhance content retention. The second pivotal characteristic is visualised learning, contingent on learners possessing visual literacy skills (McVicker, 2018). Visualised learning implies effective comprehension of subject matter through visual means, aligning with the contemporary prevalence of digital content. McVicker (2018) deems visualised learning akin to language arts standards and a fundamental element for grasping the essence of comics.

Contextualised learning, elucidated by De Jong et al. (2008), stands as another crucial aspect, fostering the connection between classroom learning and real-world events. This connection stimulates learner interest, enhances content comprehension, and cultivates critical thinking skills. Understanding these attributes is instrumental in deepening comprehension and improving the implementation of comics in science education. Subsequently, the following section explores the utilisation of comics as a teaching and learning medium after an exploration of the essence and composition of comics.

The use of comics as teaching and learning media

The exhaustive examination of literature on diverse comic formats and their constituent elements provides a robust foundation for an in-depth investigation into the integration of comics within educational contexts. Notably, comics emerge as particularly well-suited tools for enhancing science education due to their inherently self-explanatory nature, surpassing many other instructional tools (Syslak, 2020). The majority of studies reviewed indicate a statistically significant positive impact of comics on learning outcomes. While the impact of comics is widely acknowledged, the specific distinctions between video and book comics remain unexplored (Jang & Park, 2014; Rokhayani & Utari, 2014; Panjaitan et al., 2019; Soewardini et al., 2019).

For instance, Al-Rabaani and Al-Aamri (2017) conducted a study on the influence of cartoons on water-related awareness among Omani Grade 4 learners in social studies. The findings revealed noteworthy differences in performance between the experimental and control groups, with the experimental group exhibiting a preference for comics in social studies lessons. Similar positive opinions were observed in studies by Marianthi et al. (2008), Hosler and Boomer (2011), Trnova et al. (2013), and Harahap and Bukit (2020) consistently indicating that learners perceive comics as effective tools for addressing misconceptions across various subjects, enhancing academic performance, and fostering positive attitudes. In the domain of science education, comics have proven beneficial in diverse contexts. Koutnikova's (2017) project affirms their efficacy in teaching Natural Studies, while Dalacosta et al. (2009) highlight the significant improvement in learners' knowledge and comprehension of science concepts facilitated by video-mode comics. The relationship between reading book-mode comics and creativity is underscored by Jang and Park's (2014) study. Da Silva et al. (2017) argue for the pivotal role of book-mode comics in cultivating reflective practice and nurturing creativity.

Comics extend their utility beyond specific subjects, with Panjaitan et al. (2019) asserting their feasibility and suitability for teaching Ecology. Noteworthy is the assertion by Spiegel et al. (2013) that comics can captivate learners who may not have previously shown interest in science education, motivating them through interactive and relatable content. This motivational aspect is corroborated by Syarah et al. (2019) and Rahayu et al. (2021), who emphasise the active engagement fostered by comics through interactive and real-life connections. Zhang-Kennedy et al. (2016) argue for comics as instrumental tools in enhancing comprehension and changing behaviour, particularly in cybersecurity education. Lin et al. (2015) and Nashir et al. (2021) stress the communicative potential of comics, establishing effective channels that promote active learner engagement within the classroom. As per Awe (2007), Amakali (2017), and Haimbangu (2018), it is evident that the implementation of learner-centred approaches in Namibia faces challenges. Comics emerge as

a potential solution to address this predicament. Additionally, Lee and Kim (2015) observe that comics can facilitate self-study methods and reading guidance plans, and Maryani et al. (2019) found evidence supporting the positive impact of comics on narrative writing skills.

However, amidst these benefits, concerns have been raised regarding the potential negative impact of comics on literacy and education (Kachorsky, 2022). Historical criticisms, particularly those by Wertham in the 1940s, have contributed to reservations about the educational value of comics. Teachers, as highlighted by Avarogullari and Mutlu (2019) and Muyassaroh et al. (2019), face challenges such as the inability to draw comics and a need for access to technological devices. Nevertheless, this is countered by recommendations for comic creator software and a balanced view that technology, including comics, should complement rather than replace teachers (Artigliere, 2016; Meyers, 2014; Shively, 2011; Dejanovic, 2021). In conclusion, the synthesis of literature underscores the multifaceted role of comics in education, particularly in science. While acknowledging the historical concerns and modern challenges associated with comics, it becomes evident that the artistic components foundational to comics are invaluable in teaching and learning, contributing to the emergence of STEAM (Science, Technology, Engineering, Arts, and Mathematics) as a holistic educational approach.

Art and Science as part of STEAM

Traditionally, art and science were often perceived as distinct disciplines, with science being prioritised as an essential competency for future preparation, while art was considered a supplementary skill (Eisner & Powell, 2002). However, Eisner and Powell (2002) argue that these subjects are inherently complementary, addressing emotional and factual knowledge aspects, respectively. The emergence of STEAM education, encompassing Science, Technology, Engineering, Arts, and Mathematics, signifies a paradigm shift, recognising the synergy between arts and sciences for holistic education (Setiawan & Saputri, 2019). Barks (2020) contends that the arts and sciences share fundamental creative practices, such as imagination and reflection. STEAM education, according to Barks, provides a platform for learners to make sense of scientific phenomena, moving away from rote learning to fostering creative thinking (Soroko et al., 2020). Soroko et al. (2020) emphasise STEAM's role in motivating learners and nurturing creative thinking abilities, integrating Information, Communication, and Technology (ICT) and various art forms into science learning. Perignat and Katz-Bvonincontro (2019) support this, highlighting how STEAM education enhances creativity and thinking skills.

Setiawani and Saputri (2019) add that STEAM education enriches learners' emotional and spiritual aspects, fostering academic excellence and overall personal growth. These positive attributes underscore that incorporating art into science education aligns with the competencies needed in the era of the Fourth Industrial Revolution (IR4.0) (Shatunova et al., 2019). As Kim et al. (2019) assert, STEAM education is a practical approach to address diverse learner needs in the classroom. Considering the formulation of STEAM and its alignment with comics, it is evident that schools integrating comic instruction are more likely to achieve STEAM objectives (Shatunova et al., 2019). Teaching science through comics involves integrating art into science education, a fundamental aspect of STEAM. Both STEAM and comics contribute to enhancing learners' creativity and critical thinking, addressing challenges in understanding complex science concepts (Shatunova et al., 2019).

Methodology

The study employed a true-experimental design with various randomised pre-test and post-test intervention methods, including an equivalent group design (Handley et al., 2018; Bevans, 2023). True experimental designs involve subjecting participants to distinct treatments and assessing their effectiveness through performance comparisons in randomly assigned groups (Reichardt, 2009; Bevans, 2023). This research aimed to investigate the impact of video-mode and book-mode comics on science teaching and learning in four schools, employing Analysis of Variance (ANOVA) to ensure initial comparability among groups in essential syllabus competencies. The three-way ANOVA examined statistically significant differences in average competency levels at the project's outset, considering school, group, and time as fixed factors and participant as a random factor. To assess the impact of comic interventions, Least Significant Difference (LSD) post hoc tests were conducted for pairwise mean comparisons, examining statistically significant differences in average

competency levels between experimental groups and the control group in the post-test. Cohen's d effect size measures were computed to determine the practical importance of the results, classifying gains as having small, medium, or large practical importance (Diener, 2010; Cohen, 1988). Researchers were cautioned about interpreting p-values and deliberating on significance thresholds (Amrhein et al., 2019). The study focused on the entire population of 200 public primary schools in the Omusati region, utilising purposive sampling to select four schools purposefully and explore causal relationships between variables (Babbie, 2010; Crossman, 2019). The purposive sample comprised rural village and town schools, representing diverse contexts with differing challenges and resources. Using purposive sampling, I selected a primary school in an urban environment that used English as the medium of instruction and another primary school in the same environment that used the mother tongue as the medium of instruction. The choice of schools from contrasting contexts ensured comprehensive representation of primary schools in Omusati region, Namibia, making findings potentially applicable to other Namibian regions due to similarities in language, culture, socio-economic conditions, and environmental factors across the '4 O-regions', as referred to Omusati, Oshana, Ohangwena and Oshikoto regions.

A total of 178 fourth-grade learners from both genders were selected based on class group assignments, contributing to experimental and control groups. Learners were allocated to their groups from each class in the following manner: For example, in Grade 4A, the first learner on the list was assigned to Group A (Book Mode), the second learner to Group B (Video Mode), and the third to Group C (Traditional Method). This process continued until all learners were assigned, and the same method was applied to other class groups. The study commenced with the selection of relevant topics from the Grade 4 Science syllabus, and Grade 4 Science teachers actively participated in discussions to determine optimal content presentation methods. A book-mode comic was created, with teachers significantly contributing to the integrated content. The selection of topics aligned with the regional year plan, ensuring adherence to prescribed content and timing (Table 1). No specific criteria were set for topic selection, emphasising the belief that all curriculum topics could be effectively taught using comics.

Table 1: Part of Grade 4 Natural Science and Health Education Syllabus

Topic 3 Matter and environment	
3.3 Matter	
• **Understand that everything around us can be divided into matter and non-matter and that matter can be classified into living and non-living matter.**	• define the term matter • outline the difference between matter and non-matter (for non-matter only restricted to heat, light and sound) • recognise non-matter as a form of energy (with reference to Topic 4) • classify matter into living and non-living groups

The study focused on Grade 4 topics like heat, light, and sound, utilising a series of comic strips aligned with syllabus sub-topics (Figure 1). A pilot test in primary school S5, which did not take part in the study, followed by adjustments and expert validation, ensured the suitability of the comic book for intervention. The expert validation team consisted of senior teachers and Senior Education Officers specialising in Natural Sciences from various regions and schools. A Grade 4 Science teacher, independent of interviews or comic production, reviewed the book-mode comics. In video adaptations (Figure 2), the teacher portrayed character Muna, and the researcher portrayed Mega, representing a male-female contrast. While book-mode comics underwent a separate piloting phase, video-mode comics, adhering to the same script, were expected to possess similar potential efficacy if the former proved effective.

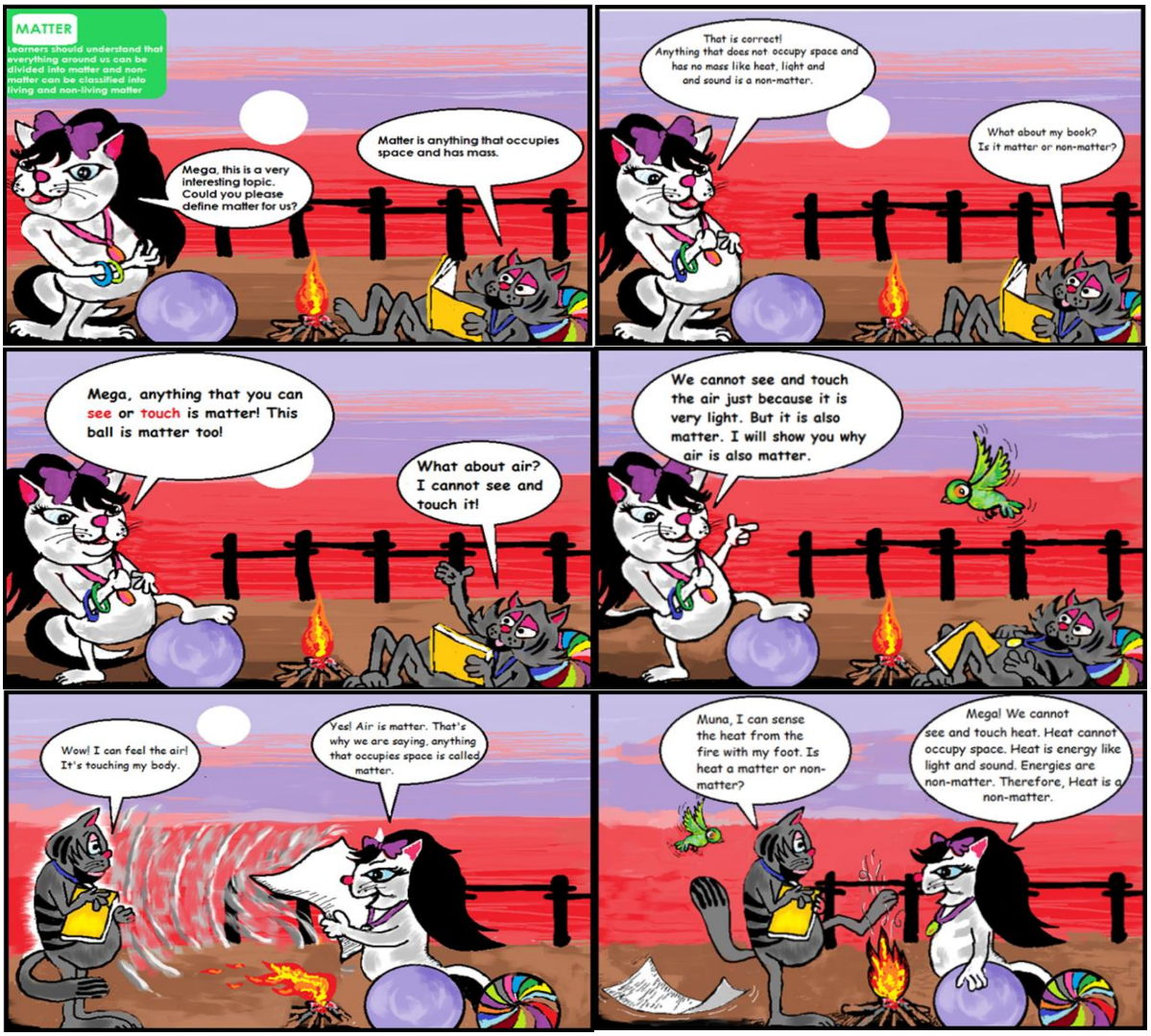

Figure 1: Examples of comic strips from a comic book Mega & Muna

Figure 2: Snapshots from the video-mode comics showing the characters (Muna and Mega)

Results

The research design incorporated a pre-test and post-test framework to investigate the impact of comics in video and book modes on learning achievement within three distinct groups (A, B, and C) across each of the four schools. Group A was instructed using book-mode comics, Group B through video-mode comics, and Group C

served as the control group, receiving instruction through traditional teaching methods. Learners in the book-mode and video-mode comic groups worked independently, without direct teacher guidance, while the traditional method groups were taught by teachers using standard instructional techniques. Teachers distributed materials or operated equipment but did not actively intervene in the learning process for the comic groups. All learners were provided with pencils and notebooks but were not instructed to write summaries or participate actively. Book-mode learners worked at their own pace, while video-mode and traditional groups followed the pace set by the television or their teachers. After 90 minutes, learners were given 15 additional minutes to engage with the material before applying what they had learned.

Finding 1: This study found a statistically significant disparity in Grade 4 Science learning outcomes among learners who were exposed to video-mode and book-mode comic instruction in comparison to their counterparts who received instruction through traditional teaching methods.

Table 2: ANOVA results

	Sum Sq	Mean Sq	Num DF	Den DF	F value	p-value
School	3170.85	1056.95	3	166	17.90	<0.01
Group	146.64	73.32	2	166	1.24	0.29
Time	9775.40	9775.40	1	166	165.57	<0.01
School*Group	151.75	25.29	6	166	0.43	0.86
School*time	443.16	147.72	3	166	2.50	0.06
Group*time	1494.41	747.20	2	166	12.66	<0.01
School*group*time	346.85	57.81	6	166	0.98	0.44

The data in Table 2 indicates a significant interaction between the group-by-time effect, suggesting that the change in pre-test to post-test results varied across groups. This change was more pronounced in experimental groups (A and B) compared to the control group (C), as illustrated in Figure 3. Table 3 outlines observed distinctions among the groups, highlighting statistically significant differences in post-test scores between Group C and Groups A ($p=0.03$) and B ($p<0.01$). These findings align with Figure 3, reinforcing the substantial impact of both video-mode and book-mode comics on learning outcomes in science. This positive impact corroborated the work of Al-Rabaani and Al-Aamri (2017), who found statistically significant differences favouring the experimental group in Omani Grade 4 learners regarding water awareness.

Similar positive impacts have been observed in various studies (Marianthi et al., 2008; Hosler & Boomer, 2011; Trnova et al., 2013), indicating that comics effectively rectify misconceptions and enhance academic performance across subjects like ecology, mathematics, and English (Koutnikova, 2017; Panjaitan et al., 2019; Soewardini et al., 2020; Harahap & Bukit, 2020). These collective findings suggest that comics could address underperformance in Grade 4 Science classrooms. Crafted to align with syllabus objectives, the comics conveyed subject matter comprehensively without direct teacher involvement. Group A engaged with book-mode comics, and Group B with the video-mode version. Both modes facilitated conceptual change, illustrated through an experiment demonstrating that air is matter. The comics effectively conveyed abstract concepts related to fundamental particles of matter and their arrangements, fostering engagement and reinforcing a learner-centred pedagogical approach. The positive post-test results affirmed the efficacy of comics in enhancing science comprehension.

The study's findings aligned with Social Learning Theory (Bandura, 1971), indicating that comics, as symbolic representations, effectively conveyed abstract science concepts in the teacher's absence. While supporting Sari's (2018) perspective on the partial role of comics in replacing the teacher, the study does not advocate for complete exclusion of teachers, acknowledging their multifaceted roles. Comics, both video-mode and book-mode, serve as autonomous tools for content delivery, allowing teachers to focus on broader aspects like classroom management. Comics' alignment with the Namibian education reforms emphasising learner-centred learning is evident, as learners interacted independently with comics, resulting in improved outcomes

compared to traditional methods. Comics prove valuable in scenarios like online learning during pandemics or teacher shortages, offering a learner-centred approach. The effectiveness of comics in motivating and engaging learners, even without direct teacher involvement, positions them as a viable solution to challenges in the Grade 4 Science classroom (Awe, 2007; Amakali, 2017; Haimbangu, 2018).

Finding 2: This study revealed that there were no statistically significant disparities in Grade 4 Science learning outcomes between learners exposed exclusively to video-mode comic instruction and those solely exposed to book-mode comics. Despite the absence of statistical significance, it is noteworthy that learners exposed to video-mode comics demonstrated higher learning outcomes compared to those exposed solely to book-mode comics. The primary aim of this study was to determine whether a statistically significant difference existed between video-mode and book-mode comics regarding their impact on learning outcomes. Table 3 illustrates statistically significant levels for both book-mode comics ($p=0.03$) and video-mode comics ($p<0.01$), showing a substantial difference compared to the control group's post-test results. Although video-mode comics resulted in a more considerable increase in learning outcomes than book-mode comics, the difference in post-test means between the two was not statistically significant ($p=0.17$). Notably, despite being live-action rather than animated, the video-mode demonstrated a more substantial improvement. Smith et al. (2012) suggested that computer animation technology might offer more advantages to learners compared to live-action videos with human actors. However, our results indicate that, while animation may have certain advantages, live-action videos could also yield significant benefits for learner learning.

Table 3: Group*Time - Least Significant Difference (LSD)

Cell No.	Group	Time	{1} 43.857	{2} 48.885	{3} 42.451	{4} 53.975	{5} 42.283	{6} 57.183
1	Control	Pre		<0.01	0.55	<0.01	0.51	<0.01
2	Control	Post	<0.01		<0.01	0.03	<0.01	<0.01
3	Book-mode	Pre	0.55	<0.01		<0.01	0.94	<0.01
4	Book-mode	Post	<0.01	0.03	<0.01		<0.01	0.17
5	Video-mode	Pre	0.51	<0.01	0.94	<0.01		<0.01
6	Video-mode	post	<0.01	<0.01	<0.01	0.17	<0.01	

The existing literature on the distinctions between the effects of video-mode and book-mode comics is limited, prompting an exploration of their comparative effectiveness in teaching and learning Science subjects at the primary level (Jang & Park, 2014; Rokhayani & Utari, 2014; Panjaitan et al., 2019; Soewardini et al., 2019). Video comics and book comic interventions, though equally significant, might yield different outcomes due to their unique approaches—one emphasising visual and auditory elements, and the other combining visual and written components. Despite both modes involving visual and textual elements, they represent distinct modes of communication. Reading, unlike listening, requires a specific skill set for comprehending written content, potentially accounting for the greater significance observed in video-mode comics compared to book-mode comics. The disparity between video-mode and book-mode comics is akin to IvyPanda's (2020) explanation of the distinctions between books and movies, emphasising the differing levels of effort required in their production. Book-mode comics demand explicit detailing, akin to a traditional textbook, necessitating reader experience for interpretation (Zhao & Mahrt, 2018). In contrast, video-mode comics may reduce the necessity for advanced interpretation skills, as characters overtly exhibit actions, speech, and emotions. Statistical analysis revealed pronounced significance ($p < 0.01$) for video-mode comics and moderate significance ($p = 0.03$) for book-mode comics. While video-mode comics exhibit more significance than book-mode comics, the distinction between the two formats was not statistically significant ($p = 0.17$). Considering the p-value exceeding the threshold of 0.05, further research explicitly dedicated to elucidating the disparity between video-mode and book-mode comics is imperative. A larger sample size might definitively ascertain whether this observed difference holds statistical significance, as the current outcomes do not indicate a statistically

significant divergence in learning attainment between video-mode and book-mode comics interventions.

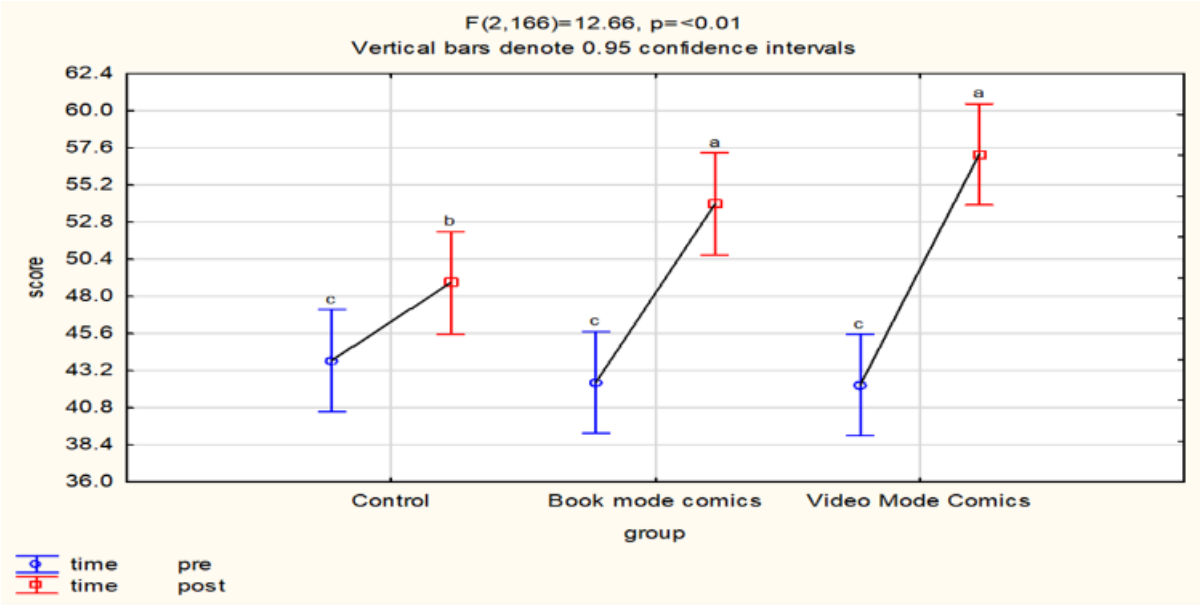

Figure 3: Group*Time Least Square (LS) means graph

Finding 3: This study found that there was a large practical significant difference between the pre-test and post-test of the video-mode and book-mode. At the same time, there was a medium practical important difference between the pre-test and post-test of the control group. Therefore, the p-values associated with learning attainment in video-mode and book-mode indicated the presence of effects but failed to quantify the magnitude or practical importance of these effects. To assess the practical importance of the performance variation between the pre-test and post-test, Cohen's d was employed, measuring the effects on learning attainment (Diener, 2010). The differences in learning gains between the pre-test and post-test for comics in book-mode were recorded at 0.76, for video-mode at 1.01, and for the control group at 0.4. Cohen's d results for book-mode and video-mode comics exhibit a more substantial effect compared to the control group (as presented in Table 4), despite the negligible disparities detected among the three pre-tests prior to the intervention.

Table 1: Cohen's d results

No.	Group	Time	{1}	{2}	{3}	{4}	{5}	{6}
1	Book	Post		0.76-larg	0.34-sma	0.74-med	0.20-sma	0,8-larg
2	Book	Pre	0.76-larg		0.46-med	0.11-negli	0.97-larg	0.01-negli
3	Contr	Post	0.34-smal	0.46-med		0.40-med	0.55-med	0.48-med
4	Contr	Pre	0,74-med	0.11-negli	0.40-med		0.97-larg	0.12-negli
5	Video	Post	0.20-smal	0.97-larg	0.55-med	0.97-larg		1.01-larg
6	Video	Pre	0.80-larg	0.01-negli	0.48-med	0.12-negli	1.01-larg	

An intriguing observation from Table 4 is the effect size discrepancy between video-mode and book-mode comics, standing at 0.20, indicative of a small practical importance. Consequently, while the statistical difference between video-mode and book-mode surpassed the significance threshold of 0.05, suggesting no statistical significance, the practical importance of this discrepancy was small. In light of this, it is reasonable to conclude that, even though the statistical difference between video-mode and book-mode may not be deemed statistically significant, the observed difference possessed small practical importance and should not be disregarded. Hence, it is crucial to acknowledge the complexity of drawing conclusions about statistical significance when the p-value approaches the significance threshold. This cautionary stance finds support in the work of Amrhein et al. (2019), who advocated for vigilance among researchers when interpreting p-values and considering significance

thresholds. It is essential to clarify that their perspective did not advocate for an outright ban on using p-values, nor did they assert that p-values are unfit for use as decision criteria in specific specialised applications; instead, they emphasised exercising prudence in their interpretation and application.

Hypothesis results

The study found a difference in average achievement between video-mode comics and traditional science teaching to be 18.00, with a p-value of <0.01, consistent with my alternate hypothesis.

Conclusion

This study delved into an examination of the impact of video-mode, book-mode comics, and traditional methods on learning attainment. The findings underscored the positive effects of both comic modes over the traditional methods, whether in book-mode or video-mode, while highlighting notable disparities between the two. Despite the statistical analysis revealing a p-value discrepancy, this disparity lacked statistical significance. Moreover, the study provided empirical support for Bandura's (1971) Social Learning Theory, emphasising that symbolic representation can enhance learning even in the absence of a teacher in the classroom. To quantify the magnitude of learning gains attributed to the two interventions, Cohen's d was computed. The results indicated that both video-mode and book-mode comic instructions had a significant impact on the learning attainments of Grade 4 Science learners. Additionally, a small practical difference was observed between the two comic modes.

Recommendations

Participating teachers in this study recommend mandatory training on comic instruction for future teachers in university education programs. Universities, in collaboration with education faculties, should integrate comic courses into their curriculum, potentially by partnering with international experts. The Ministry of Education, Arts and Culture should allocate resources for comic materials and technology. In-service training programs are needed for existing teachers, and regional education directorates should organise workshops on comic instruction. Senior education officers can lead training within their regions to disseminate knowledge. Community awareness initiatives can encourage involvement in the comic industry. Implementing these suggestions aims to enhance the effective use of comics in education, making learning more engaging and accessible for teachers and learners.

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