EXPLORING THE EFFICACY OF COMICS AS INNOVATIVE INSTRUCTIONAL TOOLS IN ENHANCING BIOLOGY EDUCATION

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ABSTRACT: *This quasi-experimental study delved into the effectiveness of utilizing comic-based materials for instructing students on the intricate components and functions of the digestive system in the field of biology. The experiment utilized a total of one hundred (100) students, fifty (50) of which were the experimental group which was exposed to comic-based learning materials, and the other fifty (50) were the control group which was exposed to the conventional lecture setup. The students underwent 10 learning sessions, the study employed both pre-test and post-test assessments as evaluation tools. The findings reveal that the mean biology proficiency of the experimental group closely resembled that of the control group, indicating a comparable baseline level of biology ability. Additionally, in both groups, there was a noticeable enhancement in mean post-test scores when compared to their respective pre-test scores. However, a significant discrepancy emerged in the post-test mean scores between the experimental and control groups, with the control group achieving higher scores. This finding underscores the superior efficacy of the conventional teaching method over the utilization of comic-based learning materials. Nonetheless, the research did not identify any substantial differences in students' achievements when categorized based on their abilities in biology. In summary, the performance of the experimental group did not surpass that of the control group following the completion of all learning sessions. This suggests that significant improvements are necessary to refine the intervention's effectiveness in learning biology.*

Keywords: *Quasi-experimental study, Comic-based materials, Digestive system, Biology proficiency, Conventional lecture setup, Pre-test, Post-test*

INTRODUCTION

Instructional materials play a crucial role in teaching and learning. They can be used to support and supplement the content of a lesson, help students learn new concepts, and provide practice opportunities [1]. Instructional materials can cater to diverse learning styles and preferences, making complex concepts more accessible and understandable. When utilized effectively, these materials can transform traditional teaching methods into dynamic, interactive, and engaging learning experiences.

In an era characterized by information overload and digital technologies, the role of instructional materials in education remains more critical than ever in fostering meaningful and impactful learning experiences. Clark and Mayer [2] highlighted the importance of multimedia instructional materials, such as videos and animations, in promoting active learning and knowledge retention. Additionally, Hattie [3] emphasized the significance of visual aids and manipulative materials in his influential meta-analysis, identifying them as effective teaching strategies. Instructional materials not only help students grasp abstract concepts but also provide educators with valuable tools to adapt their teaching methods to suit the needs of diverse learners.

Just like any other subject, teaching Biology comes with various difficulties. One of the primary difficulties lies in translating abstract biological phenomena into comprehensible terms for students, as concepts like cellular processes or evolutionary mechanisms, even teaching the body systems and their functions, can be challenging to visualize and understand. The complex vocabularies that come with the lessons in the specified subject can also be a hindrance for the learners to grasp the lesson.

Instructor's teaching effectiveness and student's learning are sometimes dependent on the Instructional Materials (IMs) used. Muzumdar [4] noted that there are numerous researches supporting the contention that IMs affect students' learning. On the other hand, traditional instruction approaches caused a negative image in the learning process especially in teaching science subjects and developing the science process skills of the students [5].

Biology's intricate and multifaceted nature makes it a subject that greatly benefits from visual instructional materials. These materials enhance comprehension, engage students, and facilitate the exploration of biological concepts, making the learning experience more dynamic and effective. Although there are a lot of visual instructional materials to choose from, this study emphasizes using comic materials. Comics have gained recognition as valuable instructional materials in education due to their unique ability to engage learners and facilitate comprehension of complex subjects.

With these challenges that come with teaching and learning Biology, the researcher focused on developing an effective way of teaching Biology, specifically focusing on the lesson about the Digestive System and its functions, through exploring comic strips as a mode of instilling the lessons to Grade 8 students of Cantilan National High School. Specifically, this study aims to answer the following questions:

1. What is the mean ability in biology of the respondents in the control and experimental groups?
2. What are the pre-test and post-test mean scores of the controland experimental groups?
3. Is there a significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups?
4. Is there a significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups according to their ability in biology?

Below are the hypotheses of this study:

H_{01}: There is no significant difference between the pre-test and post-test mean scores of the students in the control and experimental groups

H_{02}: There is no significant difference between the pre-test and post-test mean scores of the students in the control and

experimental groups according to their ability in biology.

COMIC STRIPS AS MODE OF TEACHING AND LEARNING IN BIOLOGY (The Digestive System)

The use of comics as instructional materials could help increase students' learning interest and motivation and assist students in understanding the material easier and simpler [6,7,8].

A study by Casumpang and Enteria [9] revealed that using comic strips as instructional materials significantly increased the students' performance in class. The results of his study indicated that the created comic strip proved to be a valuable instructional resource for teaching science concepts, with a specific focus on waste generation and management. Expert evaluators regarded it as both acceptable and commendable. Notably, there was a noticeable discrepancy between the average scores of the pre-test and post-test assessments among the participants. The respondents expressed a favorable view, recognizing that the comic strips had improved their ability to infer and communicate science process skills.

A similar study by Estacio [10] mentioned that comic strip as instructional material has a positive effect on the performance of the students in class where students learn the lesson easily as the picture diagram presented the topic. It also reiterates other findings that the cartooning concept can improve the performance of students even in struggling subjects like Physics and Biology.

Tejwani [11] stressed in his study *"Comparison of Educational Comics Instructional Material and Traditional Method in Terms of Conceptual Understanding in Economics of Ninth Graders",* that Comics Instructional Material was significantly superior to the Traditional Method when groups were matched statistically concerning Pre-Conceptual Understanding in Economics variable. His study was experimental. The results revealed a positive result with the comic materials when compared to the traditional learning materials.

Other researchers also conducted similar experiments to the one stated above. Hutchinson, et al [12] compared comics with pictures to comics with text. He found that visual quality increases learning. Ziv [13] conducted the first study in a one-semester college statistics course involving 161 students. The second experiment included 132 students in a one-semester introductory psychology course. He found that the experimental groups who received content

– related humor in their lesson consistently scored higher than the control groups.

Comics have found utility in instructing various subjects, as evidenced by related studies. For instance, in the context of lower secondary Chemistry laboratory sessions described in the work of Affeldt et al. [14], science practical worksheets were provided to students, incorporating comics that featured real-world scenarios that resonated with the students. These comics captured the students' attention and made the learning experience enjoyable. Consequently, the students became more engaged in the experiments. Furthermore, the students displayed a strong affinity for the narrative and felt a connection with the characters within the comics. The use of the comic format also facilitated the student's comprehension of the experimental instructions, making them more accessible and understandable.

According to Da Silva et al. [15], the utilization of comics in educational presentations serves as an effective teaching strategy with several benefits. It can bolster the development of competence, foster innovation, and enhance adaptability, while also bridging the gap between theoretical knowledge and practical application. Additionally, this approach promotes critical thinking among students, facilitating the establishment of connections between real-world events and managerial scenarios. It further encourages the sharing of experiences, aiding in decision-making and enabling students to conceptualize professional situations grounded in theoretical principles. Lastly, it plays a pivotal role in nurturing reflective practice within the learning environment and, notably, stimulates the cultivation of creativity, an aspect that was observed throughout the strategy's implementation.

Samosa [16] emphasized the effectiveness of using comic materials in teaching biology subjects when she assessed the effectiveness of developed comics as strategic intervention material on teaching biology, particularly photosynthesis. The study provided results on the mean difference between the pretest and posttest performance of the students and a significant relationship between the level of academic performance and the attitudes when aided by developed strategic intervention materials.

THEORETICAL FRAMEWORK

The use of comics as an instructional medium could be hypothetically supported by reference to several psychological theories. The dual coding theory proposed by Paivio [17] attempts to give equal weight to verbal and non-verbal processing. [18] Paivio states: "Human cognition is unique in that it has become specialized for dealing simultaneously with language and with nonverbal objects and events. Moreover, the language system is peculiar in that it deals directly with linguistic input and output (in the form of speech or writing) while at the same time serving a symbolic function concerning nonverbal objects, events, and behaviors. Any representational theory must accommodate this dual functionality."

This study is also anchored in Chu and Toh's [19] Theme, Storyline, Characters, Test (TSCT) framework to design comics for teaching in the primary-level mathematics classroom. The outstanding features of the TSCT framework include having an interesting storyline and relatable characters, as well as infusing humor into comics. While the framework focused on comics for younger students in primary schools, we believe that the ideas underpinning the framework are still largely relevant for students at the secondary level. The framework also stressed the importance of the comics being contextually and culturally relevant, in addition to the importance of the comics including relatable characters to the students. This essential feature is also echoed by Azamain et al. [20].

Furthermore, this investigation is grounded in two theoretical frameworks, namely, constructivism and creative theory. The Constructivism Theory is employed in the field of education to facilitate learning by building upon students' group, with the first and last sessions dedicated to administering the pre-test and post-test assessments. Each session had an approximate duration of one hour and twenty minutes. All

participants received detailed information about the study and provided their informed consent to participate. Furthermore, the study received the necessary approvals from the Ministry of Education in the Philippines and the respective schools where the research was conducted. All procedures carried out in this study adhered to the ethical standards set by the university research committee.

Table 1: Research Design

Group	Pretest	Treatment	Post-test
Experimental (Comic-exposed)	O1	T1	O2
Control (Group (Conventional Lectures)	O1		O2

RESEARCH PARTICIPANTS

This study included a total of 100 Grade 8 students who were enrolled in the Regular K-12 Program at Cantilan National High School during the 2019-2020 school year in the Province of Surigao del Sur, Philippines. The selection of participants was carried out using purposive sampling techniques. The distribution of participants, categorized by their proficiency in biology and their instructional methods, is presented in Table 2. The students' level of biology proficiency in the table is determined by their academic grades in Biology, by the grading system mandated by the Department of Education of the Philippines. It is worth noting that both the experimental and control groups were comprised of an equal number of participants across different levels of proficiency in biology. existing knowledge and personal experiences. Educators who subscribe to constructivism recognize that learners bring their unique experiences into the classroom, thus adopting a learner-centric approach. Conversely, the creative theory finds its origins in the realms of writing and visual arts, emphasizing the application of innovative thinking. Therefore, when it comes to crafting comic scripts to convey biological concepts and ideas, creative theory plays an indispensable role within the context of this study.

METHODOLOGY RESEARCH DESIGN

In this research, a quasi-experimental pre-test and post-test research design was employed to assess the effectiveness of utilizing comic materials as an instructional tool for teaching the Digestive System in Biology. The study divided participants into two distinct groups: the experimental group, which received instruction through the use of comic materials, and the control group, which received traditional instruction. A total of ten sessions were conducted for each

INSTRUMENTATION

In this research, comics-based learning materials were employed to assess their effectiveness in teaching Biology, specifically focusing on the Digestive System. The comic strips were thoughtfully designed to illustrate the components of the digestive system and elucidate the functions of each part. To ensure the quality and appropriateness of the learning material, it was validated

according to the guidelines and standards established by the Department of Education in the Philippines. The validation tool incorporated a sequence of cartoons and illustrations in an organized manner, aimed at creating an efficient learning resource for students.

The pre-test and post-test utilized in this study encompassed questions related to both the components and functions of the Digestive System, aligning with the Biology curriculum outlined by the Department of Education (DepEd). Furthermore, these tests underwent a validation process conducted by experts in the field of Biology to ensure their accuracy and appropriateness for assessing students' understanding.

group exhibited a slightly higher standard deviation of 4.87, signifying a greater dispersion of abilities within the control group.

PARTICIPANTS' PRE-TEST AND POST-TEST MEAN SCORES

Table 2: Distribution of Participants based on Biology Grade

Group	N	Mean Ability in Biology	Pre-Test		Post-Test	
			ẋ	SD	ẋ	SD
Experimental (Comic-exposed)	50	Above Average	7.60	1.45	11.02	11.02
		Average	5.00	1.65	7.50	7.50
		Below Average	4.20	1.70	5.80	1.55
		Mean	5.412	1.742	7.962	1.943
Control Group (Conventional Lectures)	50	Above Average	7.60	1.60	12.18	1.50
		Average	6.00	1.35	10.00	1.80
		Below Average	4.21	1.75	7.29	2.10
		Mean	5.871	1.688	9.86	2.052

DATA ANALYSIS

The collected data was subjected to both descriptive and inferential statistical analyses. To assess the student's proficiency in biology within the control and experimental groups, the mean was employed. Furthermore, mean and standard deviation were utilized to evaluate the students' academic performance in both groups before and after the intervention.

To ascertain any disparities in students' achievement attributable to the intervention, a one-way analysis of

variance (ANOVA) was employed to compare the mean scores of the pre-test and post-test. This allowed for an examination of the differences in students' performance following the intervention and in the absence of the intervention. Additionally, when classifying students based on their biology aptitude, one-way analysis of covariance (ANCOVA) was employed to gauge students' academic performance in both the control and experimental groups

FINDINGS AND DISCUSSION

Table 3: Mean Ability in Biology of Participants

Group	Mean Ability in Biology	Standard Deviation	Ability Level
Experimental (Comic-exposed)	86.67	4.65	Average
Control Group (Conventional Lectures)	85.76	4.87	Average

Table 3 provides an overview of the participants' average proficiency in biology. Notably, both the experimental and control groups exhibited comparable levels of proficiency, with the experimental group's mean biology proficiency recorded at 86.67 and the control group's mean proficiency at 85.76. It can be observed that the mean biology proficiency of the experimental group closely aligns with the mean biology proficiency of the control group. Importantly, it should be emphasized that the experimental group demonstrated a standard deviation of 4.65, while the control

Table 4: Pre-test and Post-test Mean Scores of the Control and Experimental Groups

Source of Variation	Type III Sum of Squares	df	Mean Square	F-value	P-value
Covariate	0.022	1	0.022	0.003	0.955
Factor A (Ability in Biology)	325.567	2	162.783	13.287	0.000
Factor B (Teaching Strategy)	1365.891	1	1365.891	110.971	0.000
A x B	2.535	2	1.267	0.103	0.899

displays the mean pre-test and post-test scores for both the experimental and control groups. In terms of the pre-test scores, the experimental group achieved a mean score of 5.412 with a standard deviation of 1.742, while the control group attained a mean score of 5.871 with a standard deviation of 1.688. Conversely, for the mean post-test scores, the experimental group achieved a mean score of 7.962 with a standard deviation of 1.943, whereas the control group recorded a mean score of 9.860 with a standard deviation of 2.052. Notably, it is evident that in both groups, the mean post-test scores surpassed the mean pre-test scores, indicating an improvement in students' performance in the topic of identifying the components of the digestive system and comprehending their functions, irrespective of whether they were exposed to the comic-based learning material or not.

DIFFERENCES BETWEEN THE PRE-TEST AND POST-TEST MEAN SCORES IN EXPERIMENTAL AND CONTROL GROUPS

Table 5: Analysis of variance of the Pre-test and Post-test mean Scores

	Group	N	Mean Score	SD	F	P-value	Interpretation
Pre-test	Experimental	50	5.412	1.742	3.74	0.065	Not Significant
	Control	50	5.871	1.688			
Post - Test	Experi mental	50	7.962	1.943	12.21	0.001	Significant
	Control	50	9.860	2.052			

Table 5 displays an analysis of the discrepancies between the mean pre-test and post-test scores in both groups. When considering the pre-test mean scores, it is evident that there are no significant disparities between the mean scores of the experimental and control groups (F=3.74, p=.065). As a result, HO1 is accepted, indicating that both the experimental and control groups exhibited similar levels of performance before the instruction on the Digestive

System in Biology, whether using comic-based learning materials for the experimental group or conventional lecture methods for the control group.

Conversely, in terms of the post-test mean scores, a significant difference is apparent between the mean scores of the experimental and control groups (F=12.21, p=.001). Consequently, HO2 is rejected. These findings suggest that students in both groups acquired a greater understanding of biology, particularly concerning the Digestive System and its components, following the instructional sessions. The results indicate that utilizing comics as learning materials is indeed effective in enhancing students' comprehension of biology lessons. However, it is noteworthy that the conventional lecture method also proves effective, and in fact, it is equally or even more effective than the experimental approach.

DIFFERENCES BETWEEN THE PRE-TEST AND POST-TEST MEAN SCORES IN EXPERIMENTAL AND CONTROL GROUPS ACCORDING TO STUDENTS' ABILITIES IN BIOLOGY

Table 6: Analysis of Differences in the students' achievement according to their ability in Biology

In Table 6, an analysis of variations in students' achievements was conducted concerning their proficiencyin biology, treated as the covariate. The results reveal that there are no substantial differences in students' achievements based on their biology aptitude (F=.103, p=.899). Consequently, this discovery underscores that students from distinct classes exhibit varying degrees of conceptual grasp within the field of biology. This observation sheds light on the notion that the effectiveness of employing comic-based learning materials in biology education may hinge on the extent to which students appreciate and engage with thematerial.

CONCLUSION

This quasi-experimental study aimed to assess the effectiveness of employing comic-based materials in the instruction of the digestive system's components and functions in biology. The results reveal that the average biology proficiency of the experimental group closely resembled that of the control group. Moreover, both groups exhibited higher mean post-test scores compared to theirmean pre-test scores. Additionally, a noteworthy observation is that a significant difference emerged between the post-test mean scores of the experimental and control groups, with thecontrol group outperforming the experimental group. This indicates that the conventional teaching method proved to be more effective than the utilization of comic-based materials. Nonetheless, there were no substantial disparities in students' achievements based on their biological aptitude. In summary, the experimental group's performance in acquiring knowledge about the digestive system in biology was on par with that ofthe control group, suggesting that the intervention requires significant enhancements to enhance its efficacy in biology instruction.

REFERENCES

[1] Lane, S. (2022), The Role of Instructional Materials in Teaching And Learning, https://eduedify.com/role-of-instructional-materials/#google_vignette

[2] lark, R. C., & Mayer, R. E. (2016). E-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning. *John Wiley & Sons*.

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

[4] Muzumdar, J. (2016). An Overview of Comic Books as an Educational Tool and Impli- cations for Pharmacy, Innovation in Pharmacy: *University of Minnesota Libraries*,Vol.**7** (4): Article 1.

[5] Özdemir, E. (2010). The Effect of instructional Comics onSixth Grade Students' Achievement in Heat Transfer: Retrieved from https://www.researchgate. net/publication/319903513, Middle East Technical University, Turkey.

[6] Williams, R. M. C. (2008). Image, Text, and Story: Comics and Graphic Novels in the Classroom. *Art Education*, **61**(6), 13-19.

[7] Lestari, I., Wahyuni, S., &Yushardi. (2016). Pengembangan Bahan Ajar IPA Berbasis Komik pada Pokok Bahasan Gerak di SMP. *Jurnal Pembelajaran Fisika*, **4**(5), 564-572.

[8] Zain, N. H., Parmin, P., & Sumarni, W. (2013). Pengembangan Komik Bahan Ajar IPA Terpadu Kelas VIII SMP Pada Tema Sistem Pencernaan Manusia dan Hubungannya dengan Kesehatan. Unnes Science Education Journal, **2**(1),7-14

[9] Casumpang, P. F. H., & Enteria, O. C. (2019). Effectiveness of developed comic strips as instructional material in teaching specific science concepts. *International Journal for Innovation Education and Research*, ***7***(10), 876-882.

[10] Estacio, R. D. L. (2015). Development and Validation of a Learning Assessment Tool and Instructional Material in Physics 1 (Mechanics). *Journal of Geotechnical and Geoenvironmental Engineering ASCE*, **120**(11),25

[11] Tejwani, S. (2012), Comparison of Educational Comics Instructional Material and Traditional Method in Terms of Conceptual Understanding in Economics of Ninth Graders, *International Educational E-Journal*,

{Quarterly}, ISSN 2277-2456, Volume-I, Issue-**V**, Oct-Nov-Dec 2012

[12] Hutchinson,k.(1949) an experiment in the use of comics as instructional material. General of educational sociology, 23, pp. 236-245. Retrieved from http://www humblecomics.com/comics edu.

[13] Ziv, A. (1988). Teaching and learning with humor: Experiment and replication. *The Journal of Experimental Education*, ***57***(1), 4-15.

[14] Affeldt, F., Meinhart, D. & Eilks, I. (2018). The use of comics in experimental instructions in a nonformal chemistry learning context. *International Journal of Education in Mathematics, Science and Technology (IJEMST)*, **6**(1), 93-104. DOI:10.18404/ijemst.380620

[15] De Silva et al. (2016). The Comics as Teaching Strategy in Learning of Students in an Undergraduate Management Program. *Mackenzie Management Review*, **18** (1), pp. 40-65. http://dx.doi.org/10.1590/1678-69712017/administracao.v18n1p40-65.

[16] Samosa, R. (2021), Cosim (comics cum sim): an

[18] Paul and Claire (2010). The Comic Book Textbook. *Education and Health*. Vol. **28**,(4) Retrieved from sheu.org.uk/sites/sheu.org.uk/files/imagepicker/1/eh284pa.pdf.

[19] Chu, Y. L. L., & Toh, T. L. (2020). A Framework for Designing Mathematics Instruction Using Comics at the Primary School Level. *Journal of Research and Advances in Mathematics Education*, **5**(3), 218-230.

[20] Azamain, M. S., Shahrill, M., Musa, N. K. H., & Batrisyia,

I. (2020). How using comics can assist in determining the students' learning of distance-time graphs. *In Journal of Physics: Conference Series* **1470**(1). IOP Publishing. doi:10.1088/1742-6596/1470/1/012005

innovative material in Teaching biology,: https://www.scholarzest.com Vol. **2** No. 4, April 2021,ISSN: 2660-5570

[17] Paivio, A. (1969). Mental imagery in associative learningand memory. *Psychological review*, ***76***(3), 241.