

Research Article:

## **Development and Implementation of a Contextualized Comic Book to Improve Students' Conceptions of Cell Division**

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### **ABSTRACT**

Cell division was identified as one of the least learned competencies in teaching biological science to junior high school students. Comics' combination of pictures and words makes the process more engaging to students by changing their perspective on learning. Reading literacy and motivation are improved by contextualized comic books. The use of comic books as instructional material significantly influences academic attainment, particularly for low achieving youngsters. As a result, instructors' teaching strategies and approaches reflect the growth and inclusion of comics in teaching-learning. The study aimed to develop and assess a contextualized comic book teaching cell division concepts to improve students' conceptions. The research used a modified exam from the General Biology book based on Curriculum Guide Competency and Most Important Learning Competency (MELC). The accomplishment exam consisted of 20 items covering the following topics: Cell Division/ Cell Cycle. The contextualized comic book was rated acceptable and with moderate agreement by the evaluators. The findings showed that the developed contextualized comic book positively influenced the knowledge level of the student's cell division concepts. Moreover, there was a significant difference between the student's pre-test and post-test mean scores. Additionally, they positively perceived that the developed contextualized comic book had increased their interest and creativity and enhanced their knowledge and understanding of Cell Division. Because of their significance to the teaching process, instructional comics are suggested for inclusion in many courses, notably in science.

**Keywords:** Cell division, contextualized comic book, learning materials, instructional materials, science education

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## INTRODUCTION

The need for contextualizing teaching and learning is one common request for teaching the several basic education subdisciplines, including biology. By focusing teaching and learning on real applications in a particular setting that is of interest to the learner, contextualized education connects the development of core abilities with academic or vocational material. Contextualization, as defined by Mazzeo (2008), is a diverse family of instructional strategies designed to more seamlessly link the learning of foundational skills and academic or occupational content by focusing teaching and learning squarely on concrete applications in a specific context that is of interest to the student. Contextualization is a method of teaching science that could improve students' performance. Science domain and educational level were shown to have little impact on students' performance. To provide the best possible learning results, contextualized education employed a variety of strategies (Picardal & Sanchez, 2022). Additionally, King et al. (2006) suggested that curricular contextualization is "context-based learning," defined as "a group of learning experiences that encourages students to transfer their understanding of critical concepts to situations that mirror real life." As supported by Yamauchi (2003), when teachers contextualize instruction, students become motivated because what they teach us is more meaningful and relevant to their lives outside of school. Therefore, contextualizing concepts and teaching them to the students bears a significant relationship in the teaching-learning process.

Several studies were conducted to correlate the different factors like reading skills and comprehension (Imam et al., 2014; Imam, 2016), learning styles and study habits (Magulod, 2019), and infographics (Basco, 2020) to science performance of Filipino students. Additionally, Filipino teachers utilized various modalities to deliver quality science education to students. Some of these were educational games, such as Learners Active Response to Operant (LARO) (Barantes & Tamoria, 2021), Strategic Intervention Material (SIM)-based Instruction (Gabucan & Sanchez, 2021), and ICT integration (Sasota et al., 2021). However, some studies also reveal that students face problems and difficulties with some science concepts in secondary education. According to the National Assessment of Education Progress, the science proficiency of high school seniors dropped from 21% in 1996 to 18% in 2000 and remained at 18% in 2005 (Grigg et al., 2006). As a result, the public's science literacy is remarkably low. In addition, the Philippines lags behind other countries as far as the quality of science education is concerned. Additionally, in the World Economic Forum Global Competitiveness Report (2017-2018), the Philippines ranked 76th out of 137 countries in the quality of science education.

Prior studies have also shown that students experience difficulties learning concepts related to the cell division process (Kindfield & Smith, 1999). Cell division constitutes the basis for genetics, reproduction, growth, development, and molecular biology subjects in the biology curriculum. Lewis et al. (2000) findings also showed a poor understanding of the processes by which genetic information is transferred and a lack of basic knowledge about the structures involved (gene, chromosome, cell). Most students or teachers evaluated topics such as genes, DNA, chromosome, and cell division as complex topics (Oztap et al., 2003). Thus, there is a need to design an intervention to address these difficulties faced by the students.

In response to the scenario and its corollary regarding the role of teachers' teaching strategies in raising the level of knowledge of the students on the cell division concept, the study was prompted to conduct this quasi-experimental study to ascertain whether or not the creation and use of comic books as an aid in teaching the concept are beneficial or may contribute to raising student knowledge. By altering their viewpoint on learning processes, the mix of graphics and words in comics enables students to see the process as more appealing. Various studies have shown that adopting comics as a teaching tool will benefit the learning-teaching process in this regard. Comics are becoming more and more popular in the field of education (Lazarinis et al., 2015; Topkaya, 2016) because of their effectiveness and positive contributions to the teaching/learning process (Rota & Izquierdo, 2003; Mamolo, 2019) used as an assessment in evaluating students ideas in the classroom (Song et al., 2008), a tool in expressing feelings, anxieties, and other emotions (Beard & Rhodes, 2002), and it present real-world situations which have no clear answer (Arroio, 2011). Further, Astuti et al. (2014) pointed out that combining images and texts in comics helps students see the process more attractive by changing their perspective on learning.

It was also supported by Kerneza and Kosir (2016) that this learning material has a positive effect on reading literacy and reading motivation. Furthermore, Hutchinson (1949) posited that using comics as instructional material, particularly for low-achieving students, significantly influences their academic performance. Thus, the development and integration of comics in teaching-learning are evident in teachers' teaching strategies and approaches. Moreover, the study would serve as an avenue for crafting new approaches and techniques in teaching, especially among science teachers who have long encountered difficulties in dealing with their tasks.

## **LITERATURE REVIEW**

The term contextualization in instruction refers to the utilization of unusual situations or events that occur outside of science class or are of particular interest to students to stimulate and drive the presentation of scientific ideas and concepts in this study. Contextualization is frequently in the form of actual events or circumstances that are personally meaningful to students, the local community, or the scientific community. These are situations in which students are engaged for extended periods of time and may have some experience (directly or indirectly) prior to or during the presentation of objective issues in science class. The goal of integrated instruction, in contrast to contextualized education, is to teach disciplinary content rather than fundamental abilities, according to Pearson (2010). Teaching fundamental abilities is still a necessary first step in developing critical thinking about the subject, though.

Science seems to be a complex subject to understand and comprehend (Etobo & Banjoko, 2017). Moreover, Genetics is one of the problematic concepts in Biology because of its broad and complex nature. In contrast, Dikmenli (2010) stressed that students experience difficulties learning concepts related to the cell division process. Cell division constitutes the basis for genetics, reproduction, growth, development, and molecular biology subjects

in the biology curriculum. Most students or teachers evaluated topics such as genes, DNA, chromosome, and cell division as complex topics (Oztap et al., 2003). Hence, because of the complexity of the subject, students need clarification and help with some of the concepts.

People learn more thoroughly through words and pictures than through words alone, according to the multimedia principle, however just verbalizing visuals will not result in multimedia learning (Mayer, 2009). The Cognitive Theory of Multimedia Learning seeks to characterize the mental processes that occur during meaningful learning through multimedia education. The idea has significant implications for instructional design to facilitate multimedia learning, especially in terms of avoiding cognitive overload. The goal is to examine instructional content through the prism of how the human mind works. This is the foundation of Mayer's cognitive theory of multimodal learning.

Subsequently, in Williams' (2009) Visual Learning Theory, it states that literacy precedes verbal literacy in human development. Visual learning is the basic building block in the thought processes and a critical foundation for learning to read and write. Some early studies conducted in the 1970s explain how a child looks and recognizes before it can speak. Research consistently shows that people learn best when they are involved in direct, purposeful experiences using multiple intelligences (theory of multiple intelligences by Howard Gardner). Experiments by others support the importance of imagery in cognitive operation, and that recall and recognition are enhanced by presenting information in both visual and verbal form; in other words, visual, graphic, and auditory cues positively impact cognition. Therefore, teaching science concepts and integrating visual approaches like comics might positively influence the students' learning.

Educational activities with comics have been reported to develop critical thinking (Yolanda et al., 2019). As a medium, comics are a sequence of static images which present a story. Since the pictures are still, readers' minds fill in the action. Thus, most of the work is done between the panels (frames) by the readers' minds, which could be a powerful tool in teaching (Lazarinis et al., 2015). Hosler and Boomer (2011) highlighted that comic books employ a complex interplay of text and images that gives them the potential to convey concepts and motivate student engagement effectively. This makes comics an appealing option for educators trying to improve science literacy about pressing societal issues involving science and technology. As a strategy for teaching, comics can help students understand lesson contents faster and remember longer through a combination of text and drawings.

Moreover, Ramos (2006) explains that, if used correctly and planned, the comic "can achieve concrete results in learning such as instigating the debate and reflection on a particular theme." Hosler and Boomer (2011) suggest that comic book stories can play a significant role in coherently conveying the content and, in the process, improving learning and students' attitudes across other disciplines. Instructors who incorporate comics into their curricula suggest that comics generate increased individual student interest (Sones, 1944).

On the other hand, Atilboz (2004) concluded that students experience difficulties in understanding fundamental concepts, such as DNA, chromosome, chromatid, homologous chromosomes, haploid and diploid cells, and the relationships between such concepts, and

possess some misconceptions. Furthermore, studies conducted on problem-solving related to genetics revealed that students have some misconceptions regarding the stages of meiosis (Brown, 1990; Stewart & Dale, 1989). The accurate organizing of many concepts in cell biology depends on the degree of understanding of cell division. It further suggested that such misconceptions lead to conceptual problems in genetics (Kibuka-Sebitosi, 2007). Thus, these problems prompt teachers to design or devise innovative teaching approaches to address these difficulties.

## **OBJECTIVES OF THE STUDY**

The study aimed to develop and assess a contextualized comic book teaching cell division concepts to improve students' conceptions. Specifically, it aims to:

1. Describe the process of the development of the contextualized comic book.
2. Assess the reliability of the comic book in terms of content, instructional design, technical design, and social consideration.
3. Determine the level of knowledge of Grade 10 students of Tucdao National High School on cell division concepts in terms of pre-test and post-test scores.
4. Ascertain the significant difference between the pre-test and post-test scores.
5. Elicit feedback from the students on the contextualized comic book.

## **METHODOLOGY**

### **Research Design**

The study employs the regression discontinuity design analysis. Regression Discontinuity Design (RDD) analysis is a quasi-experimental design in which a specific threshold value or cut-off score assigns participants to treatment conditions. It is an evaluation option that measures the impact of an intervention, or treatment, by applying a treatment assignment mechanism based on a continuous eligibility index, a variable with a continuous distribution (Thistlethwaite & Campbell, 1960).

### **Research Respondents**

A purposive sampling technique was applied in selecting the research respondents. The study was conducted at Tucdao National High school, a secondary school located in Tucdao, Kawayan, Biliran, where the researchers were stationed. The school is composed of grade levels (Grades 7–10) in Junior High School and Senior High School (Grades 11–12). Most respondents lived in the province's coastal and mountainous rural areas. Farming and fishing are the main occupations of their families, and modern educational gadgets

like internet connection and computers are limited and not readily available to them. The participants of this study are 189 Grade 10 Junior High School students; however, the researchers identified the qualified respondents after answering the Pre-test that evaluated their knowledge of the Cell Division concept. Only those students who failed to pass the Pre-test were chosen to be the study’s respondents since its purpose is to intervene and assess the impact of the contextualized comic book to improve students’ conceptions.

Moreover, the study involved a group of expert validators composed of five teachers. It utilized purposive sampling to determine the evaluators for the developed contextualized comic book. These evaluators were chosen based on the following criteria:

1. He/She is a graduate of Bachelor of Secondary Education major in General Science or Biological Science.
2. He/She finished a Master’s or Doctorate Degree in Science Education or any related field.
3. He/She has rendered at least five years of teaching service.

These evaluators checked the acceptability of the contextualized comic book in terms of content, instructional design, technical design, and social consideration.

### Research Instruments

The study utilized an adapted test from the recommended textbook of Department of Education (DepEd) for General Biology in K-12. The adapted test from the book by Ramos and Ramos (2018), with the title “Grade 7 and Grade 8 Learners Module K-12 General Biology 1 (Exploring life Through Science Series),” was based on Curriculum Guide Competency and Most Essential Learning Competency (MELC) from DepEd. The achievement test comprised a twenty-item test with the following topics: Cell Division/ Cell cycle Stages which includes Mitosis and Meiosis. Table 1 displays the example of the learning objectives and competency standard.

**Table 1.** Curriculum guide and inter-rater comic evaluation form

<b>I. OBJECTIVES</b>	
A. Content Standards	The learner demonstrates understanding on reproduction being both sexual and asexual.
B. Performance Standards	The learner creates a comic strip on the advantage and disadvantages of sexual and asexual reproduction.
C. Most Essential Learning Competencies	Differentiate asexual from sexual reproduction in terms of: <ul style="list-style-type: none"> <li>• Numbers of individuals involved</li> <li>• Similarities of offspring to parents (S7LT-1lg-7)</li> </ul>
Enabling Objectives	<ul style="list-style-type: none"> <li>• Describe the different types of sexual and asexual reproduction, and</li> <li>• Using the Venn diagram, differentiate asexual from sexual reproduction.</li> </ul>
<b>II. CONTENT</b>	Sexual and Asexual Reproduction

*(Continue on next page)*

Table 1 (Continued)

TITLE: THE CELL CYCLE ADVENTURE OF CYTO (CONTEXTUALIZED COMIC BOOK)				
SA – Strongly Agree A – Agree D – Disagree NA – Not Applicable				For each of the following statements, check the box which best reflects your judgment of the resource.
SA	A	D	NA	CONTENT
				Content is accurate
				Content is in line with the K-12 Curriculum
				Scope (range) and depth of topics are appropriate to student needs.
				Material has significant scientific content.
				Level of difficulty is appropriate for intended audience.
				Content integrates “real-world” experiences.
<b>INSTRUCTIONAL DESIGN</b>				
				Resource is suitable for a wide range of learning / teaching styles.
				Resource promotes student engagement.
				Methodology promotes active learning.
				Methodology promotes the development of communication skills.
				Resource encourages group interaction.
				Resource encourages student creativity.
				Resource allows/ encourages students to work independently.
				Resource is suitable for intended purpose.
				Material is well organized and structured.
				Material have unity/ congruency.
				Concepts are clearly introduced.
				Concepts are clearly developed
				Concepts are clearly summarized.
				Integration across curriculum subjects is supported.
				Non-technical vocabulary is appropriate.
				Technical terms are consistently explained/introduced.
				Pedagogy is innovative.
				Adequate/appropriate pre-teaching and follow-up activities are provided.
				Adequate/appropriate assessment/ evaluation tools are provided.
<b>TECHNICAL DESIGN</b>				
				The material is appropriate to the learners’ level.
				Visual design is interesting/ effective.
				Illustrations/ visuals are effective/ appropriate.
				Character size/typeface is appropriate.
				Layout is logical and consistent.
				Users can easily employ the resource.
				Packaging/design is suitable for classroom/library.

(Continue on next page)



Table 1 (Continued)

<b>S</b> – Suitable or appropriate <b>NS</b> – Not suitable or appropriate <b>NA</b> – Not applicable			Consider whether the resource addresses the following issues appropriately.
<b>S</b>	<b>NS</b>	<b>NA</b>	<b>SOCIAL CONSIDERATIONS</b>
			Gender/sexual roles
			Sexual orientation
			Belief systems
			Age
			Socio-economic status
			Political bias
			Regional bias
			Multiculturalism/anti-racism
			Aboriginal culture/roles
			Special needs
			Ethical/legal issues
			Language
			Violence
			Safety standards compliance
Do you recommend this contextualized comic book for utilization in instruction? Yes _____ No _____			
State the major reason(s) for the recommendation of this contextualized comic book. _____ _____ _____ _____			
Evaluator: _____		Date: _____	

The contextualized comic book material developed for this particular study follows the following elements as shown on Figure 1: (1) cover page with title; (2) learning objectives and competency standards; (3) exposition of the character; (4) comic narratives are communicated through graphic arts and illustrations with dialogues.

The contextualized comic book is “The Cell Cycle: Adventure of Cyto.” The comic book includes a cover page, Permission to Use the Comic Book from the Authors, and the actual Content. The cover page of the contextualized comic book shows the story’s main character of the story, named “Cyto” which means cell. He is also with his friend named, Cell-O. Cyto is human in physical appearance, while Cell-O is a robot that can talk, fly and interpret science concepts and data. Cyto wears a protective armor in color blue, while Cell-O is color silver which corresponds to the color of silver. The content of contextualized comic book range from pages 3-24, respectively. The first scene in the comic book shows Cyto in his human form, lying in the grass and thinking when suddenly he hears some noise from afar. After that, he discovered something and traveled to another universe,



where he met Cell-O. They met bacteria and viruses in that place, and their adventure in fighting these microorganisms will start. The two characters travel to the cell, its parts, and organelles, shown with descriptions in the comic book. The comic's phases of Mitosis and Meiosis were also shown using the diagram of these stages from reference books. The two characters have a conversation about the diagrams on each page. Aside from the mitosis and meiosis stages, interphase and cytokinesis were also included in the story. Figure 1 below displays some snippets from the contextualized comic book. The other section is the statement for intellectual property rights as indicated in the Republic Act 8293, section 176. Additionally, this section indicates (5) the author's and illustrators' profiles; and (6) the contact information as seen on Figure 2.

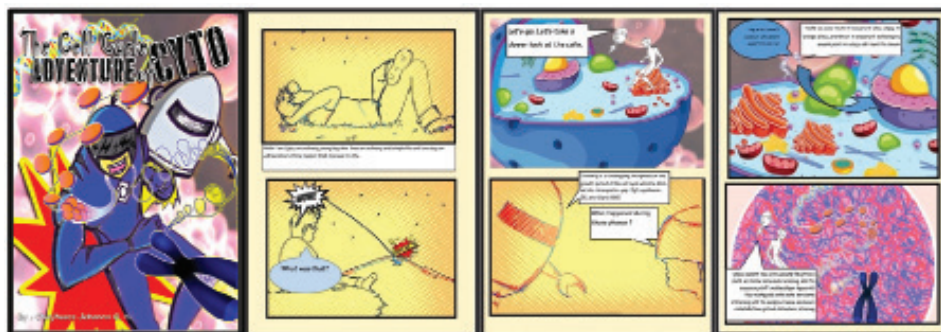


Figure 1. Sample screenshots of the contextualized comic book

**The Cell Cycle Adventure of Cyto**  
Contextualized Comic Book  
1st Edition of 2021

Republic Act 8293, section 176 states that: No copyright shall subsist in any work of the Government of the Philippines. However, prior approval of the government agency or office wherein the work is created shall be necessary for exploitation of such work for profit. Such agency or office may, among other things, impose as a condition the payment of royalties.

Borrowed materials (i.e., songs, stories, poems, pictures, photos, brand names, trademarks, etc.) included in this comic book are owned by their respective copyright holders. Every effort has been exerted to locate and seek permission to use these materials from their respective copyright owners. The author do not represent nor claim ownership over them.

Reference:

K-12 General Biology 1 (Exploring life Through Science Series): A.M. Ramos, J.A. Ramos: Phoenix Publishing House

Published by Chiejheaca Jehanna G. Yu

**Development Team**

Author: Chiejheaca Jehanna G. Yu  
Illustrator/Animator: Jeremiah O. Vertulfo  
Philip Franck Rodvick G. Yu

Figure 2. Declaration of the intellectual property rights (Note: Screenshot of the intellectual property rights declaration from the comic book page)

Visual images, such as pictures and photos, are nonverbal representations that precede verbal cues and abstract symbols, such as letters and words. In many ways, these are aligned with the constructivist theory of learning, where higher thinking skills are built on a solid foundation of concrete learning, which includes experience, environmental stimuli, visual feedback, and motor activities. Particularly for young children, multisensory visual, auditory, and tactile cues play critical roles in their learning. It is often said that individuals remember only 10% of what they read, 30% of what they see, and 70% of what they say, see and write.

The study utilized Inter-Rater Reliability Design (IRR) prior to the intervention's conduct to ensure the Comic book's reliability. Interrater reliability measures the extent to which data collectors (raters) assign the same score to the same variable. It is measured as percent agreement, calculated as the number of agreement scores divided by the total number of scores. A Comic Book Evaluation Form adopted from Evaluation and Selection of Learning Resources (2008) was utilized to evaluate the comic book's validity. Fleiss kappa (a measure of inter-rater agreement used to determine the level of agreement between two or more raters) was utilized to measure the inter-rater reliability of the contextualized comic book (Fleiss, 1971; Fleiss, 2003).

### **Data Gathering Procedure**

Prior to the actual conduct of the study, letters requesting permission from the respondents (including District Supervisor, School Principal) were sent out. The letter stated, among others, that the data obtained would be used for research purposes only and would be treated with the utmost confidentiality. Rest assured that the researchers will strictly follow the standard health protocols like physical distancing, wearing of facemasks, and face shields set by the IATF and DOH. Upon approval of such a request, the researchers gather the study's data. A pre-test about the Cell Division concept to all grade 10 students with a population of 189 was administered. The pre-test was distributed to every barangay in Kawayan II, where the students reside, following the protocols set by the IATF. Students who did not achieve a passing score or did not reach the cut-off score were the study's respondents. Intervention through a comic book consisting Cell Division concept based on Joseph Campbell's "The Hero's Journey- Mythic Structure" was given to the respondents.

After the intervention delivery, a twenty-item post-test was given. The pre-test and post-test results were statistically analyzed to determine any significant difference between the scores of the two tests. Respondents were also asked about their perception of the intervention given.

### **Data Scoring**

To determine the student's performance in their pre-test and post-test, the grading system in the K-12 curriculum, as prescribed by DepEd Order No. 8, s 2015, was adopted.

The students' pre-test/post-test scores are categorized as shown in Table 2.

**Table 2.** Proficiency level for pre-test and post-test score

Percentage scores	Proficiency level
90–100	Highly proficient
75–89	Proficient
50–74	Nearly proficient
25–49	Low proficient
0–24	Not proficient

To determine the percent of agreement of the raters regarding the validity of the contextualized comic book, the Fleiss Kappa scale (JR & GG, 1977) interpretation was utilized. The value and interpretation is shown in Table 3.

**Table 3.** Fleiss Kappa scale interpretation

Value	Interpretation
< 0.80–1.00	Almost perfect agreement
< 0.60–0.79	Substantial agreement
< 0.40–0.59	Moderate agreement
< 0.20–0.39	Fair agreement
< 0.0–0.19	Poor agreement
< 0	No agreement

### Statistical Treatment of Data

Data from this study were coded and analyzed using JASP (Jeffreys's Amazing Statistical Program) for descriptive statistics such as mean, frequency count, range, and standard deviation. To find out the significant difference of the variables, a t-test or the non-equivalent non-parametric test, which is the Wilcoxon, was utilized. To measure the percent of agreement of the raters concerning the validity of the contextualized comic book, Fleiss Kappa was utilized. The results of the study are presented in tabular and narrative form.

## RESULTS

### Development of the Contextualized Comic Book

As mentioned earlier, the contextualized comic book was evaluated by expert validators based on four factors: content, instructional design, technical design, and social consideration. The evaluation results determine the validity and acceptability of the contextualized comic book based on the points system indicated in the evaluation tool. The inter-rater reliability of the contextualized comic book based on content, instructional design, technical design and social consideration are shown in Tables 4 to 7.

### Pretest Phase

A pre-test was conducted to determine the number of respondents. It was administered to all Grade 10 students in Tucdao NHS administered by a Science teacher. Out of 189 students, there are only 50 students got a passing score, leaving 139 students as the study’s respondents.

### Inter-rater Phase

Prior to the delivery of the contextualized comic book, it underwent an inter-rater evaluation to ensure the validity and reliability of the learning material in terms of content, instructional design, technical design, and social consideration using the evaluation form. After the evaluation, student respondents received the contextualized comic book with cell division content as an instructional aid. Respondents were given ample time to read the contextualized comic book to increase their knowledge about cell division.

### Post-test Phase

A post-test was conducted to measure the terminal knowledge of the students. Terminal knowledge of the students from the pre-test to the post-test was compared using a t-test to determine significant differences.

**Table 4.** Inter-rater reliability of the contextualized comic book in terms of content

Content	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
C1	0	0	1	2	0.33	Fair agreement
C2	0	0	0	3	1.00	Almost perfect agreement
C3	0	0	1	2	0.33	Fair agreement
C4	0	0	0	3	1.00	Almost perfect agreement
C5	0	0	1	2	0.33	Fair agreement
C6	0	0	2	1	0.33	Fair agreement
Total	0	0	5	13		
	0	0	0.27	0.72		
Average proportion of agreement ( $p_{bar}$ )			0.56			Moderate agreement
Expected outcome ( $Pe$ )			0.60			
Kappa ( $K$ )			-0.11			

Notes: NA (Not Applicable), D (Disagree), A (Agree), SA (Strongly Agree)

Based on the Fleiss Kappa scale interpretation, the evaluators rated the contextualized comic book 0.56 value as moderate agreement.

**Table 5.** Inter-rater reliability of the contextualized comic book in terms of instructional design

Instructional design	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
ID1	0	0	2	1	0.33	Fair agreement
ID2	0	0	3	0	1.00	Almost perfect agreement
ID3	0	0	0	3	1.00	Almost perfect agreement
ID4	0	0	0	3	1.00	Almost perfect agreement
ID5	0	0	1	2	0.33	Fair agreement
ID6	0	0	2	1	0.33	Fair agreement
ID7	0	1	0	2	0.33	Fair agreement
ID8	0	0	0	3	1.00	Almost perfect agreement
ID9	0	0	0	3	1.00	Almost perfect agreement
ID10	1	0	2	0	0.33	Fair agreement
ID11	2	0	1	0	0.33	Fair agreement
ID12	0	0	0	3	1.00	Almost perfect agreement
ID13	0	0	1	2	0.33	Fair agreement
ID14	0	0	0	3	1.00	Almost perfect agreement
ID15	0	0	1	2	0.33	Fair agreement
ID16	0	0	1	2	0.33	Fair agreement
ID17	0	0	1	2	0.33	Fair agreement
ID18	0	0	0	3	1.00	Almost perfect agreement
ID19	0	0	2	1	0.33	Fair agreement
Total	3	1	17	36		
	0.05	0.01	0.29	0.63		
Average proportion of agreement ( $p_{\bar{}}$ )			0.61			Substantial agreement
Expected outcome ( $P_e$ )			0.49			
Kappa ( $K$ )			0.24			

*Notes.* NA (Not Applicable), D (Disagree), A (Agree), SA (Strongly Agree)

On the other hand, in terms of instructional design, the evaluators agreed that the comic book is classified as substantial, with an average proportion agreement of 0.61 and a *k*-value of 0.24.

**Table 6.** Inter-rater reliability of the contextualized comic book in terms of technical design

Technical design	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
TD1	0	0	1	2	0.33	Fair agreement
TD2	0	0	1	2	0.33	Fair agreement
TD3	0	0	2	1	0.33	Fair agreement
TD4	0	0	2	1	0.33	Fair agreement
TD5	0	2	0	1	0.33	Fair agreement
TD6	0	0	2	1	0.33	Fair agreement
TD7	0	0	1	2	0.33	Fair agreement
Total	0	2	9	10		
	0	0.09	0.43	0.48		
Average proportion of agreement ( $\bar{p}$ )				0.33		Fair agreement
Expected outcome ( $P_e$ )				0.42		
Kappa (K)				-0.15		

*Notes.* NA (Not Applicable), D (Disagree), A (Agree), SA (Strongly Agree)

Moreover, in technical design, the average proportion of agreement and *k* value, 0.33 and -0.15, respectively, means that the evaluators have a fair agreement.

**Table 7.** Inter-rater reliability of the contextualized comic book in terms of social consideration

Social consideration	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
SC1	0	0	1	2	0.33	Fair agreement
SC2	2	0	0	1	0.33	Fair agreement
SC3	1	0	0	2	0.33	Fair agreement
SC4	0	0	0	3	1.00	Almost perfect agreement
SC5	2	0	0	1	0.33	Fair agreement

(Continue on next page)

Table 7 (continued)

Social consideration	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
SC6	0	0	0	3	1.00	Almost perfect agreement
SC7	0	0	0	3	1.00	Almost perfect agreement
SC8	0	1	0	2	0.33	Fair agreement
SC9	0	0	0	3	1.00	Almost perfect agreement
SC10	1	0	0	2	0.33	Fair agreement
SC11	2	1	0	0	0.33	Fair agreement
SC12	1	1	0	1	0.00	Poor agreement
SC13	0	1	0	2	0.33	Fair agreement
SC14	1	1	0	1	0.00	Poor agreement
Total	0	2	9	10		
	0.24	0.12	0.02	0.62		
Average proportion of agreement ( $\bar{p}$ )					0.48	Moderate agreement
Expected outcome (Pe)					0.45	
Kappa (K)					0.04	

Notes. NA (Not Applicable), D (Disagree), A (Agree), SA (Strongly Agree)

Table 7 presents that out of the 13 Inter-Rater Evaluation indicators in terms of social consideration, the developed contextualized comic book was rated by the experts with a  $k$ -value of 0.04 with an average proportion of agreement of 0.48, classified as Moderate Agreement.

**Table 8.** Inter-rater reliability result of the contextualized comic book

Area of evaluation	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
Content	0	0	5	13	0.56	Moderate agreement
Instructional design	3	1	17	36	0.61	Substantial agreement
Technical design	0	2	9	10	0.33	Fair agreement
Social consideration	10	5	1	26	0.48	Moderate agreement
Total	13	8	32	85		
	0.09	0.06	0.23	0.61		

(Continue on next page)



Table 8 (continued)

Area of evaluation	Ratings				Proportion of agreement	Interpretation
	NA	D	A	SD		
Average proportion of agreement ( $p_{\text{bar}}$ )				0.52		Moderate agreement
Expected outcome ( $P_e$ )				0.44		
Kappa (K)				0.14		

Notes. NA (Not Applicable), D (Disagree), A (Agree), SA (Strongly Agree)

As reflected in Table 8, the developed contextualized comic book was evaluated by three (3) raters to assess its validity in terms of content, instructional design, technical design, and social consideration, and all the items were rated by the experts with a  $k$ -value of 0.14 with an average of the proportion of agreement of 0.52 classified as Moderate Agreement. In particular, contextualized comic books' content gained 0.56 proportion of agreement which is interpreted as Moderate Agreement. 0.61 proportion of agreement for Instructional Design which is classified as Substantial Agreement, 0.33 proportion for Technical Design, classified as Fair agreement; and 0.48 proportion of agreement for Social Consideration which obtained Moderate Agreement.

### Effectiveness of the Comic Book

Table 9 presents the pre-test scores of grade 10 students. It indicates the frequency distribution of the 189 Grade 10 students as to their proficiency level in cell division concept before the intervention.

**Table 9.** Frequency distribution of the Grade 10 students as to their proficiency level in cell division concept before the intervention

Proficiency level	$f$	%
90–100 (Highly Proficient)	3	1
75–89 (Proficient)	47	25
50–74 (Nearly Proficient)	25	13
25–49 (Low Proficient)	100	53
0–24 (Not Proficient)	14	8
Total (N)	189	100
Mean	47.751	
SD	21.209	

It can be gleaned from the table that out of 189 students, only a few with a total frequency of 50 got a passing score ranging from 75–89, classified as Proficient and 90–100, classified as Highly Proficient, respectively. However, most of the students' scores belonged to the Proficiency Levels of Nearly Proficient, Low Proficient and Not Proficient, with a frequency value of 139. This finding confirms the PISA (Programme for International

Student Assessment) 2019 result in science below the average among the participating Organization for Economic Co-operation and Development (OECD) countries.

### Grade 10 Students as to their Proficiency Level in Cell Division Concept after the Intervention

The post-test scores of the grade 10 students are illustrated in Table 10. Table 10 indicates the Frequency distribution of the 139 Grade 10 students (those who belonged to a performance of nearly proficient, low proficient, and not proficient in the pre-test) as to their proficiency level in cell division concept after the intervention.

**Table 10.** Frequency distribution of the Grade 10 students as to their proficiency level in cell division concept after the intervention

Proficiency level	<i>f</i>	%
90–100 (Highly Proficient)	19	14
75–89 (Proficient)	56	40
50–74 (Nearly Proficient)	49	35
25–49 (Low Proficient)	15	11
0–24 (Not Proficient)	0	0
Total (N)	139	100
Mean	70.540	
SD	16.840	

It can be drawn from the table that out of 139 students who took the post-test, most got a passing score of 75–89, classified as Proficient, and 90–100 classified as Highly Proficient, with a total frequency of 75. On the other hand, fewer students with a total frequency value of 64 who got a score of 50–74, classified as Nearly Proficient, and 25–49, classified as Low Proficient, and none got 0–24, classified as Not Proficient. The table shows that there is evidence of improvement in the scores of the students after the investigation.

### The Difference in the Pre-test and Post-test Performance

The significant difference in the pre-test and post-test performance of the students is revealed in Table 11.

**Table 11.** Comparison of students' scores before and after the intervention

Students Performance Score	Pre-test mean	Post-test mean	w	<i>p</i>	Decision
	47.75	70.54	28.00	< 0.001	Reject Ho

Table 11 shows that there is strong evidence of a significant difference between the pre-test performance and the post-test performance of the students. The computed Wilcoxon value reached 28.00 with a *p*-value of < 0.001. Since the *p*-value is less than 0.05, it indicates a significant difference between the two tests. This implies that the students exposed to contextualized comic books increased their level of knowledge in terms of the cell division

concept after the study. Notice that the mean score of the students during the pre-test is 47.75 compared to a higher mean score of 70.54 during the post-test. The mean score of the two tests indicates that students classified as Nearly Proficient, Low Proficient and Not Proficient prior to intervention when exposed to and utilizing the contextualized comic book have potentially improved their performance.

### **Feedback from the Students on Contextualized Comic Book**

The results revealed that the student respondents generally favor comic books as instructional materials for learning science concepts, specifically Cell Division. They appeared to have learned and understood better, heightened their interest and curiosity and awakened their imagination and creativity. Most students perceived that the developed comic book is a good provider of information about Cell Division for it discusses the different stages of the Cycle. One of the students said:]

I've learned a lot. I understand the lesson easily by just reading the comic book since it shows and explained the topic clearly and concisely. The images and figures helped me understand the process of Cell cycle.

According to other students, the comic book provides a comprehensive and engaging way of learning that allows them to interact and use their imagination while learning the concept. One of the students said:

It is entertaining and enjoyable because of the colorful drawings at the same time comprehensive. It allows us to interact with other students while reading by letting us imagine the story and image.

Moreover, only some students suggest and hope to receive more activities or instructional materials like a comic book for better understanding and a fun way of learning. "Thank you for this wonderful activity. I love reading comic books and every time I read one, my mind keeps imagining the story. I hope we will receive more activities like this, comic book", one student commented. The results are supported by the ideas of Mallia (2007) and Özdemir (2010) that comics promote productive classroom engagements and show cognitive potential for students' motivation and retention purposes.

## **DISCUSSION**

The conceptualization of cell division using a contextualized comic book was established from the pre-test performance of the students, where the majority are classified as Nearly Proficient, Low Proficient and Not Proficient. In terms of the post-test performance, most of the students under the intervention using contextualized comic books belonged from Proficient to Highly Proficient. The significant difference between the pre-test and the post-test clearly indicates a significant difference between the pre-test and the post-test scores. The findings affirm the study of Enteria and Pet (2019) that comics were influential as instructional material in teaching science concepts. Further, comic strip as instructional

material positively affects students' performance; they learn the lesson quickly as the picture diagram presents the topic. It also reiterates other findings that cartooning can improve students' performance even in struggling subjects like Physics.

In addition, experts agreed that the instructional material is acceptable and commendable to use in the classroom setting. Moreover, the students elicited positive feedback regarding using the contextualized comic book "The Cell Cycle Adventure of Cyto" as instructional material in the teaching and learning process, for it fostered their interest, creativity, and a better understanding of the concept of Cell Division. The results imply that the developed contextualized comic book is suitable to the learner's level of knowledge and development in which the content is in line with the K-12 curriculum, contributes to the achievement of the specific objectives, abides by social considerations, is free from biases and prejudices, enhances the development of creativity, communication, promotes student interaction and collaboration. The overall evaluation of its validity and reliability revealed that the contextualized comic book as a developed instructional material in teaching the Cell Division concept is highly usable. Evaluators concluded that the contextualized comic book possesses high acceptability and efficacy in enhancing learners' performance in science.

In educational and training settings, comics are frequently used as an instructional resource or activity in a graphically enhanced format while maintaining the features mentioned in the definitions (Akkaya, 2013; Joshi et al., 2019). It is considered that if comics are written in accordance with two fundamental educational ideas, they would assist students in learning. The first is to arrange stories that students could find attractive in a particular environment, while the second is to provide a meaningful relationship between the topics covered and the students' real life (Toh et al., 2016).

Moreover, the effectiveness of the study's results, which pertain to the effect of the contextualized comic book on the academic science performance of the students to Cell Division concept, support the idea of the Cognitive Theory of Multimedia Learning, where visual learning helps enhance the cognitive skills of the learners. Due to challenged teachers in discovering and designing instructional materials, learning resources for each student need to be increased. The contextualized comic book stems from issues that subsequently contribute to student's disinterest in reading. They may be utilized as an effective additional teaching tool for concretizing abstract topics, particularly in science lectures. They may also be used to amuse pupils while teaching abstract subjects (Akcanca, 2020). Despite the fact that the source of learning is one of the instruments that every school must have, the school has desperately needed learning resources that constitute instructional materials pertinent to the subject matter until now.

Students will be able to find a balance between learning contents from the curriculum and real-life experiences if the contents of the instructional comics used in scientific education are chosen from everyday life. Students will recall content better when it is integrated with visual explanations via dialogues and script, and they will participate more completely in scientific sessions when this engaging teaching technique is used. This will have an influence on students' scientific education and make a more substantial contribution to

their learning. It is hoped that by doing so, any possibility of student misunderstandings might be averted. Numerous examples and ideas are offered in this study to enhance awareness of the possible use of comics in scientific instruction. According to the articles, comics may be used to both entertain and teach students in science courses. Because of this feature, comics are sometimes seen as genuine edutainment tools as alternatives to standard teaching techniques. Researchers, teachers, and academics are doing deeper and larger investigations into the types of comics and their use in educational settings in relation to various educational theories and practices.

## **CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS**

Developing and implementing the contextualized comic book significantly improved students' understanding of some complex science concepts, such as cell division. The nature of the comic in delivering the content in colored pictures and a storyline positively impact the student's ability to understand cell division concepts better and successfully answer various questions. Using comics in instructional activities will give students a new doorway into their imagination and contribute to their creative thinking processes. Furthermore, visually enhanced educational materials are crucial in improving children's visual perception abilities and preparing them for the future. As a result, it is believed that the bonds pupils form with comic books should be noticed. Thus, incorporating a contextualized comic book in teaching science concepts is recommended, particularly for science concepts identified as difficult or complex and for science competencies considered to be the least learned.

The study acknowledges the research's inherent limitations. Because the study was limited to the topic cell division, the effect of incorporating contextual variations in other topics may have substantially influenced the outcomes. It may be essential to replicate the study in another topic with various sets of most essential learning competencies in science.

Using topics from everyday life to create instructional comics for scientific education can help students establish a balance between their personal and academic lives. When visual and audio explanations are merged, students' recollection of knowledge increases, and they engage more actively in scientific sessions when employing this unique teaching style. This will impact students' scientific knowledge and contribute significantly to their learning. This is supposed to help remove any misconceptions among students. Simultaneously, including information about societal issues such as science and technology in instructional comics would improve students' science literacy. The Philippines and some other Asian countries are developing countries with limited access to learning materials and technology, making using sophisticated and high-end gadgets in the classroom impossible. Thus, contextualized comic books in these locations are also beneficial because this material can be delivered and facilitated to isolated areas with limited access to technologies and other learning materials. It is recommended that instructional comics be included in many courses, particularly in science, due to their contribution to the teaching process.

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