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Research Article

THE IMPACT OF CONCEPT CARTOONS AS AN INSTRUCTIONAL MATERIAL AND FORMATIVE ASSESSMENT TOOL IN TEACHING EVOLUTION ON THE ACHIEVEMENT OF GRADE 11 STEM STUDENTS ENROLLED IN SYNCHRONOUS MODALITY

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Abstract
Employing a pretest-posttest quasi-experimental design, this study ventures into uncharted territory by investigating the impact of Concept Cartoons as a pedagogical tool in teaching Evolution on the academic performance of 40 Grade 11 STEM students enrolled in General Biology 2, conducted synchronously. Furthermore, the research pioneers an exploration into students' misconceptions surrounding foundational concepts in Evolution, leveraging Concept Cartoons as a formative assessment tool deployed within an online learning platform. The cohort was divided into control (n = 21) and experimental (n = 19) groups, with the former receiving instruction through traditional lecture methods and the latter through Concept Cartoons administered digitally. Surprisingly, while students exhibited a spectrum of misconceptions related to Evolution, both experimental and control groups demonstrated statistically significant improvements in academic achievement from pre-test to post-test. Intriguingly, however, comparison of post-test scores between the experimental and control groups via independent t-test yielded no significant difference in achievement. This incongruity prompted a nuanced discussion on potential contributing factors, including the efficacy of Concept Cartoons in digital media and unforeseen technical challenges encountered during synchronous instruction. These findings offer valuable insights for science educators navigating the transition from face-to-face to online instruction amid the ongoing pandemic, underscoring the importance of critically evaluating the adaptability and effectiveness of instructional materials within diverse learning modalities.

Keywords: Biology Education, Concept Cartoons, Evolution, Synchronous Modality

INTRODUCTION

Stimulating critical thinking and reasoning had become a challenge when the educational system, not just in the Philippines but also worldwide, was forced to shift from face-to-face to blended or flexible learning due to the Covid-19 pandemic. Since interactions are limited, instructional materials and learning activities that were long before used by the teachers to stimulate and develop science process skills had not become applicable in the pandemic educational context. Even in synchronous learning, it is quite a challenge for basic education teachers to sustain engagement in studying Science and ensure that students keep on developing their science process skills even if they are at a distance.

If common cartoons are used to provoke humor, Concept Cartoons not just entertain but also stimulate critical thinking and reasoning inside the classroom, thus making students inquire about knowledge. Concept Cartoons combine visual elements with the texts written in dialogues (Keogh & Naylor, 1999). Brenda Keogh and Stuart Naylor first created Concept Cartoons in 1991 to elicit learners' ideas, challenge their thinking, and support learners in developing their understanding. As a formative assessment tool, Concept Cartoons are also used to diagnose misconceptions (Chin & Teou, 2010; Serttaş & Türkoğlu, 2020).

The scientific community considers Evolution as an integral part of science education. It is the sole theory that serves as a thread that meaningfully 'links' the knowledge related to all domains of biology. However, it has been revealed that high school students matriculate to college holding misconceptions related to biological Evolution. These misconceptions interfere with students' abilities to grasp accurate scientific explanations and serve as fundamental barriers to understanding Evolution (Yates & Marek, 2014).

Concept Cartoons is a seasoned instructional material in developing Science students' critical thinking and reasoning, thus helping increase the students' achievement in the subject. However, aside from the little amount of information on the effect and use of Concept Cartoons or even cartoons as integrated into teaching in the Philippine schools, the researchers found a dearth of published studies as regards the utility of Concept Cartoons in an online learning environment. Surveyed literature and studies generally focused on the effects and use of Concept Cartoons in a face-to-face classroom set-up.

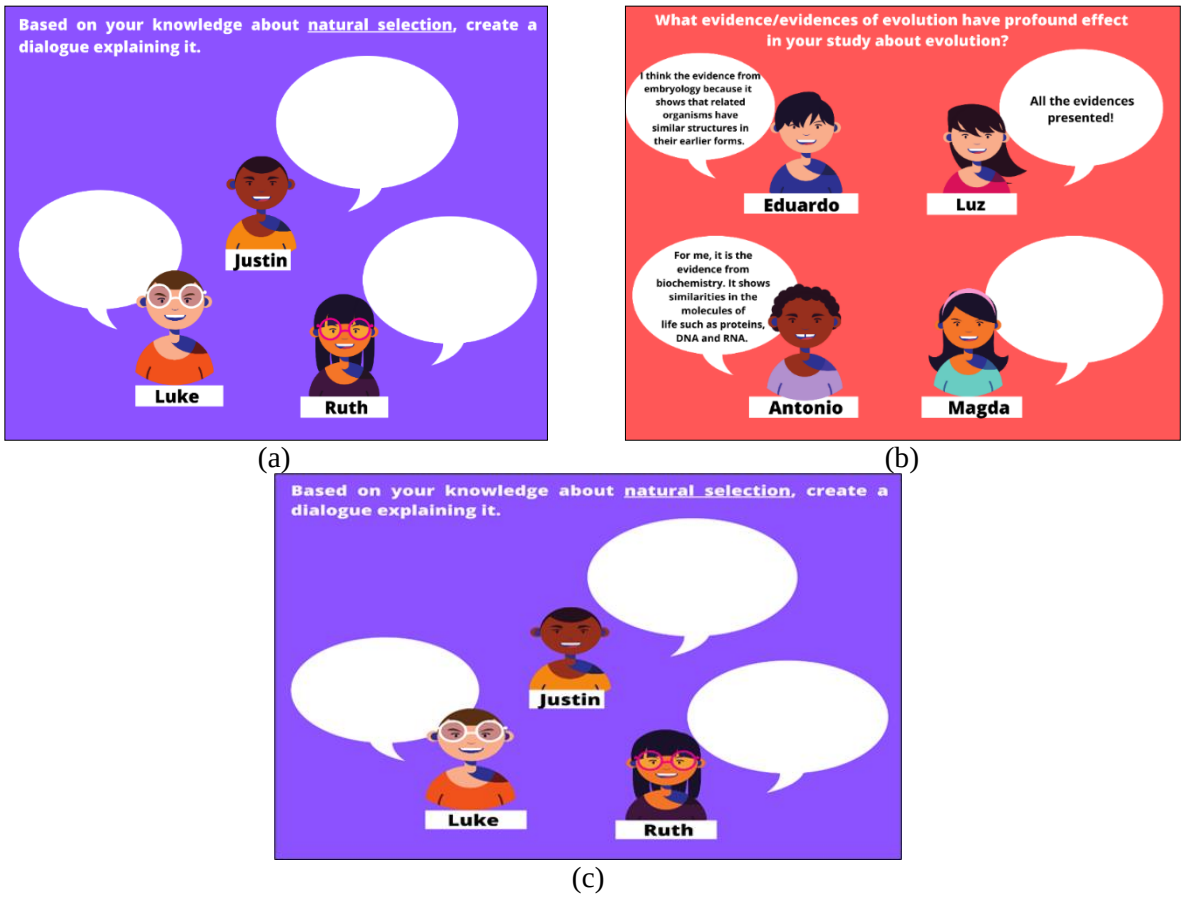
Evolution is a topic that is prone for the students to have misconceptions due to its abstraction, complexity, and previous false assumptions influenced by religious beliefs and media. Since STEM students are most likely to pursue STEM-related degrees in the future, Science teachers must ensure that misconceptions on one of the foundation subjects in STEM courses are lessened if not totally eliminated, thus, facilitating greater understanding and learning achievement. Moreover, the value of critical analysis and reasonable judgments are needed to develop in them as future professionals dealing with much decision-making. Therefore, this study investigates the effect of Concept Cartoons as instructional material and as an assessment of learning tool in teaching Evolution to the achievement of Grade 11 STEM students enrolled in synchronous modality. Specifically, it seeks to: 1) describe the students' achievement in Evolution before and after the use of the Concept Cartoons; 2) diagnose the students' misconceptions about concepts in Evolution through Concept Cartoons as a formative assessment tool implemented in synchronous teaching mode, and; 3) determine the significant difference in the scores of students.

RESEARCH METHOD

The study utilized a pretest-posttest quasi-experimental design. The study was conducted during the 2nd semester of Academic Year 2020-2021 in a Science High School in Cabanatuan City, Nueva Ecija. Subjects of the study were composed of 40 Grade 11 students under the STEM strand. Students were divided as a group taught the conventional method (n = 21) and a group taught using Concept Cartoons (n = 19). Purposive sampling research method was thought to be the most appropriate because the study made no attempt to generalize its findings to a larger population due to its parochial nature. A letter requesting for authorization to conduct the study was personally delivered to the Schools Division Office and the school principal prior to the start of the study. Because all of the subjects were minors at the time of the study, the researchers were required to obtain permission from their parents through a consent form administered via Google Forms.

The Concept Cartoons were developed based on the Most Essential Learning Competencies (MELCS) prescribed by the Department of Education (DepEd) for General Biology 2 under the unit of Evolution. A set of Concept Cartoons (Figure 1) consisting of three different types were developed and

utilized in every meeting: first, a Concept Cartoon consists of four expressions in speech bubbles indicating four different ideas, only one of these expressions included a scientific judgment, while the others are misconceptions; second, a Concept Cartoon where one speech bubble was empty, and the students' task was to write or give their personal opinion on the empty speech bubble; and third, a Concept Cartoon where all speech bubbles of the four characters were empty, and the students' task was to answer the question being posed by writing simple dialogue based on what they learned from the lesson.



(a) (b)

(c)

Figure 1. Sample of the first type of Concept Cartoon used; (b) Second type; (c) Third type

In determining students' achievement before and after the experiment, the researchers constructed a 30-item multiple-choice test based on the prescribed MELCS. The achievement test was administered using Google Forms. The teacher-made test was piloted to 20 students, who were not part of the actual quasi-experimental procedure. Internal consistency was tested using Cronbach's coefficient alpha. The results showed that the instrument has a reliability of 0.802, which indicates that it is acceptable.

The topics under the unit Evolution were presented in a synchronous teaching mode for 60-minutes for two weeks. The lessons were delivered using *Google Classroom* (DepEd recognized LMS) and *Google Meet* (video conferencing tool). One group used regular lecture-discussion for delivering the lessons. Concept Cartoons were used as instructional materials in presenting each lesson to the other group. The Concept Cartoons were presented to the students via a screen-sharing feature in Google Meet. Moreover, the developed Concept Cartoons were uploaded to the class's group chat on *Facebook Messenger* for the students to access and edit the Concept Cartoons using the built-in text editor in the platform during instruction. Then, they individually sent their outputs through private messages to the researchers. Furthermore, Concept Cartoons were also used as a formative assessment tool. The online tool called *Mentimeter* was used to present the Concept Cartoons to diagnose the students' misconceptions since this online tool facilitates interaction within synchronous teaching mode.

The developed instrument for students' achievement in Evolution served as the subjects' pretest and posttest achievements. The pretest was conducted before teaching the students with Concept

Cartoons, and the posttest was given after two weeks. The achievement test was administered using Google Forms. Paired sample t-test was used to determine if there was a significant difference between the pre-test and posttest scores in each group. Furthermore, the posttest scores of students in different groups were compared through an independent sample t-test at a 0.01 level of significance. For the diagnosed misconceptions, frequency and percentage distribution were used to present and analyze the data obtained.

RESULTS AND DISCUSSION

This section presents the results of the study on the students' achievements taught in traditional way of instruction and through the use of Concept Cartoon on the topic of Evolution.

Pretest and Posttest Achievements of subjects in the Control Group

The achievements of the subjects under the control group before and after receiving the traditional way of instruction were determined through their pretest and posttest scores as shown in Table 1.

Table 1. Pre-test and Post-test achievements of subjects in control group

Classification	Score Range	Pretest A X=17.24, SD=3.71		Score Range	Posttest A X=20.76, SD=4.23	
		f	%		f	%
Above Average	21 and above	4	19.05	25 and above	6	28.57
Average	12 - 20	16	76.19	18 – 24	10	47.62
Below Average	13 and below	1	4.76	17 and below	5	23.81

It can be gleaned from the table that 16 (76.19 %) subjects are classified as average, 4 (19.05%) are above average, and only 1 (4.76 %) participant had a below-average score before receiving the traditional way of instruction. The table also presents that 10 (47.62%) subjects obtained average scores, 6 (28.57%) scored above average, and 5 (28.81 %) scored below average after receiving the traditional way of instruction.

This result suggests that majority of the students in the control group already attained the necessary and required competencies and standards about Evolution, with only one participant scored below average in the pretest and five in the posttest. This finding can be attributed to the fact that the subjects were from a Science High School. Ass stipulated in DepEd Order 69 series of 1993, Science High Schools are special schools that cater intellectually promising students and has an enriched Science, Math and English curriculum.

In addition, the research locale also imposes stringent examinations and qualifications for a student to be part of their STEM program track. One of the major qualifications is that the students must have an 85 % and above rating in Science, Math, and English in the National Career Assessment Examination (NCAE). This examination is an annual test taken by all Grade 9 students in public and private secondary schools. If the student's rating, for example, does not meet this qualification, a student can take a qualifying exam but still needs to obtain 85% mark to be admitted in the STEM program.

Furthermore, it can be noted that the number of students who scored below average increased, from only one student in the pretest to five students in the posttest. The researchers did a post-conference interview with those students who fell below average and traced the possible reasons for this finding. Based on the interview, students underscored several factors attributed to their low scores as compared to their classmates in the posttest in Evolution. These include (1) limited time in finishing the test, (2) tons of assignments and activities needed to finish in other subjects, and (3) sluggish internet connection during synchronous discussion. Moreover, one of the students told the researchers that her family was exposed to COVID-19, which made her distracted from her studies.

The foregoing narratives from the subjects corroborate the findings of Moore and Tenney (2012), Kamel (2018), and Rasheed et al. (2019). Moore and Tenney (2012) reported that time constraints could impair performance because they limit thought and action capacity and exploration. However, it must be noted that the researchers allotted limited time for pretest and posttest in the

synchronous modality that affected some students. Kamel (2018) stated that students who were overwhelmed by their daily academic requirements and responsibilities will have a lower academic adjustment. Lastly, Rasheed et al. (2019) listed slow internet connection and low bandwidth under technological sufficiency as one of the reported students' challenges in blended learning.

Pre-Test and Post-Test Achievements of subjects in the Experimental Group

The achievements of the subjects under the treatment group in Evolution before and after receiving Concept Cartoons as instructional material and formative assessment tool were determined in their pretest and posttest scores (Table 2).

Table 2. Pretest and Posttest achievements of the subjects in experimental group

Classification	Score Range	Pretest B X=16.84, SD=3.53		Score Range	Posttest B X=20.63, SD=5.28	
		f	%		f	%
Above Average	21 and above	4	21.05	26 and above	3	15.79
Average	14 - 20	11	57.89	17 - 25	13	68.42
Below Average	13 and below	4	21.05	16 and below	3	15.79

Table 2 shows that 11 (57.89 %) subjects obtained average scores, and 4 (21.05 %) subjects obtained both above-average and below-average scores, respectively. Moreover, 13 (68.42 %) scored average, and 3 (15.79 %) scored both above average and below-average, respectively, after receiving multimedia instruction and learning,

This result suggests that majority of the students performed well in both tests, with only four subjects who scored below average in the pretest and three in the posttest. Similar with the control group, the experimental group already attained the required competencies on the topic Evolution. The foregoing result may also be attributed to the fact that the subjects were enrolled in a Science High School that observes more rigorous entrance examinations for intellectually promising students, emphasizing problem-solving and critical thinking. Further, they went through a rigid selection in terms of examination ratings in science which made them qualified for the STEM track.

Misconceptions on Evolution through Concept Cartoons as a formative assessment tool in Experimental Group

As a formative assessment tool, the developed Concept Cartoons were used to diagnose students' misconceptions on Evolution (i.e., species and speciation, evolution and diversity, evidence that support evolution) in the experimental group. The findings reported below (Table 3) indicated that students had a series of misconceptions on the topics under Evolution.

Table 3. Misconceptions of the experimental group categorized based on the topics under the unit of Evolution of General Biology 2 (n=19)

Topics	Misconceptions	f	%
Species and Speciation	Species had all been specially created and within relatively recent history.	8	42.11
	The goal of Evolution is to make faster, bigger, and smarter species.	5	26.32
Evolution and Diversity	Evolution explains the origin of life.	8	42.11
	Evolution only occurs over millions of years.	5	26.32
	Survival of the fittest means only the fastest, smartest and strongest organism will live on.	4	21.05
Evidences of Evolution	Species may share similar physical features only if they are close relative species of one another.	7	36.84
	Gaps in fossils records can disprove Evolution since there is a lack of transitional fossils between all animals.	5	26.32
	Embryonic stages of some chordates are the same.	1	5.26

It can be gleaned from Table 3 that under the topics *Species and Speciation and Evolution and Diversity,* almost half of the students (n = 16) in the experimental group had a misconception that is rooted in the belief of creation reported that "*Species had all been specially created and within relatively recent history* (n=8 or 42.11%)*"* and "*Evolution explains the origin of life* (n=8 or 42.11%)".

This finding was less surprising because the Philippines is predominantly a Christian country and the only Christian nation in Asia. As such, their beliefs were influenced by the Biblical theory on creation. Moreover, the case studies done by Clores and Bernardo (2007) also showed that attitudes and *religious beliefs* both affect acceptance and understanding of evolutionary theory. Meanwhile, this finding conforms with the study of Clores and Limjap (2006) who explored the beliefs on ecological evolution held by university students from a catholic university. In their investigation, they concluded that there is a clear interaction between science and religion in learning Science. They also concluded that students' current worldviews affect how they understand concepts in the form of attitudes and beliefs.

Still under the topic *Species and Speciation,* five (26.32%) students picked the statement *"The goal of Evolution is to make faster, bigger, and smarter species"* revealing a misconception about the intention of biological Evolution. A wide study done by Yates and Marek (2015) participated by 993 pre-biology high school students in Oklahoma revealed that 30% of its subjects held the same misconception. Thus, it shows that students tend to see evolutionary processes as *deterministic in nature,* with improvement as its aim. However, scientifically speaking, Evolution has no purpose, it has no goal.

The same study of Yates and Marek (2015) found a misconception about the misinterpretation of the phrase "Survival of the fittest" with a hefty 62.5% of students of students having a misconception. The present study also revealed that under the topic *Evolution and Diversity,* a misconception of almost the same statement was diagnosed, with four students or 21.05% chose the statement *"Survival of the fittest means only the fastest, smartest and strongest organism will live on".* Yates and Marek (2015) explained that this pervasive misconception reflects a misunderstanding of the significance of variation in evolution and its relationship to fitness.

Still under the topic *Evolution and Diversity,* the table presents that five (26.32%) students concur that "*Evolution only occurs over millions of years."* Though it is true that with huge changes like formation of lungs or gaining sense of sight can take millions of years especially with large mammals, that is not the absolute case for all organisms. There are traits that can change much earlier, not requiring over millions of years. For example, with the light of modern genomic tools, Wang et al. (2013) discovered that the evolutionary divergence between wolves and Chinese indigenous dogs only happened *32,000 years ago.*

The table also shows that under the topic, *Evidences of Evolution,* seven (36.84 %) subjects from the experimental group had a misconception that "*Species may share similar physical features only if they are close relative species of one another"*. Five subjects (26.32 %) believed that "*Gaps in fossils records can disprove evolution since there is a lack of transitional fossils between all animals"*. The result showed that the idea that all organisms on the earth are connected because they share a common ancestor was not fully grasped by the subjects. This finding echoes Seoh et al.'s (2016) findings in which their interviews with high school students revealed that some of them thought that interbreeding between two or more species can result in the speciation of humans, together with several misconceptions about the term "last common ancestor".

Difference in the Achievements of Control Group after receiving traditional instruction

The difference in the achievement of the subjects under control group before and after receiving the traditional instruction method was determined using the pretest and posttest scores (Table 4).

Table 4. Difference in the achievements of subjects under control group before and after instruction

Parameter	Mean	SD	Mean Difference	df	t	p-value
Pre-test	17.24	3.71	-3.52	20	-3.88**	.001
Post-test	20.76	4.23				

** highly significant at .001 level (2-tailed)

Table 4 shows that the subjects had a pretest mean of 17.24 (SD = 3.71), and a posttest mean of 20.76 (SD = 4.23). The results show that the posttest mean is statistically higher than the pretest mean. Further, the t value is -3.88 with a p-value of .001, which is less than 001, which rejects the null hypothesis stating that there is no significant difference in the pre-assessment scores and post-assessment scores of the control group.

The performance of the subjects in Evolution has statistically improved after receiving the traditional way of instruction. It is tenable to assume that the traditional way of instruction is most likely effective in improving the achievement in Evolution. It may be attributed to the fact the subjects are exposed to the presentations and explanations of the concepts, asked questions and clarifications about the lessons, received soft copies of Self-Learning Modules (SLMs) via Google Classroom, and completed their Written Works in learning the topics under the unit of Evolution.

The results of the study do not concur with Blumberg (2015) when she found that the traditional methods of content delivery had a negative impact on how the students gained background on the subject presented and that the students performed poorly on the standardized tests given. The limited way in which the content of the lessons was delivered in the traditional manner of lecture and worksheets was not an effective way to engage students' abilities.

Difference in the Achievement in Evolution of the Subjects under Experimental Group before and after Concept Cartoons as an Instructional Material and Formative Assessment Tool

The difference in the achievement in Evolution of the subjects under experimental group before and after receiving Concept Cartoons as instructional material and formative assessment tool was determined using the pretest and posttest scores as shown in Table 5.

Table 5. Difference in the subjects' achievements under experimental group before and after the instruction

Parameter	Mean	SD	Mean Difference	df	t	p-value
Pre-test	16.84	3.53	-3.79	18	-2.92**	.009
Post-test	20.63	5.28				

** highly significant at .001 level (2-tailed)

Table 5 shows that the subjects in the experimental group had a pretest mean of 16.84 (SD =3.53) and posttest mean of 20.63 (SD = 5.28) after receiving instructions through Concept Cartoons. The results suggest that the posttest mean is significantly higher than the pretest mean. The table also presents that the t value is -2.92 with a p-value of .009, which is less than 001. It means that the null hypothesis stating that there is no significant difference in the pre-assessment and post-assessment scores of the experimental group who used the Concept Cartoons is rejected. The achievement of the subjects in experimental group had significantly improved after receiving Concept Cartoons as instructional material and formative assessment tool. The foregoing results can be attributed to the fact that critical thinking and reasoning of the students were stimulated through Concept Cartoons.

Difference in the Achievement in Evolution of the Two Groups of Subjects after Using Concept Cartoons in Teaching and Learning Evolution

The difference in the achievement of control and experimental groups after having received traditional instruction and instruction through the use of Concept Cartoons is shown in Table 6.

Table 6. Difference in posttest scores of control and experimental groups

Groups	Mean	SD	Mean Difference	df	t	p-value
Control	20.76	4.23	0.13	38	$.09^{ns}$	.931
Experimental	20.63	5.28				

^{ns} not significant at .05 level (2-tailed)

Table 6 shows that the control group has a posttest mean of 20.76 (SD = 4.23) after receiving the traditional way of instruction, and the experimental group has a posttest mean of 20.63 (SD = 5.28)

after receiving Concept Cartoons as instructional material and formative assessment tool. The results show that the mean of the experimental group is the same with the mean of the control group. The table also presents that the t value is 0.09 with a p-value of .931, which is greater than .05. It reveals that the null hypothesis stating that there is no significant difference in the post-assessment scores of the control and experimental groups is accepted.

This finding does not concur with the previous studies on Concept Cartoon. Several studies documented the effect of Concept Cartoons on the students' achievement in science. For instance, Yilmaz (2020) found that the instruction with Concept Cartoons effectively increased the academic achievement of Grade 4 in science lessons. In addition, Filipino first-year students college students' achievement in the topic Evolution and Diversity was examined in the study of Estacio (2015). The findings revealed that when posttest scores of experimental and control groups were compared, results revealed a statistically significant difference between experimental and control groups as regards their achievement. The effect of Concept Cartoons on students' achievement was also assessed by Teke, et al. (2013). The result implied that in terms of post-test scores, Concept Cartoon enriched education is more effective due to the higher score attained in the achievement test of the experimental group as compared to the control group.

However, the foregoing studies, which indicate that Concept Cartoons could improve the achievement of students in science, were all done in the pre-COVID era, where face-to-face classes are still available. The current study differs from the previous studies conducted about Concept Cartoon because the Concept Cartoons were given and answered online, using different online tools and platforms. Moreover, subjects in this study were enrolled in a synchronous modality. This provides new perspectives on the use of Concept Cartoons in learning. The researchers then posit that the effectiveness of Concept Cartoons may vary depending on the learning modality in which it is used.

The researchers surmised two factors to explain this interesting finding. First, it has to do with which media facilitates more information retainment: print or digital. The study of Mangen et al. (2013) explores the effects of the technological interface on reading comprehension in a Norwegian school context by comparing the reading comprehension performance of tenth graders who read texts in print and those who read the same text but in PDF format on a computer screen. The study concluded that students who read texts in print scored significantly better on the reading comprehension test than students who read the texts digitally. Take note that the inclusion of text in the form of dialogue is one of the distinguishing elements of Concept Cartoons over other regular cartoons. According to its creators, conceptual cartoons combine visual elements with the *texts written in dialogues* (Keogh & Naylor, 1999; Naylor & Keogh, 2013).

In addition, findings from neuroscience also favor print over digital media. The branding agency called Millward Brown (2009), investigated how the brain processes physical marketing materials, such as direct mail, compared to virtual (or digital) materials presented virtually. Twenty subjects were shown both ads that were already in the market and an equal quantity of "scrambled" images. The same material was shown on-screen (to produce the online, virtual experience) and printed on cards (to produce the physical experience). Then they used functional Magnetic Resonance Imagery (fMRI) scanning to understand how the brain reacts to physical and virtual stimuli. The results revealed that printed materials produced more brain responses connected with internal feelings, suggesting greater "internalization" of the ads. Moreover, physical materials involve more emotional processing, which is vital for memory and brand associations. With these findings and supporting studies, the researchers found a possible link between the effectiveness of Concept Cartoons in print hard copies compared to its virtual versions. Therefore, the researchers suggest that a hybrid of the two channels seems to be the best way to effectively use Concept Cartoons in the new normal where synchronous classes are prevalent.

The second factor that might influence this finding is the occurrence of technical problems during the subjects' synchronous classes due to the unstable and intermittent internet connection of both the researchers and students. The study of Fabito et al. (2020) revealed that the lack of a good internet connection for participating in online activities is one of the top three barriers of university students in the Philippines in their online learning amidst the pandemic. Also, Reyes-Chua et al. (2020) reported that poor Internet connection was evident during the implementation of their E-learning classroom in selected Higher Education institutions in the Philippines, thus producing poor interactions among the students.

Several technical problems occurred during the conduct of this research which include (1) researchers abruptly lost their audio and eventually disconnected while discussing the lesson, (2) students having difficulty connecting to the virtual meetings due to weak signal, and (3) power outage in some areas where students reside. Moreover, some students lack resources that is why they only rely upon prepaid mobile data connection. Since it is only limited and capped, prepaid mobile data was (4) prone to immediate mobile data exhaustion, especially when the students are not monitoring their data usage in between their classes.

In face-to-face classes, the above identified problems were absent, which ensured that the delivery of instruction and activities were done smoothly with minimal or even without interruption as compared to online synchronous classes. In addition, the comparison of exam average shows that students learning in face-to-face classes perform better than those who are online learning modality (Arias et al., 2018). Therefore, the researchers infer that Concept Cartoons is most likely best delivered in face-to-face classes than in online synchronous modality.

CONCLUSION

Due to the pandemic, the educational landscape was changed, shifting the classes from physical classrooms to virtual ones. Finding material that can stimulate critical thinking and reasoning in teaching and learning Science, despite being done virtually, was a challenge. Due to its effectiveness in face-to-face classes, Concept Cartoons were hypothesized to be also effective in synchronous modality. However, findings of this study showed that Concept Cartoons, which are administered online, do not affect the achievement of Grade 11-STEM students in Evolution enrolled in a synchronous modality. Therefore, the researchers reflected that not all instructional materials and formative assessment tools could all be converted to digital format and expected to have the same effectiveness. Thus, a hybrid of the two channels seems to be the best way to effectively use Concept Cartoons in the new normal where synchronous classes are prevalent. Future studies could replicate this research but may explore comparing the achievement of students between those who will use hard copies and those who will use a hybrid of two modalities (hard copies and virtual versions). Moreover, the present study does not take into account the learning styles of the students. Therefore, it is strongly suggested that future studies may include students' learning styles as one of the variables to be included in exploring the effectiveness of Concept Cartoons as instructional material and formative assessment tool in teaching key concepts in science.

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Conceptualization, Jade O. Hizon and Nikki Y. Cruz; Writing, Original Draft Preparation, Methodology, Leila M. Collantes, and Joel M. Torres; Software, Formal Analysis, Writing & Editing, Amirul Mukminin.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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