Asia Research Network Journal of Education
Vol. 3, No. 3, pp. 119-142, Sep. – Dec. 2023

Development and Implementation of Vodcast in Teaching Light for Grade 8 Students

Dimaro, Sittie Raiyah M., Garzon, April Jane B., Matba, Bindah Arhana J., Sotero O. Malayao Jr.*
Mindanao State University – Illigan Institute of Technology, Illigan, Philippines
Email: Sotero.malayao@g.msuiit.edu.ph

Received: 19 May 2023 Revised: 30 Nov 2023 Accepted: 15 Dec 2023

Abstract. The study was about the development and implementation of vodcast for teaching light. The development flow followed the ADDIE framework. Analysis stage strongly suggests the need for effective material for teaching light. The developed vodcast was rated very satisfactory by experts and a very good material for classroom use. Student performance based on pretest and posttest yielded a 4.88 signifying a very positive perception of student user. The study concludes the effectiveness of vodcast in optimally presenting an abstract concept. The comments of the experts greatly improved the vodcast. The study concludes that the vodcast is a very effective vehicle for a meaningful delivery of a science lesson and would support high motivation of learners.

Keywords: Vodcast; Light; Development; Perception; Conceptual understanding

1. Introduction

Pandemic significantly affects not just our economic growth but also the educational aspect of society. The Philippines were startled by the sudden change in just a short period. In just a short span of a moment, the Philippine educational approach becomes distance learning for safety purposes. As our mode of learning changes, teachers and students are continuously adjusting. It creates a significant problem for teachers and students regarding complementing objectives with this type of learning method. Low internet connection and low resource material are those problems encountered in this new learning approach. It is essential to strategize a learning tool aligned with the lesson objectives and accessible to the students. In this study, a specific instructional/learning tool will be developed to utilize learning light effectively. The reason for this approach is that vodcasts are trending nowadays.

Furthermore, students are becoming aware that these trends may be employed for educational purposes rather than amusement and personal gain. As for its benefits, many vodcasts are informative, yet it has a relaxing or chill vibe that students will be able to focus on a topic with virtual actualization with the aid of interactive simulation.

Also, students' views about a course influence their understanding and learning of the course. Many students think and say, "Physics is challenging." Angell et al. (2004) examines the views of high school students and physics teachers about Physics. They conclude that students find physics challenging because they have to contend with different representations, such as experiments, formulas and calculations, graphs, and

conceptual explanations at the same time. Moreover, they have to make transformations among them. Moreover, the geographic distance between the students and the teacher also poses a serious problem (Ulla, 2021 - Unpublished Thesis).

With the fast growth of wireless networks and mobile technology, learners have become more digital literate, and learning has become more accessible and pervasive than ever before (Boulos et al., 2006). This concept of 'anytime, anywhere' learning has offered multiple challenges to educators and learning technologists, as well as a motivation for learning to be given at the right time, right location, and right form (Bomsdorf, 2005). It is commonly acknowledged that in today's world, when mobile infrastructure is becoming prevalent, educators must adapt to the problems of personal, accessible, and flexible learning.

With the advent of high-speed bandwidths, there has been a major shift to audio podcasts and integrated videos (VODcasts - where the 'VOD' dictionary stands for 'video on-demand'; Meng, 2006). Vodcast instruction is found to be effective in increasing productivity, promoting creativity, and facilitating academic learning (Nwachokor et al., 2019). Vodcasts yielded positive results comparable to that of the traditional face-to-face instruction in teaching trigonometry (Larisma et al., 2017) and significantly helped improve the achievement of students' in a flipped classroom utilizing a module on a topic (Pierce & Fox, 2012).

Schreiber et al. (2010) pointed out that podcasts have several advantages such as lecturers using it to augment their teaching and to teach without restrictions in time or place; secondly, students appreciate learning on the go as they can repeat learning. There have been some little intricacies in Podcast (Campbell, 2005), which are barriers in the increase of workload for the faculty who must learn the technology and upload audio files, understanding the basics of digital audio files, copyright issue, editing of recorded file consumes time and for the most part, podcast for students with disabilities are not achieved because they are not properly edited and these students can't contribute after it has been uploaded. Schreiber et al. (2010) stated that there are some downsides to the podcast which are reduced interaction between students and lecturers, the inability of students to ask questions, the inability of lecturers to gauge the understanding from non-verbal cues and questions. Students may be less engaged in the learning and motivation may suffer. It is important to note that vodcast is the video version of the podcast. To address this situation, running interactive simulations while delivering learning instructions through teacher/researcher-created video podcasts or vodcasts points to promising results (Ulla, 2021 – Unpublished Thesis)

The researchers used an intervention like a developed vodcast - a podcast that works on the concept of video rather than audio, in imparting knowledge about the light because it is more likely to be suggested. After all, this approach has an important stand in learning light. Light must be discussed with a visual aid to address the concept of the topic effectively. Developing a vodcast about light is an intervention to teach light to grade 8 students effectively.

1.2 Statement of the Problem

One of the biggest challenges facing teachers in this pandemic is the learning outcomes that students need to achieve. With the existing challenges such as infrastructure factors, poor learning environment, and nature of content/academic barrier in the Philippine education system, it can be predicted that this challenge can drastically affect the upholding of the quality education in the Philippines (Pitogo, 2021). Thus, this study developed a vodcast-based teaching strategy as a reinforcement to guide students with their experiential and remote learning.

In this study, vodcast which consists of various activities with interactive simulations on light would be utilized first with prior knowledge through the pretest achievement. This simulation would be tried out to find out its effect on students' performance especially to

achieve the specific learning objectives given as the standard curriculum set by Department of Education (DepEd) and to know their conceptual understanding and perception on the developed vodcast as reinforcement in learning light.

1.3 Research Objectives

This study aims to develop vodcast and utilize it as a tool to demonstrate and teach the concept of light specifically to:

1. Develop a vodcast on light.
2. Evaluation of vodcast
    a. By the experts
    b. By the learners
3. Investigate the performance of the learners.
    a. Difference in pretest and posttest
    b. The normalize gain of the learners
4. Investigate the intrinsic motivation to the developed vodcast.

1.4 Null Hypothesis

H0: There is no significant difference in pretest and posttest scores.

1.5 Scope and Delimitation

This study would focus on developing a vodcast on light and how it affects the students' performance and conceptual understanding based on the post-test result and the perception of the developed vodcast through a survey questionnaire.

The developed vodcast would be based on the K-12 Science MELC's given by the Department of Education (DepEd) and the designed vodcast would be evaluated by the students, research panels, research adviser, and content experts.

Table 1. Learning Competencies for Grade 8 Science

Content	Content Standards	Performance Standards	Most Essential Learning Competency
Light	*The learners demonstrate the understanding of:* • some properties and characteristics of visible ligh t	*The learners should be able to:* • discuss phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light	• Explain the hierarchy of colors in relation to the energy of visible light

1.6 Significance of the Study

Physics has been connoted as a challenging subject in school. Based on this perception, it is one of the reasons why some students cannot excel in this area of science. This reputation has to be reduced and let students see the positive side of learning Physics. When an average person is asked to describe physics, a term they use is "challenging." Some find the algebraic emphasis difficult, the physical concepts challenging to wrap around their mind, workload, or the level of critical thought required is intimidating (Checkly, 2010). To aid this wrong perception, the researchers would conduct a study that would develop a vodcast in teaching light for grade 8 students effectively. Hopefully, this study would benefit the following:

The students. The direct recipients of this study are the students taking up Physics. Any development of learning light through vodcast can pave the way for a better conceptual understanding about light.

The Physics Teachers. The study would help them to figure out different approaches that can be used effectively in teaching light. This would give them a diverse scope of educational approach that they would use during discussion of the concept.

The Curricularist. The research would benefit those people who are involved in curriculum planning. This development of different approaches in teaching would guide them to plan an effective curriculum that can be applied in the classroom due to the fact that the curriculum is constantly changing to meet the different and changing learning styles of the students.

The School Administrators. The study would serve as a guide or a basis for implementing the said curriculum and on how to improve the learning progress of the students.

Future Researchers. The outcome of this study would serve as a resource material for future researchers whose study is in connection with the development of the vodcast approach in teaching light.

1.7 Theoretical Framework

This study was influenced from the Cognitive Theory of Multimedia Learning which is based on three fundamental ideas: (a) that audio and visual stimuli are the two types of sensory input, (b) that learners can only take in a limited amount of sensory information at any given time, and (c) that learners engage in an active process of selecting images and sounds, organizing these sensory inputs, and integrating (SOI) these images and sounds from a multimedia presentation (Clark & Mayer, 2007). Although the CTML is heavily based on SOI theory, the three main foundational ideas of the CTML are also derivative of several other theories, including: (a) Paivo's theory of dual coding, which posits that audio and visual codes for representing information are used to construct knowledge; (b) Sweller's cognitive load theory and Baddeley's model of working memory, which refer to the amount of information stored in working memory; and (c) Sweller's cognitive load theory and Baddeley (Mayer & Moreno, 1998). The CTML is used to guide the creation of vodcasts as well as to encourage their usage as a revision tool.

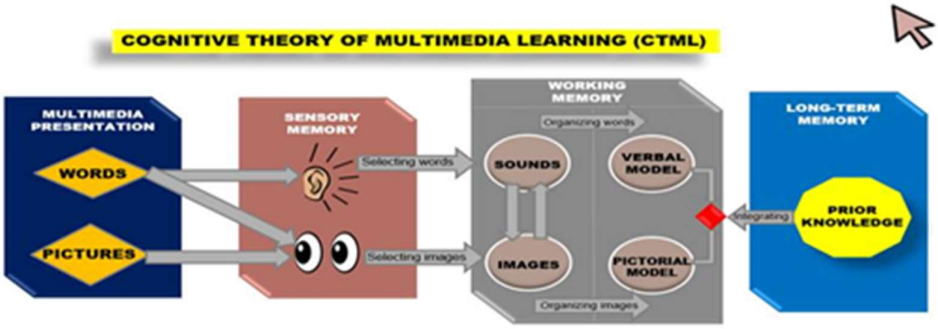

Figure 1. Cognitive Theory of Multimedia Learning (CTML)

The cognitive theory of multimedia learning serves as the major theoretical basis for this study (CTML). Cognitive theory, as applied to learning through multimedia presentations such as review vodcasts, says that learners absorb sensory information through their eyes and ears and then store this knowledge in working memory, where the learner constructs graphical and verbal models (Clark & Mayer, 2007). The learner then combines these graphic and verbal models with prior information to build long-term memory and knowledge of the information taught.

1.8 Review of Related Literature

1.8.1 Challenges Encountered by Educators

The name physics conjures up images of complexity. Therefore, teachers must devise methods for stimulating learners' interest in the physics subject while also convincing them

that learning the various lessons of the physics subject is not rigid but rather exciting and interesting. Learning physics can be both of these things. Learning physics will open your eyes to many new possibilities, and you will be amazed by the world around you and by everything that happens in it.

Educators must deal with the variety of learning styles among their students. Physics can be a complex subject for some students, and educators' job was to encourage them to continue learning. Things will take time to change, but they will. As long as educators successfully pique students' interest and motivate them to study physics, they will eventually enjoy the subject and learn more about it. Life's difficulties, including the problems in the teaching-learning process, are unavoidable. For a variety of reasons, educators may find it challenging to teach physics. Obstacles to teaching physics for educators include a lack of lab space or outdated lab facilities, malfunctioning laboratory equipment and supplies, poor administration or teacher recognition, subpar reference volumes in the library, and a lack of online connectivity (internet access) (Solomon et al. 2015). Among others, the availability of instruments in teaching Physics is one of the most stressed defining attributes of a successful Physics classroom (Diate et al. 2021). The challenges that a physicist educator faces will differ depending on where they teach.

Light is one of the lessons that learners should learn in physics. Challenges that teachers might encounter in teaching the concept of light vary depending on the situation. The difficulties in introducing the idea of light are the mode of delivering it to the student, like will the learners be able to learn when it teaches in this way? Is this activity effective in learning? And many more. Introducing the concept of light will be challenging for the educator because they should think of and make ways to effectively deliver the lesson to the learners.

1.8.2 Vodcast

In the study of innovative use of vodcast (video-podcast) to enrich learning experience in structures laboratory (Mann et al. 2009), it used material consisting of a questionnaire completed by the students, follow-up semi structured interviews and the practical reports submitted by them for assessment. It shows that most of the students who have not fully grasped the theory after the practical, managed to gain the required knowledge by viewing the vodcasts. According to their feedback, the students felt that they had control over how to use the material and to view it as many times as they wished. Some students who have understood the theory may choose to view it once or not at all. Their understanding was demonstrated by their explanations in their reports, and was illustrated by the approach they took to explicate the results of their experimental work. The findings are valuable to instructors who design, develop and deliver different types of blended learning, and are beneficial to learners who try different blended approaches. This study recommended the role of the innovative application of vodcasts in the knowledge construction for structures laboratory and to guide future work in this area of research.

A study on E-learning tools and their impact on pedagogy (Chug, 2010), it explained that educators' expectations and the needs of their students will help determine the kind of e-learning tool to be used. This study has identified some key intrinsic strengths and weaknesses of e-learning tools, which have implications for teaching and learning. E-learning should be seen as an innovative force that improves pedagogy and engages students in productive and exciting ways. Pedagogically richer forms of e-learning can be accomplished by anticipating the requirements of a growing technology savvy generation. This study also discussed that the nature of students, nature of content and infrastructure issues are key areas that educators need to explore before implementing e-learning. Globalization and the trend towards a competitive educational environment have certainly accelerated the development and use of various e-learning tools. It is important to

remember that e-learning tools such as vodcasts are best when considered more broadly than as technology alone. In an educators' perspective, the impact these tools will have on shaping the future and present needs of the student is well worth consideration and should not create any discord and distraction for students. It concluded that E-learning using tools like vodcasts may not necessarily be a panacea for education but a starting point for educators to make educational practices contemporary in the 21st century.

1.8.3 Vodcasting as a Tool to Develop the Skills of Information

By the standards of American Association of School Libraries, the use of video podcasts develops in students the following matters:

• Read, watch, and listen to the information in any format for gathering knowledge. Students would be qualified to evaluate the video podcast and include it in their range of knowledge.

• Collaboration with others to enlarge and deepen their knowledge. With the vodcast, the learning is more attractive for young people and it is easier to reach to more persons, being the action of sharing computer issues a type of divulgation of the knowledge very common among students.

• Using technology to create new knowledge. It is an innovative way to get information to students and create projects that develop information skills.

• Use technology and other information tools for organizing and presenting knowledge, and understanding the ways that others see, use and access (Jeyakumar, Mr., 2014)

1.8.4 PhET Interactive Simulations

According to Mallari et al. (2020), the integration of PhET interactive simulation-based activities significantly improves students' academic performance in Science. Utilizing PhET interactive simulation-based activities saves time for the teacher and the students in terms of laboratory experiments. And the simulations have implicit guidance and balanced challenges, which encourage engaged exploration where students approach problem-solving and knowledge acquisition similarly to experts.

One of the problems that educators face as their profession is the way students approach their schoolwork. Educators want their students to do more than answer questions and retain a little knowledge since they are unprepared, do not care, and are in a hurry. But, this matter already has a solution with the help of technological advancement. With PhET Interactive simulations, students engage in scientist-like exploration, resulting in greater and deeper learning of scientific concepts and balanced challenges and eliciting the correct mode of engagement (W.K. Adams, 2010). The PHET simulations are created with an easy-to-use interface and little text for pupils. The sims are dynamic and interactive, reacting instantly to student input. Real-world objects (for example, light bulbs, bicycle pumps, and skateboards) are utilized to help students see the links between the occurrences and their prior knowledge. Nonetheless, sims benefit from making the invisible visible and providing multiple representations such as macroscopic, microscopic, graphs, etc. (W.K. Adams, 2010). Based on the valuable things mentioned, indeed, PHET interactive simulations are a massive help for the teachers and students to achieve the goal of the education team (W.K Adams, 2010).

1.8.5 Online Education Qualities

Learning enhanced by online technologies follows the principle of "anywhere" and "anytime". Personalization and flexibility are the leading keywords when we think about online-based learning. Students can choose when to attend a particular study unit, and can

usually personalize their learning schedule to a large extent (making allowances for unrelated work and family issues, etc.). Teachers can set up general guidelines and deadlines to be followed, the rest of course time management, however, remains the responsibility of students themselves. Furthermore, students can self-regulate the pace of their learning and progress according to their skills and abilities (Zounek et al. 2012).

Multimedia approaches in physics teaching and learning have been applied through ICT pedagogy in many schools, including lesson recordings, animated videos, internet resources, simulations and virtual laboratories. Adeyemo (2010) summarized previous research on the benefits and impact of ICT (including simulation programs) on physics education, one of the benefits was that students were able to apply higher reasoning skills in order to process complex and challenging situations. In addition, simulations also provide equality in learning opportunities in terms of different styles of learning and levels of ability because they allow more time and place flexibility.

Students tend to better respond to situations in which they have more time to think about and perhaps also post-edit the individual questions, comments, and other contributions.

In this way, implementing online technologies may result in increased student self-confidence, especially when application of e-learning tools closely correlates with student success in a particular course. Also, the reductions in a variety of expenses (travel, printing, buying books, etc.) should also be taken into account when considering the overall implications of installing selected e-learning solutions.

Students may lack sufficient knowledge and skills to use these technologies efficiently in order to enhance their study experiences. In particular, students often struggle to utilize various time-management, presentation, word-processing, collaboration, and other kinds of tools for personal learning purposes; a situation which many times leads to replicating old, ineffective ways of ICT implementation and sometimes even to a complete refusal of any e-solutions whatsoever. In addition, prior negative attitudes towards information technologies in general may present a significant block for some people, whatever the original reasons.

Technology-enhanced learning may also cause negative resentments with students who lack sufficient motivation and the ability to organize workload and learn independently. For unmotivated students with poor learning habits, therefore, technologies may become the reason for decreased productivity and worse study results. Furthermore, students may sometimes feel isolated and abandoned in the virtual environment (i.e. "lost in cyberspace"), especially in cases where there is a prolonged period of no face-to-face instruction, nor any other forms of offline interaction (e.g. in distance education programs).

ICT-based education also raises some health-related issues connected predominantly to spending long periods of time working with computers. Problems such as eye-strain, back pain, lack of movement, and even mental disorders may be listed among the major considerations (Zounek et al. 2012).

1.8.6 Problems Associated With Online Teaching and Learning

Online learning has become common in high school science instruction, but it is often designed in ways that do not accommodate the varied characteristics of high school learners. The cognitive approach to learning holds that the learner's current knowledge has a significant effect on learning.

E-learning has specific weaknesses: it can hamper the learner and the educator; direct contact and human touch are lost. Users can face many technical difficulties that hinder and slow down the teaching-learning process (Favale et al. 2020). Time and location flexibility is the strength of online learning; these aspects are fragile and create problems. Students' irresponsible behavior in terms of time and flexibility might generate plenty of

issues. All students and learners are not the same; they differ in words of their talents and confidence level. Some people may not feel at ease when studying online, which leads to more significant irritation and misunderstanding. Inadequate compatibility between the design of the technology and the component of psychology required by the learning process; and insufficient customization of learning processes can impede and produce an imbalance in the teaching process.

There are several technologies available for online education, but sometimes they create a lot of difficulties. Downloading failures, installation issues, login issues, audio and visual problems, and so on are all examples of challenges and problems connected with contemporary technology. Online teaching may be uninteresting for students at times. Students never have time to conduct online learning since it requires so much time and flexibility. Personal attention is also a significant concern in online education. Students want two-way interaction, which sometimes gets challenging to implement. The learning process cannot reach its full potential until students practice what they learn. Sometimes, online content is all theoretical and does not let students practice and know effectively. Mediocre course content is also a significant issue. Students feel that lack of community, technical problems, and difficulties in understanding instructional goals are substantial barriers to online learning (Song et al. 2004). In a study, students were not sufficiently prepared to balance their work, family, and social lives with their research in an online learning environment. Students were also found to be poorly designed for several e-learning competencies and academic-type competencies. Also, there is a low-level preparedness among the students concerning the usage of Learning Management Systems (Parkes et al. 2014).

1.9 Conceptual Framework

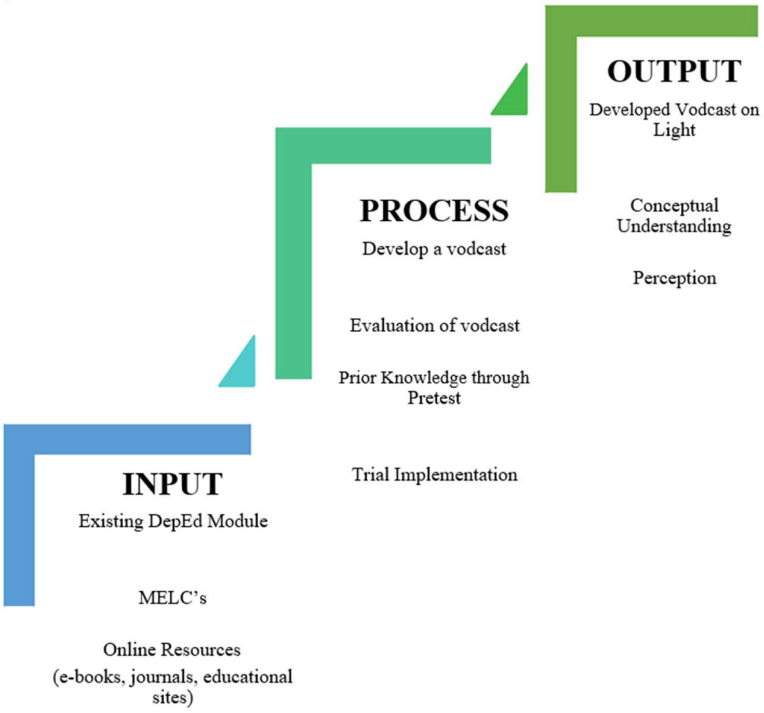

Figure 2. Conceptual Framework of the Study

For the first phase, the science topic and the target respondents were determined. The second phase involved developing a vodcast, evaluation of vodcast, prior knowledge through pretest and trial implementation. The developed vodcast on light would be evaluated by the panel of experts to assess its appropriateness for implementation. The utilization of the developed vodcast on light in promoting conceptual understanding was

measured and identified through the posttest and the qualitative description of students' perception of the usefulness of vodcast.

Input involved the existing DepEd module, MELC's, Online Resources (e-books, journals, educational sites). Process involves developing a vodcast, evaluation of vodcast, prior knowledge through pretest. In developing the learning material, the researchers aligned the objectives to the learning competencies of K to 12 Basic Education Curriculum as seen in the Matrix of Competencies. The ratings, comments, and suggestions would be used for revision purposes on the learning material.

Conceptual understanding was based on their normalized gain result and the perception was assessed through the perception survey questionnaire.

1.10 Operational Definition of Terms

For purposes of clarification, the following key terms are hereby defined:

Conceptual Understanding. It refers to knowing more than isolated facts and methods, which explains that a successful student understands mathematical ideas, and has the ability to transfer their knowledge into new situations and apply it to new contexts; it refers to the score of the respondents in the pretest and posttest of items about light in Grade 8 Science.

Development. It refers to a process of changing or improving teaching strategies/materials/approaches/aid to effectively apply in the classroom.

Diagnostic Test. It is a form of pre-assessment that allows a teacher to determine students' individual strengths, weaknesses, knowledge, and skills prior to instruction.

Evaluation. It is` a process of characterizing and appraising some aspect/s of an educational process.

Implementation. This involves putting a plan into effect, including the process of monitoring progress, making adjustments, and evaluating.

Interactive Simulation. It refers to the use of simulation software, tools, and serious games to enrich the teaching and learning processes.

MELCs. It refers to the learning competencies that will be applied in the developed video podcasting of the researchers.

Perception. It refers to the insights, thoughts and feedback about light of the target students. Prior Knowledge. It refers to the information about light that the learner has before and to the pretest score of the respondents in Research-made Achievement Test items. Light. It is the specific topic to be tackled in the developed video podcasting.

Utilization. It refers to the use of developed video podcasting.

Vodcast. It refers to video files that are distributed in a digital format through the Internet using personal computers or mobile devices. (McGarr, 2009)

2. Research Methods

This chapter covers the discussion on the research design, research setting, research participants, research instruments, and data gathering procedure, statistical tools and ethical considerations.

2.1 Research Design

This research aimed to develop vodcast in teaching light for 8th grade students with the aid of interactive simulation. The study utilized a combination of descriptive and development approaches to examine the data. The research involved the vodcast, implementation of the vodcast and the impact of the vodcast on the learners.

2.2 Research Setting

This study was conducted at Iligan City East National High School – Santiago Annex which falls under Purok 5B, Brgy. Santiago, Iligan City, Philippines. Iligan City East National High School – Santiago Annex is a public secondary institution duly recognized by the Department of Education (DepEd) providing quality and affordable education to the municipality of Iligan City. In line with this, the school conducted limited face-to-face classes.

2.3 Research Participants

The study was limited only to twenty (20) grade 8 students currently enrolled this year.

2.4 Research Instruments

This study would utilize five research instruments which are the K-12 Curriculum Guide and its existing module, achievement test in Light, adapted CTML-based survey questionnaire, vodcast usefulness questionnaire and research-made vodcast.

Achievement Test on Light. – A set of questions would be used in this study for the assessment of the prior knowledge/pretest and posttest. The researchers would used the data result for the analysis of the conceptual understanding of the respondents on light.

Adapted CTML-Based Survey Questionnaire. – This would be used for vodcast evaluation by the content experts.

Vodcast Usefulness Questionnaire. – This would be used to evaluate the perception of the usefulness of the vodcast in learning light.

Research-made Vodcast – The researchers produced a vodcast on light through laptop and different video editing applications that would be used as a supplementary material.

2.5 Data Gathering Procedure

The following steps are the process of gathering data that should be followed in conducting this study. Hence, the steps are:

Analysis Stage- Before conducting the study, the researchers would choose a science topic aligned with the curriculum guide which gives students a hard time in learning.

Design Stage – The researchers would plan a storyboard on the vodcast, identify the tools to be used and used an adapted CTML-based survey questionnaire for the evaluation.

Development Stage – The researchers would develop vodcast and would be evaluated by the content experts if revision is recommended.

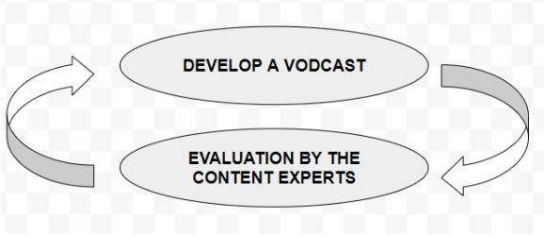

Figure 3. Development Stage

To evaluate the vodcast by the content experts, the researchers used data on the average evaluation rating of the vodcast as obtained from the researcher-developed vodcast evaluation survey result. Based on the five-point Likert scale-response, the range was calculated to be four (4). Dividing the range by five (5) corresponds to the researcher-articulated vodcast evaluation descriptions of very satisfactory, satisfactory, fairly satisfactory, unsatisfactory, and very unsatisfactory).

Table 2. Interpretation of Vodcast Evaluation (Teachers)

Mean Distribution	Description	Interpretation
Description		

4.20-5.00	Very Satisfactory	The vodcast is very useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light is strongly recommended as supplementary learning material on the topic of light
3.40-4.19	Satisfactory	The vodcast is very useful as a supplementary Learning material for properties and characteristics of light, light phenomena, and colors of light is reasonably recommended as supplementary learning material on the topic of light.
2.60-3.39	Fairly Satisfactory	The vodcast is fairly useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.
1.80-2.59	Unsatisfactory	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.
1.00-1.79	Very Unsatisfactory	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.

Implementation Stage – The researchers conducted a pretest, implemented the study by viewing the vodcast in class, and conducted a posttest.

Evaluation Stage – After the Vodcast lesson proper, the researchers would use a perception survey questionnaire for the respondents to evaluate the usefulness of Vodcast in learning light.

To evaluate the usefulness of the vodcast, the researchers used data on the average evaluation rating of the vodcast as obtained from the vodcast usefulness survey result. Based on the five-point Likert scale response, the range was calculated to be four (4). Dividing the range by five (5) corresponds to the researcher-articulated vodcast evaluation descriptions of very useful, useful, fairly useful, unuseful, and very unuseful).

Table 3. Interpretation of Vodcast Usefulness (Students)

Mean Distribution	Description	Interpretation
Description		
4.20-5.00	Very Useful	The vodcast is very useful as a supplementary learning material for properties and characteristics of light, light

		phenomena, and colours of light is strongly recommended as supplementary learning material on the topic of light
3.40-4.19	Useful	The vodcast is very useful as a supplementary Learning material for properties and characteristics of light, light phenomena and colors of light is reasonably recommended as supplementary learning material on the topic of light.
2.60-3.39	Fairly Useful	The vodcast is fairly useful as a supplementary learning material for properties and characteristics of light, light phenomena and colors of light on the topic light.
1.80-2.59	Unuseful	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic of light.
1.00-1.79	Very Unuseful	The vodcast is not useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light on the topic light.

2.6 Statistical Tools

The researchers would use the following statistical tools to interpret and analyze the data.

a) Normalized Gain

For the achievement test, the mean for pretest and posttest would be investigated. The normalized gain would also be calculated to identify the meaningful incremental change in the achievement test result.

$$< g > = \frac{(post\ test\ score - pre\ test\ score)}{(perfect\ scoe - pre\ test\ score)}$$

Standard Gain Score <g>	Criteria
0.70 < g	High
0.30 < g < 0.70	Medium

G < 0.30	Low

b) Mean would be used to determine the usefulness of the vodcast.

2.7 Ethical Consideration

To ensure quality and integrity of this research study the proponent have considered the following:

1. Seek, inform, and consent the people that will be involved in the study,
2. Respect the confidentiality and anonymity of the research respondents,
3. Ensure that the participants will participate in the study willingly,
4. Show that the research is independent and impartial specifically in treating results,
5. Acknowledge all references and sources,
6. Results will be treated with confidentiality.

3. Results and Discussions

This chapter presents the results and discussions according to the overall procedure of the study following the ADDIE model. Details concerning the results and discussions, therefore, were organized according to the order of stages in the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation.

3.1 Analysis Stage

The respondents of this study were the grade 8 students under the Science class of the teacher-researcher. There were students who were randomly picked to attend the limited face-to-face classes. This population of students was selected from Grade 8 sections by the school.

In the study of Mongan et.al (2021), they stated that students have significant misconceptions about the direction of light refraction, how light is refracted, how to determine its position from an image, and light as a ray. The study emphasized misconceptions on the importance of concept teaching. From elementary school to college, light refraction is one of the subjects that continue to present difficulties for students. Fredlund (2012) examined a group of physics students using multiple representations to describe the refraction of light on a ray diagram. The results of Fredlund's research indicate that there is interactive involvement of students in learning using multiple representations. In line with this study, researchers chose the topic light for it has a lot of misconceptions in teaching its concept. Integrating the concept through teaching method/strategy will be a good influence for continuous advancement of the curriculum which aims students to be globally competitive. Scientific concepts of light refraction are basic and yet important contents in physics education. In the context of Thailand basic education, students need to gain this scientific concept properly in order to understand related and advanced physics concepts in the future, i.e., interference of light waves and spectrum of light. Without understanding the concept of light and its properties, students may not understand many scientific domains (Djanett et al. 2013). Unfortunately, researchers have reported that the Thai students hold alternative conceptions in science phenomena about refraction of light. A few examples are they are confused about the meaning of light reflection and refraction; the direction of propagation of light; how light refraction occurs at an interface; and how to determine a position of image (Kaewkhong et al. 2010).

The MELC chosen for this study bears the code S8FE-If-26/27/28, which requires students to describe properties and characteristics of visible light, explains the hierarchy of colors in relation to the energy of visible light and discuss phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light.

The MELC was decided based on the availability of SLMs as of October 2020. Since the scheduled delivery fell on the first quarter of the school year, the topic was one of the identified least learned competencies because it was not covered in the previous school year when face-to-face classes were already suspended due to the COVID- 19 pandemic. Luckily, the said school conducted a review class for students who attended limited face-to-face in the mid-April for the upcoming parallel examination.

3.2 Design Stage

During this stage, the storyboard was planned out aligned with the curriculum guide of the chosen topic. For a teacher to produce an educational vodcast, some specifications of hardware and software must be met. For this study, Appendix N presents the available hardware and software used by the researcher to develop the vodcast. It must be noted that the vodcast production cost no money from the teacher/researcher as an existing laptop was used.

The vodcast was divided into four parts: introduction, properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). The storyboard of the vodcast prototype is shown in the following figure.

Figure 4. Sample pages of first version the storyboard of the vodcast outline

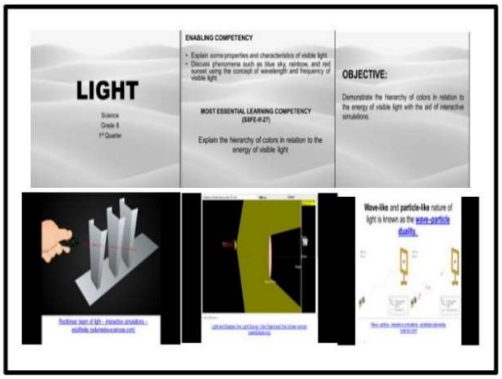

Figure 5. Sample pages of the final version of the storyboard of the vodcast outline

As shown in Figure 4, a raw version of the storyboard was outlined. After further planning and improvisation, a final version of the storyboard is produced on figure 5. Then, the researchers used an adapted CTML-based contextualized survey questionnaire which consists of three indicators of a good instructional vodcast that were identified: content, delivery, and technical production. The researcher decided to conduct a vodcast evaluation survey (Appendix E) with content experts as respondents.

3.3 Development Stage

During this stage, the development of the vodcast which covered the different versions prior to the comments and suggestions of the evaluators and the achievement test were made.

Figure 6. Sample pages of the first version of the vodcast

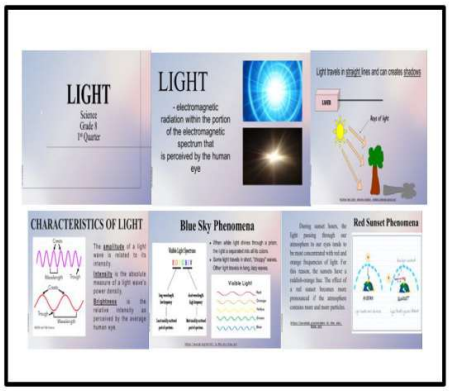

Figure 7. Sample pages of the final version of the vodcast

This first version of the vodcast was essentially a continuation of the prototype with added simulations to cover the properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). The duration of this version of the vodcast was 31 minutes and 5 seconds.

Overall, the first version of the vodcast featured eight different interactive simulations that were freely available on the internet. It was then uploaded as a video clip on Google Drive and was only accessible to the research panel and some selected teachers who were given the link. The Google Drive link of the first version of the vodcast contained the video clip and vodcast evaluation survey questionnaire. The adapted CTML-based survey questionnaire had 12 items that were distributed equally under the three indicators– content, delivery, and technical production. The first version of the vodcast was subjected to initial evaluation and validation involving the researcher's research panel and selected teacher-colleagues. Their initial feedback served as the basis for revision and was incorporated accordingly.

The first version of the vodcast was then evaluated through a survey by learning resource evaluators and science teachers. The vodcast undergoes revisions after the evaluation of the evaluators. The following are the comments and suggestions by the evaluators:

	Content	Delivery	Technical Problem
Evaluator 1	It is clearly seen that the content was comprehensive.	I suggest that you make your video interactive as if you are talking to the camera as if you are looking into the eyes of your students watching you.	None
Evaluator 2	None	The researcher showed mastery of the topic. However, some presenters need to make their voice louder because it can be a barrier in efficient learning when the listener cannot properly comprehend what you are saying.	The video is way too long.
Evaluator 3	The speaker in the vodcast clearly explained the content. And it was significantly enriched and had appealing visuals.	Much louder audio is needed.	Although the whole production is good, the researchers need to help each other to find a better space for audio-video recording where unnecessary noise is prevented.
Evaluator 4	Vodcast should only focus on the set objective and other parts should be removed.	Modulation of the voice should be improved so the vodcast be more engaging.	Remove background noise.
Evaluator 5	None	None	Have a uniform background for the PPT and make the PPT less wordy.
Evaluator 6	It is learner-friendly and well-presented.	None	No comment. I hope it will be published for reference purposes.

As shown in Figure 7, the final version of the vodcast already had the same background throughout the clip. It has a runtime shorter than the first version. After the revision, the unnecessary noise was removed. The PowerPoint was less wordy and focused on the simulations and diagrams, aligned with the MELCs. The modulation of the voice of the speakers was improved. The vodcast discussion was lessened and focused entirely on the specific objectives selected in MELCs. While the shorter duration primarily addresses the short attention span of students, it also works compatible with the unreliable internet data access of the students and the relatively low storage capacity typical of the smartphones they are using.

The vodcast was edited for the final version with the feedback from the research panel and selected teachers during the design stage incorporated in it. This version of the vodcast was trimmed into 12 minutes and 30 seconds of runtime.

Table 5. Vodcast Evaluation Survey Result

The vodcast I watched..	**CONTENT**	**MEAN RATING**	**DESCRIPTION**
1. is targeted according to the Most Essential Learning Competencies (MELC).		5.0	Very Satisfactory
2. will help students learn better about some properties and characteristics of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
3. will help the students to learn better about the phenomena such as blue sky, rainbow, and red sunset using the concept of wavelength and frequency of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
4. will help students learn better the overall topic about the hierarchy of colors in relation to the energy of visible light as they will be able to "see" or visualize the concept which is otherwise difficult with just the module alone.		5.0	Very Satisfactory
The vodcast I watched…	**DELIVERY**		
1. made the topic easier to understand with its language/narration.		5.0	Very Satisfactory
2. will hold the attention of students throughout the duration with its conversational voice/narration.		4.6	Very Satisfactory
3. will make the students feel like their teacher is there with them keeping them company and helping them in learning content/topic.		4.8	Very Satisfactory
4. featured guide questions that will get students "thinking critically" about the topic.		4.8	Very Satisfactory
The vodcast I watched…	**TECHNICAL PRODUCTION**		
1. is clear and free from unnecessary or distracting texts, images, or scenes.		4.6	Very Satisfactory
2. have clear audio/voice/narration and are free from distracting noise,		4.5	Very Satisfactory
3. have matching on-screen visual information (texts, images, or scenes) and audio/voice/narration.		4.5	Very Satisfactory
4. is not too long or too short in duration that students will be able to watch from start to end.		4.6	Very Satisfactory
OVERALL MEAN		**4.8**	**Very Satisfactory**

As shown in Table 8 above, the first version of the vodcast was evaluated as very satisfactory in all three indicators, with an overall mean rating of 4.80. This is interpreted as that the evaluators found the vodcast very useful as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light. It strongly recommended its use as supplementary learning material on the topic light. Simultaneous to the vodcast evaluation, the achievement test was administered in a posttest with grade 8 students from the same school as the respondents.

3.4 Implementation Stage

This stage was the actual implementation of the study. The achievement test consists of 30 multiple choice questions distributed among the concepts of the properties and characteristics of light, colors of light and light phenomena (blue sky, rainbow, and red sunset). Following the positive results of the vodcast evaluation survey, the

achievement test was then subjected to minor revisions. It was then administered as a pretest in printed format. The researchers ask for permission before conducting the study to the school principal and class adviser with a letter (Appendix A & C).
The following are the pictures during the implementation of the study:

The conduct of the study started with the students practicing the health protocols before entering the school premises. The class adviser informed the students of their involvement in the study. Before conducting the study, researchers had an overview of the background of the study for students to have a proper knowledge of what they would do. The pretest was given first with a time frame of 20 minutes to answer. For the proper implementation, researchers let the students view the vodcast twice. The posttest was given afterwards with a time frame of 20 minutes to answer.

There are various challenges met by the researchers during the implementation. One of them is the availability of the students. Although the school conducted a limited face-to-face class, there are various adjustments with the number of students. At first, one class contained thirteen (13) students only. Afterwards, the school adjusted it with a much larger number of students. The researchers had a lot of adjustment time when it comes to the

proper implementation of the vodcast. With the adjustments of the number of students, the school had plenty of adjustments when it comes with the schedule. The specific date for the 8th grade students always falls on school events or holidays. That is why researchers had a hard time gathering data. Nevertheless, the students were passionate to participate in the study. The researchers observed that the students were active and attentive when sessions were involved with multimedia clips.

During this stage, the pretest and posttest results were further analyzed towards a better understanding of the influence of the vodcast on the achievement of the student-respondents on properties and characteristics of light, colors of light and light phenomena. The results of the pretest and posttest were incorporated in the normalized gain score computation as summarized in the following table:

Table 6. Normalized Gain Score Analysis

Respondents	Pretest Raw Score	Posttest Raw Score	Normalized Gain	Description
#1	9	14	0.24	Low
#2	14	20	0.38	Medium
#3	15	13	-0.13	Low
#4	9	14	0.23	Low
#5	10	17	0.35	Medium
#6	9	14	0.24	Low
#7	14	20	0.38	Medium
#8	14	18	0.25	Low
#9	14	21	0.43	Medium
#10	4	13	0.35	Medium
#11	7	16	0.39	Medium
#12	2	9	0.25	Low
#13	15	23	0.53	Medium
#14	7	14	0.30	Low
#15	15	13	-0.13	Low
#16	6	13	0.29	Low
#17	9	19	0.48	Medium
#18	18	27	0.75	High

#19	18	25	0.58	Medium
#20	14	21	0.44	Medium
Overall Mean	**11**	**17**	**0.33**	**Medium**

As shown in Table 9, one (1) got a high normalized gain, ten (10) got medium and nine had a low normalized gain. Overall, the respondents posted a uniform medium gain score on the topic light. The overall pretest mean score was 11.15 while the overall posttest mean score was 17. Using the normalized gain score formula shown in chapter 2, the overall normalized gain score was computed to be 0.33 – a medium normalized gain score.

A medium normalized gain in an achievement test on science process skills using PhET Simulation under a face-to-face teaching-learning modality was considered a dramatic improvement. The present study yielded a medium normalized gain even though the study was conducted on the first week of students to experience face-to-face classes after almost three years of modular learning. Hailikari et.al (2008) suggested that prior knowledge from previous lessons significantly influenced student achievement. It has long been considered the most important factor influencing learning and student achievement and the amount and quality of prior knowledge positively influence both knowledge acquisition. Aligned with the spiral curriculum of MELCs, the prior knowledge from Grade 7 science which was the basic concept of light, it was continued with complex discussion on light. This shows the importance of prior knowledge in introducing new topics. Students can easily grasp information with continuity of the concept.

3.5 Evaluation Stage

Table 7. Vodcast Usefulness Survey Result

Adapted from Liwanag's (2021) Student Perception Questionnaire which she adapted from Deci and Ryan (1994)

1= Not all true; 2=Occasionally true; 3=Somewhat true; 4=Frequently true; 5= Very true

Statements	Mean	Description Rating
1. I believe that watching the vodcast made me more interested with the lesson.	4.75	
2. I believe that the vodcast enabled me to relate real-life situations.	5.00	
3. I felt like the vodcast I watched and interacted with is helping me develop good conceptual understanding and even good communications skills.	4.85	
4. I enjoy learning from the lesson presented in the vodcast.	5.00	
5. For me, the vodcast embedded with PhET simulation is important for my improvement because it encourages me to find more information and ask questions.	4.90	
6. The vodcast allow us to develop and acquire good values and character.	4.85	
7. I believe that the question and answer activities in the vodcast challenge me to succeed and do my very best.	4.50	
8. I gained new self-regulated learning strategies and techniques through vodcast such as taking down notes, sharing ideas with others and having further research.	4.75	
9. I watched and learned from the vodcast because I wanted and liked it.	4.85	
10. I think that the vodcast motivated me to perform better because I believe it is not about having good grades, but it is learning that I could use in the future.	4.80	

11. The vodcast makes me feel that the teacher is there with me helping me in learning the content/topic.	5.00	
12. The vodcast is not too long or too short in duration that I can watch from start to end.	4.95	
13. I find the topic easier to understand by watching the vodcast.	5.00	
14. I can control the rate and sequence of the vodcast and review the topic anytime.	5.00	
15. The vodcast cleared out my misconceptions about light.	4.95	
OVERALL RATING	**4.88**	**Very Useful**

As shown in Table 10, the vodcast was perceived as very useful by the same 20 student-respondents who took the achievement test in both pre- and post-vodcast instructions. This means that the respondents perceived the vodcast as very helpful to them on the topic of properties and characteristics of light, light phenomena, and colors of light. All vodcast indicators were perceived as very useful with an overall rating of 4.88. The same 20 student-respondents strongly recommended its use as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light. Čubrilo et.al (2014) stated in their study that multimedia teaching has statistically significant increase in the retention of knowledge quality compared to the traditional teaching method in the category of applying that leads to the conclusion that the use of multimedia had the greatest effect on the highest level of knowledge. In connection with the study, the vodcast on light did not yield the expected positive effect but there is a significant increase in the achievement performance of the respondents.

3.6 Summary of Findings

This study was guided by three objectives: develop a vodcast as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light to determine the achievement level of grade 8 Science students in pre- and post-vodcast instructions; and ascertain the level of usefulness of the vodcast as perceived by the grade 8 Science students. The findings of the study are as follows:

1. The vodcast was developed with a duration of twelve (12) minutes and thirty (30) seconds and was uploaded in Google Drive. It was rated as very satisfactory with the overall mean rating of 4.8 by 6 content-expert evaluators. Earning the "very satisfactory" rating, the vodcast was highly recommended for use on the topic properties and characteristics of light, light phenomena, and colors of light in grade 8 Science by 6 content-expert evaluators.
2. The pre-vodcast achievement of the grade 8 Science student- respondents was at the low level with the mean raw score of 11. The post-vodcast achievement of the grade 8 Science student-respondents was at the average level with the mean raw score of 17. The improvement represents an average normalized gain score of 0.33. The vodcast developed for the topic properties and characteristics of light, light phenomena, and colors of light in the coverage of grade 8 Science helped the student-respondents improve their achievement from the "low" level into "medium" level or "medium" level into "high" level as made evident by the average normalized gain score of 0.33. The average normalized gain score indicates that the vodcast had a positive influence on the achievement of the respondents.
3. The vodcast usefulness level was at "very useful" with the mean rating of 4.88 as perceived and rated by the grade 8 Science student- respondents. The grade 8 Science student-respondents perceived the vodcast as very useful and recommended its use as a supplementary learning material for properties and characteristics of light, light phenomena, and colors of light in the grade 8 Science.

The average normalized gain score indicated that the vodcast positively influenced student-respondents' achievement, helping them pass the achievement test from the “low” to the “medium” level. The “very satisfactory” rating from the 6 content-expert evaluators and the “very useful” rating of the same vodcast from the 20 student-respondents corroborated the positive influence of the vodcast on the achievement level of the student-respondents for the topic properties and characteristics of light, light phenomena, and colors of light of the grade 8 Science topics.

4. Conclusion and Recommendation

The researchers have found out that there are various elements and parameters to be considered when formulating an instructional video material which includes the preferences of the students. It was also shown that with regards to the elements found in the video material, students prefer a combination of textual and visual lecture presentation with a conceptual discussion on light. The researchers concluded that the developed supplementary vodcast for the topic of light can engender an average normalized gain. The results coincided with the findings of the study conducted by Ercan (2014) that showed multimedia has an important role for students’ achievement and that there is a significant difference in the achievement post-test.

Considering the conclusions of this study, the following points are hereby recommended:

1. The evaluation tool used in evaluating the vodcast developed in this study was the researcher-made vodcast evaluation survey questionnaire adapted from Ulla (2021). Future researchers could make improvements by adapting and using established multimedia evaluation tools or open educational resources (OER) evaluation tools in evaluating vodcasts.
2. Local literature on the use of vodcast to improve science achievement could be established by conducting more studies on the same topic as well as other topics.
3. Supplementary statistical analyses on top of using normalized gain score could also be utilized in analyzing data to gain a better understanding on the influence of vodcast on the students’ achievement.
4. More vodcasts may be developed as supplementary learning materials for other topics following the CTML principles and the recommendations of the evaluators.
5. Other parameters can be explored as intervening factors in the efficacy of vodcast in learning science concepts

The results of this study could also be used to help build baseline information that would enable school administrators to craft a school improvement plan that would empower teachers to develop their instructional vodcasts across varied science topics.

References:

Angell C, Guttersrud O, Henriksen E and Isnes A 2004 Physics: Frightful but Fun, Pupils' and Teachers' Views of Physics and Physics Teaching Science Education

Ulla, Elwells B. (2021). VODCASTING WITH SIMULATIONS FOR THE DUAL NATURE OF LIGHT COVERAGE IN PHYSICAL SCIENCE UNDER THE MODULAR DISTANCE LEARNING MODALITY. Unpublished Thesis.

Bomsdorf, B. (2005). Adaptation of Learning Spaces: Supporting Ubiquitous Learning in Higher Distance Education. Mobile Computing and Ambient Intelligence: The Challenge of Multimedia, Dagstuhl Seminar Proceedings

Boulos, M., Maramba, I., & Wheeler, S. (2006). Wikis, blogs and podcasts: a new generation of Webbased tools for virtual collaborative clinical practice and education. BMC Medical Education, 6(41). Available online: http://www.biomedcentral.com/content/pdf/1472-6920-6-41.pdf#search=%22wikis%20blogs%20and%20podcasts%20boulos%20.pdf%22

Meng, P. (2005). Podcasting and vodcasting: A white paper. IAT Services, University of Missouri, 10. doi:http://www.tfaoi.com/cm/3cm/3cm310.pdf

Nwachokor, S., Onah, I., Uddin, P. (2019). Students' perception of vodcast and podcast as instructional material. Traektoriâ Nauki = Path of Science. 5(6), 5001-5007. https://cyberleninka.ru/article/n/students-perception-ofvodcast-and-podcast-as-instructional-material/viewer

Larisma, C., Centillas Jr., C., Lumbay, C., & Pajaron Jr., G. (2017). Does vodcasting increase the achievement of the students in trigonometry of higher education institutions (HEI)?

Journal of Social Sciences. 6(2), 34- 40. https://ideas.repec.org/a/jso/coejss/v6y2017i2sp34-40.html

Pierce, R., & Fox, J. (2012). Vodcasts and active-learning exercises in a 'flipped classroom' model of a renal pharmacotherapy module. American Journal of Pharmaceutical

Education. 76(10), 1-5. https://people.ok.ubc.ca/cstother/Instructional%20Design%20and%20Assessment.pdf

Schreiber, B. E., Fukuta, J., & Gordon, F. (2010). Live lecture versus video podcast in undergraduate medical education: A randomised controlled trial. BMC Medical Education, 10(1). doi: 10.1186/1472-6920-10-68

Campbell, G. (2005). There's something in the air: Podcasting in education. Educause Review, 40(6), 32–47.

Checkly, D. (2010).High School Students' Perception of Physics. [Master's thesis, University of Lethbridge]. https://opus.uleth.ca/handle/10133/2584

McGraw Hill Canada (2019). R. E. Mayer's Cognitive Theory of Multimedia Learning Https://www.mheducation.ca/blog/richard-mayers-cognitive-theory-of-multimedia-learning

Solomon Gunta Gutulo & Kedir Ousman Tekello.(2015). https://globaljournals.org/GJHSS_Volume15/1-Problems-in-the-Teaching-and-Learning-of-Physics.pdf

Mann, P., Wong, D., Park, K.S. (2009). Innovative use of vodcast (video- podcast) to enrich learning experience in structures laboratory. Proceedings of the International

Conference on e-Learning, ICEL. Academic Conferences Limited ISBN: 978-190663837-5.

Chug, R. (2010). E-learning tools and their impact on pedagogy. In Ubha, DS & Kaur J .Emerging Paradigms in Commerce and Management Education. GSSDGS Khalsa

Chanserm, T. Tupsai, J., Yuenyong, C. (2019). Grade 11 student's mental model of the Nature of Light. *Journal of Physics: Conference Series*, 1340 (1), 012086

College Press, pp. 58-81, ISBN: 978-81-909755-2-0. [https://www.researchgate.net/profile/RiteshChugh/publication/275771731_E-learning_tools_and_their_impact_on_pedagogy/links/5666305708ae192bbf927bae/E-learning-tools-and-their-impact-on-pedagogy.pdf]

Diate, K., & Mordeno, I. C. (2021). Filipino Physics Teachers' Teaching Challenges and Perception of Essential Skills for a Supportive Learning Environment. Asia Research Network Journal of Education, 1(2), 61–76. Retrieved from https://so05.tci-thaijo.org/index.php/arnje/article/view/251765s

Jeyakumar, Mr. (2014). Learning Beyond the Classroom through Vodcast. http://www.shanlaxjournals.in/pdf/EDN/V2N3/EDN_V2_N3_008.pdf

Mallari, R., Lumanog, G. (2020). The Effectiveness of Integrating PhET Interactive Simulation-based Activities in Improving the Student's Academic Performance in Science. International Journal for Research in Applied Science & Engineering Technology. https://doi.org/10.22214/ijraset.2020.31708.

Adams, W.K. (2010). Student Engagement and Learning with PhET Interactive Simulation.

Pitogo, V. M., & Ecle, K. (2021). Insights into Undergraduate Students' Experiences of Emergency Remote Learning during COVID-19 Pandemic: A Phenomenology Study. Asia Research Network Journal of Education, 1(2), 77–95. Retrieved from https://so05.tci-thaijo.org/index.php/arnje/article/view/252993

Il Nuovo Cimento Vol. 33 C, N. 3. https://www.sif.it/riviste/sif/ncc/econtents/2010/033/03/article/25

Zounek, J., & Sudicky, V. (2012). Heads in the cloud: Pros and Cons of online learning. E-learning: Learning with online technologies.

Adeyemo, Sunday A. (2010). The Impact of Information and Communication Technology (ICT) On Teaching and Learning of Physics. International Journal of Educational Research and Technology, 1(2), 48 - 59.

Favale T., Soro F., Trevisan M., Drago I., Mellia M. (2020). Campus traffic and e-Learning during COVID-19 pandemic. Computer Networks, 176, 107290. [Google Scholar]

Song L., Singleton E. S., Hill J. R., Koh M. H. (2004). Improving online learning: Student perceptions of useful and challenging characteristics. The Internet and Higher Education, 7(1), 59–70. [Google Scholar]

Parkes M., Stein S., Reading C. (2014). Student preparedness for university e-learning environments. The Internet and Higher Education, 25, 1–10. 10.1016/j.iheduc.2014.10.002 [CrossRef] [Google Scholar]

Niwat Srisawasdi & Siriporn Kroothkeaw (2014). Supporting students' conceptual development of light refraction by simulation-based open inquiry with dual-situated learning model.

Mongan et. al (2021)Analysis of student difficulties in learning refraction of light.1968.10.1088/1742-6596/1968/1/012033.Journal of Physics: Conference Series

Djanette et.al (2013). WHAT THINKS THE UNIVERSITY'S STUDENTS ABOUT PROPAGATION OF LIGHT IN THE VACUUM?. European Scientific Journal (European Scientific Institute). oai:ojs.pkp.sfu.ca:article/1705