



# Delivering Light Propagation, Refraction, and Reflection Learning Instructions Through a Teacher-Created Vodcast Embedded with Simulations

**Elwells Ulla\***

DepEd Davao City (Senior High School)  
 Davao City, Philippines

**Monera Salic-Hairulla, Sotero Malayao Jr.**

Mindanao State University – Iligan Institute of Technology  
 Iligan City, Philippines

\*Corresponding author email: ulla.elwells001@deped.gov.ph

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**Abstract:** While literature suggests that video lectures or vodcasts may alleviate the disadvantaged situation of students under the modular distance learning modalities (MDLMs) that are implemented in the Philippines amidst the COVID-19 pandemic, there is no local purposive study examining the influence of vodcasts on science achievement. This study aims to develop a vodcast embedded with simulations on light propagation, refraction, and reflection as a supplementary learning material for the same lesson-content under the printed and digital MDLMs, to determine the achievement level of grade 11 Physical Science students in pre- and post-vodcast instructions, and to ascertain the usefulness of the vodcast as perceived by the student-respondents. The vodcast was rated as very satisfactory by 18 content and ICT expert-evaluators. The achievement level of the student-respondents improved from ‘did not meet expectations’ to ‘fairly satisfactory’ with the moderate normalized gain score of 0.46. The same student-respondents perceived the vodcast as very useful. Results suggest that the vodcast had a positive influence on the achievement of the student-respondents.

**Keywords:** video lecture; vodcast; online simulations; distance learning

## 1. Introduction

Results from recent international and national assessments highlight the sad state of basic science education in the Philippines. Amidst the COVID-19 pandemic, the Cognitive Theory of Multimedia Learning (CTML) points out that learners under the printed or digital MDLM are placed in a disadvantaged situation as they are provided with just the printed or encoded texts and limited images in their self-learning modules (SLMs). Under the printed MDLM, students take printed copies of their weekly SLMs for remote learning at home. The same SLMs are used under the digital MDLM in which students download copies from a designated google drive folder. It is particularly difficult when it comes to

theoretical science concepts that require visualization (Johan et al., 2018). Literature suggests that the use of video lectures or vodcasts may help address the problem. Vodcast instruction is found to be effective in increasing productivity, promoting creativity, and facilitating academic learning (Nwachokor et al., 2019; Suanse and Yuenyong, 2021). Vodcasts yielded positive results comparable to that of the traditional face-to-face instruction in teaching trigonometry (Larisma et al., 2017) and significantly helped improved the performance of students in a flipped classroom utilizing a module on a topic (Pierce & Fox, 2012). However, despite the increasing interest of many teachers in using vodcasts, there is no local purposive study on the use of vodcasts to improve science achievement in both printed and digital MDLMs.

The purpose of this one-group pretest–posttest study was to develop a vodcast or a teacher-created video lecture as a supplementary learning material for an essential learning competency in grade 11 Physical Science under the MDLMs. The vodcast was embedded with free online simulations on light propagation, refraction, and reflection as the main content to explain and demonstrate the same concepts. Specifically, the study aimed to evaluate the use of the vodcast as a supplementary learning material for light propagation, refraction, and reflection under the printed and digital MDLMs, determine the achievement level of grade 11 Physical Science students in pre- and post-vodcast instructions, and ascertain the level of usefulness of the vodcast as perceived by the student-respondents.

## 2. Methodology

This study followed the Analysis-Design-Development-Implementation-Evaluation (ADDIE) model as its analytical framework. The ADDIE model is a generic and simplified instructional systems-design model (Molenda, 2015) used by technology-based teaching designers (Bates, 2014).

### 2.1 Research Design

Following the ADDIE model, this study used the one-group pretest – posttest quasi-experimental design during the implementation and evaluation stages in which the vodcast – the developed instructional material, was introduced to the respondents after the pretest. The posttest was then administered after the vodcast was introduced. While this study did not venture into using mixed methodologies, qualitative support was enabled by the viewpoints obtained from the evaluation of the vodcast as an instructional material through a survey involving 18 content and ICT experts as respondents and another survey on the usefulness of the vodcast as perceived by the student-respondents.

### 2.2 Research Instruments

There were three research instruments used in this study. These were the vodcast evaluation survey questionnaire, the 30-item multiple-choice achievement test questionnaire (appendix 1), and the vodcast usefulness survey questionnaire. The researcher reviewed CTML and educational video-related literature and arrived at three indicators – content, delivery, and technical production, which were used to guide the vodcast production. A 12-item researcher-made evaluation survey questionnaire was then formulated based on the same indicators, which were used by 18 content and ICT experts in evaluating the vodcast. Each indicator had four evaluation item-statements with corresponding five-point Likert scale responses: Strongly Agree (5), Agree (4), Not Sure (3), Disagree (2), and Strongly Disagree (1). The evaluation survey questionnaire was presented to a research panel of four State University professors and was revised following their comments and suggestions.

A 30-item multiple-choice researcher-made achievement test was used for the pretest and posttest. The researcher approximated the structure of the questions to that of the

popular Force Concept Inventory (FCI). There were four options for each question which were designated as options A, B, C, and D. The achievement test went through two major revisions following the evaluation and re-evaluation of one member of the research panel. The first version was composed of plain and conventional direct fill-in-the-blank and or one-line questions with hardly few illustrations. The second version was then patterned after the FCI. As the achievement test was conceptual and can generally be answered by high school students, it was administered to 100 grade 10 and grade 12 students at the same school for the pilot test. The grade levels of the pilot test respondents were strategically decided as grade 10 students were expected to have encountered related topics during the third quarter of the school year, while the grade 12 students were presumed to have already gone through the same topics. The achievement test underwent a minor revision based on the pilot test feedback. The final version consisted of 10 items for each of the concepts of light propagation, refraction, and reflection under the topic property of light. The questionnaire was then administered as the pretest before the introduction of the vodcast to grade 11 Physical Science students identified as the student-respondents in this study. The same questionnaire with rearranged order of items was administered as a posttest following the introduction of the vodcast to the same student-respondents of this study.

Out of the evaluation survey questionnaire, a 12-item survey questionnaire on the usefulness of the vodcast was designed and formulated by the researcher for the perusal of the student-respondents. In this questionnaire, the content, delivery, and technical production indicators, including the personal pronouns, were retained to fit into the narrative of the respondents. Each indicator also had four perception statements with corresponding five-point Likert scale responses: Strongly Agree (5), Agree (4), Not Sure (3), Disagree (2), and Strongly Disagree (1). This questionnaire was administered to the same student-respondents after the posttest. The vodcast usefulness survey questionnaire and the vodcast evaluation survey questionnaire were both devised by the researcher to enable qualitative support on the analysis of data towards a deeper and wider understanding on the achievement of the student-respondents on light propagation, refraction, and reflection under the MDLMs before and after the vodcast-intervention was introduced.

### *2.3 Research Respondents*

The main respondents of this study were the 146 grade 11 students enrolled during the school year 2020-2021 in a Cluster 1 public secondary school in Davao City, Philippines. This number of students was based on the official list in the Department of Education (DepEd) Learners' Information System (LIS). About 90 percent of the respondents were under the printed MDLM, while the rest were under the digital MDLM. Most of the respondents under the printed MDLM had data-limited and purposive access to the internet. Still, only 94 were able to complete the pretest-intervention-posttest-survey phases of the study. Additionally, 18 content and ICT expert-evaluators consisting of two junior IT professionals working in the local advertising industry, two public school learning resource evaluators, two school ICT coordinator-designates, six science teachers, and six other teachers managing different junior and senior high school subjects served as respondents to the vodcast-evaluation survey. Except for the two junior IT professionals, 16 of these evaluators were teachers by profession who underwent various ICT-integration training and webinars conducted by DepEd and various other institutions to help address the teaching and learning needs arising from the COVID-19 pandemic. Notably, the same teacher-evaluators participated in a number of Microsoft Education Center trainings and webinars with DepEd providing free Microsoft 365 accounts to all DepEd teachers. Almost all these teacher-evaluators were awarded the Microsoft Innovative Educator badge.

## 2.4 Data-Gathering Procedure

Three data sets were gathered in this study. These were the vodcast evaluation survey result, the pretest and posttest results, and the vodcast usefulness survey result. It must be noted that this data-gathering phase was embedded in the implementation and evaluation stages of the ADDIE model.

The evaluation of the vodcast was done with the 18 content and ICT experts serving as evaluators. This was done online with the items in the questionnaire formatted into google forms and the vodcast embedded therein. The evaluators were reached via messenger group chats and Facebook group posts. Due to time constraints and connectivity issues experienced by some of the intended evaluators, only 18 made it to the specified date of turnout from the potentially large number of evaluators. Those who responded to the evaluation survey after the specified date were excluded. Thus, only 18 data sets were used to address the first objective of this study.

The pretest, vodcast instruction, and the posttest were given in both offline and online modes. Only 12 student-respondents claimed the printed copies of the pretest, posttest, and survey questionnaires during the weekly releasing of SLMs and submission of outputs in the school. For those who opted for the online mode, the pretest and the vodcast were embedded in google forms with the online link sent via messenger. The google forms was designed in such a manner that the respondents were able to accomplish the pretest before they were able to watch the vodcast. A separate google forms was created for the posttest. In the second google forms, the respondents were directed to watch again the embedded vodcast before they could take the posttest. The respondents were given one week to complete the pretest following the regular schedule of releasing SLMs and submission of outputs.

The vodcast usefulness survey was also remotely done in both offline and online modes. This survey was included in the separate google forms, which featured the vodcast and the posttest. Overall, only 94 out of the 146 intended respondents were able to complete the pretest, the vodcast instruction, the posttest, and the vodcast usefulness survey. This incomplete turnout was largely due to the then existing restrictions imposed by the City Government of Davao to help combat the spread of the COVID-19. While students under the age of 21 were already allowed to go out during the conduct of this study, the prevailing stance during that time was that only parents or age-appropriate guardians were allowed to claim the SLMs together with the questionnaires. Additionally, many parents and guardians and even the respondents themselves were also working for family sustenance and were not able to conform to the specified dates of release/submission. The diminished turnout of online takers was largely affected by the considerable number of working students who prioritized work and rest and only dedicated a day in a week to accomplish other school-related tasks. Thus, only 94 data sets were used in the academic achievement and vodcast usefulness analyses related to objectives number two and three of this study.

## 2.5 Data Analysis

Statistical analyses were carried out towards the success of this study. These include the Kuder-Richardson Formula 20 (KR-20) for the pilot test results, mean, and normalized gain score. The KR-20 is a measure of internal consistency, which indexes the reliability of an instrument (Thomson 2018) or the researcher-made 30-item multiple-choice achievement test in light propagation, refraction, and reflection. It ranges from 0.0 to 1.0 with 1.0 indicating a perfectly consistent measurement. This means that a higher KR-20 value is regarded as better. Nevertheless, Thomson (2018) explained that KR-20 is partially a function of test length and tends to be higher when the instrument has more items. This means that for a test length of 30 items, it is unrealistic to expect a KR-20 value

near 1.0. In this study, the KR-20 value is generated simply by using the Classical Item and Test Analysis Spreadsheet (CITAS) – an automated Excel spreadsheet useful for conducting classical item and test analysis.

There were four computed means in this study. The first mean was the average evaluation rating of the vodcast as obtained from the researcher-developed vodcast evaluation survey result. The five levels of mean distribution correspond to the researcher-articulated vodcast evaluation descriptions of Very Satisfactory, Satisfactory, Fairly Satisfactory, Unsatisfactory, and Very Unsatisfactory. The second and third means were the class average percentage scores of the respondents in the 30-item multiple-choice achievement test administered as both the pretest and posttest. The five levels of mean percentage score distribution represent five achievement descriptive levels of Outstanding, Very Satisfactory, Satisfactory, Fairly Satisfactory, and Did Not Meet Expectations which were adapted from DepEd's policy guidelines on classroom assessment for the K to 12 Basic Education Program. The fourth mean was the average score of the vodcast usefulness survey administered to the same 94 student-respondents who took the pretest and posttest. The five levels of mean distribution correspond to the five researcher-articulated vodcast usefulness descriptions of Very Useful, Useful, Fairly Useful, Unuseful, and Very Unuseful. To better understand the influence of the vodcast on the achievement of the grade 11 Physical Science students, the normalized gain score ( $g$ ) was computed. Coletta and Steinart (2020) encourage the use of normalized gain in analyzing pre- and post-instruction scores on concept inventories. The normalized gain score was the difference between the respondents' posttest and pretest percentage mean scores divided by the difference between the maximum possible percentage score and the respondents' pretest percentage mean score (Coletta & Steinart, 2020).

### 3. Results and Discussion

The result of the vodcast evaluation survey is shown in the following table.

**Table 1:** Vodcast Evaluation Survey Result

Indicators	Mean Rating	Description
Content	4.55	Very Satisfactory
Delivery	4.70	Very Satisfactory
Technical Production	4.89	Very Satisfactory
Overall Mean	4.71	Very Satisfactory

As shown in Table 1, the vodcast was evaluated as very satisfactory in all three indicators, with an overall mean rating of 4.71. Receiving the highest rating was the technical production indicator with a mean rating of 4.89. Technical production pertains to the quality of images or scenes including the texts in the vodcast, its audio and narration, the synchronization of the visual and audio components, and its duration. Delivery which relates to the geniality of the language and narration received the second highest rating of 4.70. The same very satisfactory rating of 4.55 was allotted to the content indicator which refers to the topic of the vodcast and its alignment to the learning competency set by DepEd. The overall result shows that the evaluators found the vodcast very useful as a supplementary learning material for the topic property of light and strongly recommended its use for the same topic under the MDLM. Following the positive results of the vodcast evaluation survey, the pilot testing of the achievement test involving 100 students at the same school yielded a KR-20 value of 0.76 which pointed out the considerable internal consistency of the 30-item test and therefore, its reliability. Moreover, the test was found to have an average difficulty at the index of 0.48. Its discriminatory index was also reasonably good at 0.36. Following few minor revisions of the achievement test, the pretest was administered in both printed and digital format through

google forms. The achievement of grade 11 Physical Science students in the pretest is shown below.

**Table 2: Pretest Achievement**

<b>Pretest Mean Percentage Score (%)</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>	<b>Achievement Descriptive Levels</b>	<b>Remarks</b>
84 – 100	0	0	Outstanding	Passed
76 – 83.99	0	0	Very Satisfactory	Passed
68 – 75.99	4	4.3	Satisfactory	Passed
60 – 67.99	16	17.0	Fairly Satisfactory	Passed
0 – 59.99	74	78.7	Did Not Meet Expectations	Failed
<b>Total</b>	<b>94</b>	<b>100</b>		

As shown in Table 2, 78.7% of the respondents did not meet expectations and failed the pretest with a mean percentage score of less than or equal to 59.99. Out of the 94 respondents, 74 failed the pretest. Only 21.3% passed the pretest of which 17% were at the fairly satisfactory level and 4.3% were at the satisfactory level. None of the respondents were at the very satisfactory and or outstanding levels. The pretest result showed that the respondents had no substantial understanding of the concepts of light propagation, reflection, and refraction under the topic property of light before the introduction of the vodcast as supplementary learning material. However, as it is in many cases, a pretest will reasonably yield low achievement levels of the participants or respondents.

After the pretest, the vodcast was introduced to the student-respondents. The posttest was then administered. Table 3 shows the achievement levels of the respondents during the posttest.

**Table 3: Posttest Achievement**

<b>Posttest Mean Percentage Score (%)</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>	<b>Achievement Descriptive Levels</b>	<b>Remarks</b>
84 – 100	19	20.2	Outstanding	Passed
76 – 83.99	18	19.1	Very Satisfactory	Passed
68 – 75.99	12	12.8	Satisfactory	Passed
60 – 67.99	41	43.6	Fairly Satisfactory	Passed
0 – 59.99	4	4.3	Did Not Meet Expectations	Failed
<b>Total</b>	<b>94</b>	<b>100</b>		

Table 3 shows a total of 90 respondents passing the achievement test with 19 of them able to get the percentage score of greater than or equal to 84. 18 of them were at the very satisfactory level, 12 at the satisfactory level, 41 at the fairly satisfactory level, and only four were still at the *did not meet expectations* level. The data in Table 3 represent the evidence of the positive impact of the vodcast as a supplementary learning material on the topic property of light in grade 11 Physical Science under the MDLM. The study of Acal (2010) yielded similar results, pointing out that the videotaped microlesson improved the students' performance. Acal (2010) utilized a videotaped microlesson (could be a commercially available educational video) and introduced the material to the students in a one-group pretest–posttest designed study but only had a 20-item multiple-choice achievement test. In contrast, the present study involved a teacher/researcher-created purposive vodcast (video lecture) and a 30-item multiple-choice achievement test.

Similarly, this improvement of students' achievement after the introduction of developed learning material was noted in the studies of Salic-Hairulla et al. (2019), Tecson et al. (2021), Tadena and Salic-Hairulla (2021).

As it is in most cases, posttests typically yield an improved result. For this reason, the pretest and posttest results were further analysed towards getting a better understanding of the influence of the vodcast on the achievement of the student-respondents on the concepts of light propagation, reflection, and refraction under the topic property of light. A total of 94 data sets was included in the analysis. The results of the pretest and posttest were incorporated in the normalized gain score computation as summarized in table 4 at the next page.

As shown in Table 4, the student-respondents had the highest gain score on light propagation at 0.52 starting at the pretest mean percentage score of 48 and gaining to 75% in the posttest. The respondents also got a normalized gain score of 0.44 on light reflection which was closely followed by light refraction at 0.43.

**Table 4:** Normalized Gain Score Analysis

Concept	Mean Percentage Score		Normalized gain score	Criteria
	Pretest	Posttest		
Light propagation	48	75	0.52	Moderate
Light reflection	45	69	0.44	Moderate
Light refraction	37	64	0.43	Moderate
Overall	43.33	69.33	0.46	Moderate

Overall, the respondents posted a uniform moderate gain score across the three concepts. The overall pretest mean percentage score was 43.33 while the overall posttest mean percentage score was 69.33. Using the normalized gain score formula, the overall normalized gain score was computed to be 0.46 – a moderate normalized gain score.

Interestingly, a moderate normalized gain in an achievement test on science process skills using simple computer simulations on linear motion concepts (Siahaan et al., 2017) under a face-to-face teaching-learning modality was considered a dramatic improvement. The present study yielded a moderate normalized gain score even though the study was conducted under the modular distance learning modality with the students being virtually left on their own to digest the learning instructions delivered through the vodcast. Coletta and Steinert (2020) even suggested that the backgrounds of the students should be considered when making conclusions on the effectiveness of teaching methods yielding different gains. What that implies is that a supplementary instruction used in a specialized STEM class yielding a high normalized gain score is not necessarily more effective than that supplementary instruction used in a non-STEM class for the same topic yielding a moderate normalized gain score. It must be noted that the respondents of this study were non-STEM students and had completed the grade 10 curriculum with an average grade of no higher than 89. All the top-performing students had transferred to other schools and were enrolled under the track and/or strands that are not currently offered in the same school where the respondents were enrolled in. Moreover, while there is no local study utilizing the normalized gain score in analysing students' pre- and post-instruction achievement, available foreign literature implies that the moderate normalized gain score highlights a positive influence of the vodcast instruction on the achievement of grade 11 Physical Science students on the topic property of light.

To further understand the influence of the vodcast on the achievement of the student-respondents, the perception of the student-respondents was gathered through a vodcast usefulness survey. It can be recalled that the 18 content and ICT expert-evaluators rated

the vodcast as very satisfactory and recommended its use. A similar result was obtained from the vodcast usefulness survey as shown in the table at the next page.

As shown in Table 5, the vodcast was perceived as very useful by the same 94 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 for them on the topic light propagation, refraction, and reflection under the MDLM. All vodcast indicators were perceived as very useful with an overall rating of 4.31. The technical production received the highest mean rating of 4.47, while the content and delivery indicators were rated at 4.22 and 4.24, respectively. The same 94 student-respondents strongly recommended the use of the vodcast as a supplementary learning material for the topic property of light under the MDLM. This was consistent with the evaluation rating of the 18 content and ICT expert-evaluators who rated the vodcast as very satisfactory with the overall mean rating of 4.71 and strongly recommended its use for the same topic under the MDLM.

**Table 5:** Vodcast Usefulness Survey Result

<b>Vodcast Indicators</b>	<b>Mean Rating</b>	<b>Interpretation</b>
Content	4.22	Very Useful
Delivery	4.24	Very Useful
Technical Production	4.47	Very Useful
Overall Mean	4.31	Very Useful

The researcher-created vodcast used as a supplementary learning material for the topic property of light under the MDLM had a positive influence on the achievement of the grade 11 Physical Science students as made evident by the improvement of their achievement level from ‘did not meet expectations’ into ‘fairly satisfactory’ with the normalized gain score of 0.46. This was supported by the result of the vodcast evaluation survey out of which the vodcast was rated ‘very satisfactory’ by the 18 content and ICT expert-evaluators serving as the respondents. The same support was obtained from the result of the vodcast usefulness survey out of which the vodcast was perceived as ‘very useful’ by the same student-respondents who took the achievement test.

#### 4. Conclusions and Recommendations

The purpose of this one-group pretest–posttest study was to develop a vodcast as a supplementary learning material for light propagation, refraction, and reflection in grade 11 Physical Science under the MDLMs. Below are the conclusions based on the results of this study:

1. The vodcast was developed with a duration of four minutes and 36 seconds as a supplementary learning material for light propagation, refraction, and reflection in grade 11 Physical Science under the MDLM. It was rated as very satisfactory and was highly recommended for use on the same topic under the MDLM by 18 content and ICT expert-evaluators.
2. The vodcast developed for light propagation, refraction, and reflection in grade 11 Physical Science under the MDLMs helped the student-respondents improved their achievement level from ‘did not meet expectations’ into ‘fairly satisfactory’ as made evident by the average normalized gain score of 0.46. The moderate normalized gain score indicates that the vodcast had a positive influence on the achievement of the student-respondents.
3. The vodcast was perceived ‘very useful’ as a supplementary learning material for the topic property of light in grade 11 Physical Science under the MDLM by the same 94 student-respondents who took the achievement 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. Future researchers could make improvements by adapting and using established multimedia evaluation tools or open educational resources (OER) evaluation tools when evaluating vodcasts.
2. Local literature on the use of vodcast to improve science achievement could be established by conducting more studies on the same subject.
3. Additional statistical analyses on top of using normalized gain score could also be utilized in analysing data to gain a better understanding of the influence of vodcast on students' achievement.
4. The vodcast developed in this study may be used as a supplementary learning material for the topic of light propagation, refraction, and reflection in grade 11 Physical Science under the MDLM.
5. More vodcasts may be developed as supplementary learning materials for other topics following the CTML principles and the recommendations of the evaluators.
6. When considering the use of vodcast in delivering learning instructions, teachers may arrive at a better-informed decision using the results of this study.
7. 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 vodcasts towards aiding the delivery of distance learning modalities.

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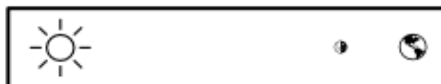
## Appendix 1

### ACHIEVEMENT TEST IN LIGHT PROPAGATION, REFRACTION, AND REFLECTION

**Directions:** Choose the letter that corresponds to the best/correct answer. On your separate answer sheet, **darken** or **shade** the circle that corresponds to your answer.

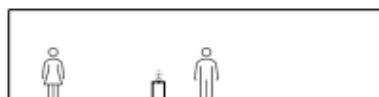
1. Twice in three years, the sun, moon, and the Earth align, and a solar eclipse occurs as shown in the image (not drawn to scale) below. Which statement is **CORRECT**?

- A. The sun will cast a shadow on Earth.
- B. The moon will cast a shadow on Earth.
- C. The whole earth will be in total darkness.
- D. The full moon will not be visible on Earth.



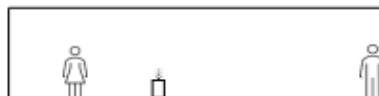
2. Tinay and Tonyo (who are of the same size and height) are standing in a room lighted by a bulb as shown in the figure below. Compared to the shadow of Tinay, the shadow of Tonyo will be \_\_\_\_.

- A. smaller
- B. bigger
- C. clearer
- D. the same in size



3. Tinay and Tonyo (who are of the same size and height) are standing in a room lighted by a bulb as shown in the figure below. Compared to the shadow of Tinay, the shadow of Tonyo will be \_\_\_\_.

- A. smaller
- B. bigger
- C. clearer
- D. the same in size



4. Tinay is standing in a room lighted by a bulb in two different setups. In both setups, all factors are held constant except for the **height** (elevation) of the bulb. Compared to setup 1, the shadow of Tinay in setup 2 \_\_\_\_.

- A. will cover the same area
- B. will cover a smaller area
- C. will cover a larger area
- D. will be darker



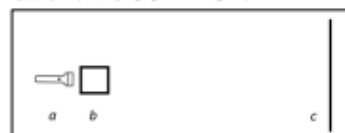
5. Tinay is standing in a room lighted by a bulb in two different setups. In both setups, all factors are held constant except for the **height** (elevation) of the bulb. Which of the following statements is **TRUE**?

- A. The "shadowed" area in **setup 1** will be **bigger than that in setup 2.**
- B. The "shadowed" area in **setup 2** will be **bigger than that in setup 1.**
- C. Tinay will have a bigger shadow in setup 1.
- D. All statements above are true.



6. In a dark room with no other light source, a flashlight (in point *a*) is shone on a box (in point *b*) before a screen (in point *c*) as shown in the following image. Which statement is **CORRECT**?

- A. A circular shadow will appear on the screen.
- B. A square shadow will appear on the screen.
- C. No shadow will appear on the screen.
- D. The screen will not be visible.



7. Another setup with variation in the distance between and among the flashlight, box and screen is shown in the following image. Which statement is **CORRECT**?

- A. A circular shadow will appear on the screen.  
 B. A square shadow will appear on the screen.  
 C. No shadow will appear on the screen.  
 D. The screen will not be visible.

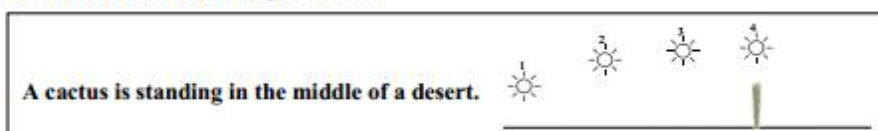


8. In their hide-and-seek game, it is Rudy's turn to stay at home-base while his friends run to hide behind a concrete wall. Why can't Rudy see his friends behind the concrete wall?

- A. The light that is reflected off his friends is **blocked** by the wall.  
 B. The light that is reflected off his friends is **refracted** by the wall.  
 C. The light that is reflected off his friends is **reflected** by the wall.  
 D. The light that is reflected off his friends **disappears** behind the wall.



For numbers 9 and 10, refer to the figure below.



9. In which position of the sun will the **LONGEST** shadow of the cactus appear?

- A. 1  
 B. 2  
 C. 3  
 D. 4

10. In which position of the sun will there be **NO** shadow of the cactus?

- A. 1  
 B. 2  
 C. 3  
 D. 4

For numbers 11 and 12, read the following situation.

**Grasya points a flashlight. The light hits an object and then travels at an angle towards a wooden table.**

11. Which of the following objects did the light most likely strike **FIRST**?

- A. wooden door  
 B. concrete wall  
 C. mirror  
 D. cloth

12. Which of the following statements is **TRUE** about the situation?

- A. The light was refracted by the object.  
 B. The light was reflected by the object.  
 C. The light was refracted by the table.  
 D. The light was reflected by the table.

13. At the foot of the mountain, the image of Mt. Apo can be seen on the surface of Lake Venado. Which of the following can help explain this observation?

- A. Lake Venado acts like a mirror reflecting Mt. Apo.  
 B. Lake Venado acts like a mirror refracting Mt. Apo.  
 C. Light reflected off Mt. Apo directly travels straight to the eyes of the observer.  
 D. Light refracted from Mt. Apo directly travels straight to the eyes of the observer.



14. Bebang wanted to clean her cellphone. When she turned off the screen, she saw her image on the screen. Which of the following statements is **TRUE**?
- The glass screen allowed light to be transmitted through it.
  - The dark screen absorbed the light that strikes it.
  - The glass screen allowed light to bounce off.
  - The dark screen bent the light that strikes it.

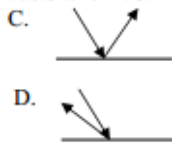
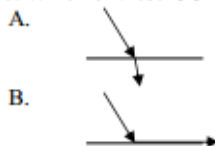
15. Ruda sees a mirror image of a house in a swimming pool on a very still day. What is the correct sequence of the light wave propagation?

- Light waves bounce off the water and travel to the eyes of Ruda.
- Light waves strike the water in the pool.
- Light waves travel from the house.

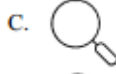
- I, II, III
- II, III, I

- III, II, I
- II, I, III

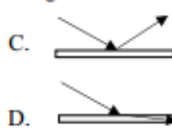
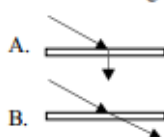
16. Which of these **CORRECTLY** shows how light acts when it strikes a mirror?



17. You walk into a room and find four different glasses: a drinking glass, sunglass, magnifying glass, and glass mirror. Which one could best help you see objects behind your back very clearly and without distortion without looking directly into them?

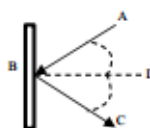


18. A reflected light is light that bounces off upon hitting a surface. Which ray diagram best show this?



For numbers 19 and 20, refer to the following figure.

The Law of Reflection states that the angle of incidence ( $\angle ABD$ ) is equal to the angle of reflection ( $\angle CBD$ ).



19. Supposed Kaloy stands at point A facing mirror B. Which of the following statements is **TRUE**?
- Kaloy will see the image of objects located at point C.
  - Kaloy will see his image in the mirror.
  - Kaloy will see his image at point D.
  - Kaloy will not see any image.

20. Supposed Kaloy stands at point A and Inday at point C both facing mirror B. Which of the following statements is **NOT TRUE**?

- A. Kaloy and Inday will not see the image of objects directly in front of the mirror.
- B. Kaloy and Inday will see the image of objects directly in front of the mirror.
- C. Kaloy will see Inday's image in the mirror.
- D. Inday will see Kaloy's image in the mirror.

For numbers 21 and 22, refer to the following situation.

**A laser pointer is turned on and pointed to a glass. The light ray it makes are shown in the diagram.**



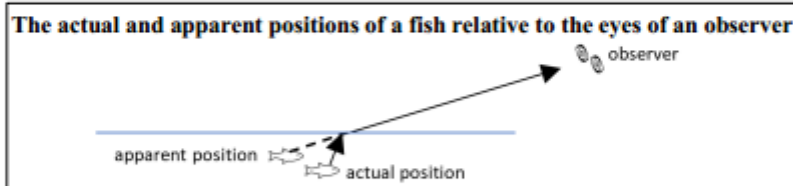
21. Which statement is **TRUE**?

- A. The light slows down as it passes through the glass and speeds up as it exits into the air.
- B. The light speeds up as it passes through the glass and slows down as it exits into the air.
- C. The light maintains the same speed as it goes through the two different media.
- D. The light curves at the interface of the two different media.

22. Based on the above situation, which of the following statements is **TRUE**?

- A. Light travels faster in air than in glass.
- B. Light travels slower in air than in glass.
- C. Light always travels at a constant speed.
- D. Light curves when passing through different media.

For numbers 23 and 24, refer to the following figure.



23. Which of the following statements is **TRUE**?

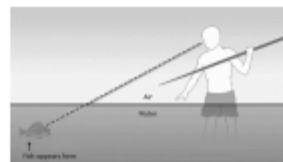
- A. There are two fishes.
- B. The observer is cross-eyed.
- C. The apparent position of the fish is due to the bending of light.
- D. The apparent position of the fish is due to the bouncing of light.

24. Which concept is best illustrated by the given figure above?

- A. light propagation
- B. light reflection
- C. light refraction
- D. dual nature of light

25. Supposed you are spearfishing. With your knowledge of refraction, what should you do to not miss the fish?

- A. Aim directly straight into the fish.
- B. Aim nearer and lower from where the fish appears.
- C. Aim farther but lower from where the fish appears.
- D. Aim farther and higher from where the fish appears.

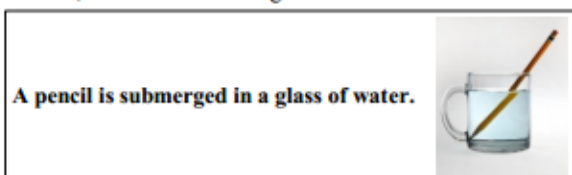




26. A light beam from a lighter medium enters a denser medium and exits to the same lighter medium. Which diagram correctly shows the path of the light beam?

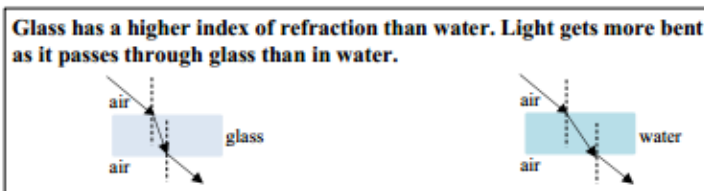


For numbers 27 and 28, refer to the following situations.



27. Which of the following statements best describes the image?
- The pencil appears broken because of refraction.
  - The pencil appears broken because of reflection.
  - The pencil is broken because of refraction.
  - The pencil is broken because of reflection.
28. Light appears to be bent as its speed changes when traveling through different media. Based on the given situation above, what is the correct sequence of the media travelled through by light starting off the pencil?
- air – glass – water
  - water – glass – air
  - glass – water – air
  - air – glass – water – air

For numbers 29 and 30, refer to the following illustrations.



29. Based on the illustrations above, compared to the speed of light passing through a **glass**, the speed of light passing through **water** is \_\_\_\_.
- faster
  - slower
  - the same
  - cannot be determined
30. Based on the illustrations above, compared to the speed of light passing through **water**, the speed of light passing through **glass** is \_\_\_\_.
- faster
  - slower
  - the same
  - cannot be determined