1. Year & Semester of assessment:

2017 Spring

2. Course assessed:

SCED 321

3. SLO assessed:

1.2 Students will be able to: demonstrate an understanding of the DCIs in Engineering, Technology and the Application of Science (ETS)

2.1 Students will be able to: Use the science and engineering practices to answer question (science) and come up with solutions (engineering)

4. Assessment Methodology Used:

We are doing qualitative analysis exploring students' diagrams of light during the first five weeks of the course as the students are developing their understanding of light and its interaction with different objects for both SLO assessed:

1.2 Explores DCIs such as PS2.B: Types of Interactions, PS2.C: Stability and Instability in Physical Systems, and PS3.B: Conservation of Energy and Energy Transfer. We contrast six diagrams developed by group of four students working collaboratively with the six diagrams developed by the same groups after analyzing the different features implemented by other groups.

2.1 Explores how students, after testing their pinhole theater with natural light, plan for further exploration on the pinhole theater making it work inside of our classroom. We analyze the different interest for the study as well as how they incorporate different elements to make the new setting work.

5. Assessment Results:

Student Learning Outcome	**Sample and Sample Size**	**Measure**	**Percent of Students Achieving**
1.2 Explores DCIs such as PS2.B, PS2.C and PS3.B.	Control n=6 groups Experimental n=6 groups	Scale from 0-2 in four different dimensions addressing the accuracy of their diagrams.	The control group showed a lower score in all of the categories, being path of light and clarity the lowest categories. We

			observed general improvement in all categories and in five out of the six groups scores. We then conclude that the students DCIs explored in this assessment are benefited from the class activities.
2.1 Use the science and engineering practices to answer question and come up with solutions	n=6 groups	Groups were able to explore how to make the pinhole theater work inside of the classroom	All of the groups were able to make modifications to their pinhole theater to make it work and identified the mechanisms used to share with others. New ideas emerged from this explorations for further examination.

6. Analysis / Interpretation of Results

1.2 We have found in our data how students engage in a very detailed analysis of light and its interactions with different objects. By analyzing their diagrams representing how light travels in a particular setting at two different moments in the course we can appreciate the changes due to the class intervention. For this particular set of data students first engaged in an individual explanation as a homework assignment to later work collaboratively to better understand the phenomenon, which resulted in our control group. Students are engaged in scientific practices in this course such as participating in research poster presentations.
The diagrams created by each group were displayed in whiteboards to later having the entire group walking around the classroom and exploring the different

representation and giving feedback to the diagrams. The diagrams were designed to be understood by the public without any introduction from the group developing them.

The intervention analyzed here includes exploring others' diagrams as well as receiving feedback, which then resulted in a revised version of the diagrams. We observe in our Assessment Data Summary 1.2 the scores obtained by each diagram, which supports an effective intervention for students to better implement the DCIs explored in this section.

2.1 Students explored the basic mechanism on how light travels through a pinhole theater. After exploring it for one session, students were challenged to make it work in the classroom with artificial light instead of natural light. Students then proceed to explore different alternatives to be able to see the image on the other side of the pinhole. All of the students were able to make the box work with artificial light after different type of interventions. In order to assess their scientific and engineering practices, we collected two type of information shared with the rest of the class after their interventions (see Appendix A, 2.1) recommendations on how to make the pinhole theater work and things they want to explore.

While examining the different ideas posed by the students we can identify the underlying principles that sustain their claims. Students are able to identify the relevance of the source of light referring to its intensity as well as the contrast in order to identify shapes, they also pointed out the focal point in order to see a clear image, as well as the component of the pinhole location and size in order to capture the image. Following their recommendations, we explore the ideas for further exploration which would be addressing in more detail the factors they have identified as relevant to make the pinhole theater work. Students briefly introduce particular strategies to better understand the way in which light is traveling and manipulate the type of image they observe with it.

7. Planned Program Improvement Actions Resulting from Outcomes (if applicable)

We will continue promoting strategies that simulates research conference practices such as poster conferences. Engaging students in an environment where they can present their work as a final outcome or work on progress allows them to better understand science as a process rather than an already established set of knowledge. We consider the data supports this strategy as effective for students' learning process of the concepts as well as their scientific skills of providing and interpreting feedback.

We will continue fostering situations in which students are challenged to redesign or adapt their experiments into new setting to further develop their understanding. We will incorporate more technology available for them to engage in a more sophisticated analysis. While one of the main purposes of this class is to make sure students are able to create experiments with using low cost materials, we consider that including some technology can enhance their scope of analysis which can benefit their design of experiments in their future teaching.

8. Planned Revision of Measures or Metrics (if applicable)

This course is a highly responsive environment where the outcomes varies from semester to semester. We consider continuing using the same rubric to analyze the different features of light and its interaction with different objects stable for future assessment while keeping in mind the description of the week in the semester the diagrams were collected. We expect students to keep engaging in a more sophisticated analysis of their diagrams as weeks goes by. We also suggest to describe the interventions in which the data was created to better understand the outcomes achieved by the students.

9. Planned Revisions to Program Objectives or Learning Outcomes (if applicable)

II. Appendices (please include any of the following that are applicable to your program)

A. Assessment Data Summaries (Details that elaborate on item 5, above.)

1.2 DCI in flashlight diagrams

Group diagrams

ID	Source-Image	Reflected-direct	Path of light	Clarity	Score
1	1	1	2	1	**5**

2	1	2	1	1	**5**
3	2	2	1	2	**7**
4	2	1	1	1	**5**
5	1	2	1	1	**5**
6	2	1	1	1	**5**
Ave.	**1.5**	**1.5**	**1.1**	**1.1**	**5.3**

Group revised diagrams

ID	Source-Image	Reflected-direct	Path of light	Clarity	Score
1	2	2	2	2	**8**
2	2	2	2	2	**8**
3	2	2	1	2	**7**
4	2	2	2	2	**8**
5	2	2	1	2	**7**
6	2	2	2	2	**8**
Ave.	**2**	**2**	**1.6**	**2**	**7.6**

2.1 Use the science and engineering practices to answer question (science) and come up with solutions (engineering)

Quotes	Recommendations to make the pinhole theater work inside
1	Sit on the floor
2	Give yourself enough time for your eyes to adjust
3	Adjust your pinhole size
4	Find appropriate focus point for your box. Projection screen may be too close/far away to clearly see anything
5	You need a strong source of light
6	High contrast help

7	Using your cellphone is a great source of light (search a bright image on the internet; like SpongeBob)
8	Using an image on a phone w/highest brightness
9	Drawing on whiteboard, moving board low & high
10	Flashing flashlight onto image on whiteboard

Quotes	**Things we want to explore**
1	Will putting a lens inside the pinhole affect the projected image?
2	Opaque wax paper collecting the image in between the pinhole and the observer
3	Black paper instead of white?
4	Does the size of the pinhole control what we see?
5	How large can the pinhole get before it stops reflecting an image onto the white paper?
6	If we expand the pinhole will we see color?
7	If I placed the pinhole closer to the center of the box, I think that I wouldn't have had to tilt the box to see the image

B. Measurement Standards (Rubrics, etc.)

1.2 Explores DCIs such as PS2.B: Types of Interactions, PS2.C: Stability and Instability in Physical Systems, and PS3.B: Conservation of Energy and Energy Transfer.

The analysis of the diagrams were coding for the following features: including the source of light and the image analyzed, distinction between reflected and direct light, indication of change of path of light as it is reflected, clarity of ideas. For each category we gave a score from 0 to 2 showing if it was not included, included but not precise, and included and clear.

2.1 We explore two sets of data regarding their manipulation of the pinhole theater while exploring it with artificial light to identify both their scientific and engineering practices. Students shared with others some advice on how to make the pinhole theater works which underlies some principles of the artifact they are exploring. The things we want to explore shows students abilities to manipulate different settings in order to further explore the mechanism of the box.