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Design, Implementation and Evaluation of a Module on Climate Change

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ABSTRACT: This research study intends to develop a learning material for Climate Change using Process Oriented Guided Inquiry Learning (POGIL) Approach and Plan-Do-Study-Act (PDSA) action research model. The developed POGIL-based Material on Climate Change (PMCC) was implemented to 2nd year and 3rd year Bachelor of Secondary Education major in Physical Science Students of Pangasinan State University, Asingan Campus during summer A.Y. 2015-2016. The duration of the implementation of the material was 15 hours. The PMCC attempted to assess the students' conceptual understanding about climate, the attitude of students towards climate change, and the attitude of students towards POGIL activities. The teacher-observers' perception in the implementation on PMCC was considered. To determine the students' conceptual understanding about climate change and attitude of students towards climate before and after PMCC instruction, the Concept Test on Climate Change (CTCC) and Climate Change Attitude Inventory adopted from Prudente, Aguja and Anito (2015) was administered. POGIL Attitudinal Survey (PAS) adopted from Shatila (2007) was administered to determine the attitude of students towards POGIL activities. Furthermore, to validate student responses in the given questionnaires each student was asked to write their comments and reflection on learning, individual interview was likewise conducted among the selected students (with extreme scores) which were done after post-test administration. Teacher-observers' perception in the implementation of PMCC was determined using POGIL Content/Process Rubric adapted from C.Bauer & K. Anderson (2009). Results of the study revealed that there was a significant change in the students' conceptual understanding before and after instruction. Moreover, there was also a significant change in the students' attitude towards climate change before and after instruction. Pearson r product moment correlation revealed a significant relationship in the conception of students about climate change and the attitude of students towards climate change. Similarly, a significant relationship was also observed between conception of students about climate change and attitude of students towards POGIL activities. Teachers-observers' revealed that PMCC was an effective tool to be use in teaching because the students actively participate in the activities. Furthermore, based from the result of the activities, student response, and the teacher-observers' perception suggest that the use of PMCC teaching climate change enhances conception and attitude of students towards climate change.

KEYWORDS: Climate Change, Module, POGIL Approach

I. INTRODUCTION

Traditional lecture methods in which professors talk and student listens dominate college and university classroom. Lecturing is a very efficient way to transmit information quickly, but students are not always ready to absorb it. Traditional teaching methods in higher education are no longer meeting students' educational needs. This has led to several reform initiatives. Some of these initiatives focus on changing the curriculum and course content; others promote more student involvement in class and seek to engage students in learning[1]. Students must do more than just listen: they must read, write, discuss, and be actively involved in higher-order thinking tasks. Process-Oriented Guided-Inquiry Learning (POGIL) is an approach encourages process-oriented skills and employs guided-inquiry learning in which students work together in team with a teacher as a facilitator to construct knowledge rather than simply having it handed to them[2]. In a POGIL classroom students work in learning teams on specially designed activities that promote mastery of discipline content and the development of skills in the processes of learning, thinking, problem solving, communication, teamwork, management, and assessment. Climate change is a great topic for students to study because it integrates so many subjects: energy, environment, geography, politics, chemistry, biology, and economics[3]. Climate change is a topic familiar to most college students. It is also a topic that will likely remain an important issue in the public for the foreseeable future. Climate change is a key cause of increased heat waves, flooding, droughts,intense tropical cyclones, rising sea levels, and loss of biodiversity. These hazards increase vulnerability to disasters and result in widespread human, material,

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economic, and environmental losses, including to education systems[4]. Thus, this study was conducted to find out the effectiveness of the developed POGIL module in teaching climate change.

II. STATEMENT OF THE PROBLEM

1. What are the features of the module?
2. How do the content experts rate the module?
3. What are the students' conception of climate change before and after instruction?
4. What are the students' attitude towards climate change before and after instruction?
5. What are the attitude of students towards POGIL Activities?
6. How do the observer rate the implementation of the module?
7. How do the students rate the implementation of the module?

III. METHOD

This study used exploratory-descriptive design and which consisted of three phases: Phase I-Design, Phase II-Implementation and Phase III-Evaluation. The researcher developed a module on Climate Change using Process Oriented Guided Inquiry Learning Activities which was evaluated by content experts to determine its alignment to the syllabus. The developed module was implemented to the 2nd year and 3rd year Bachelor of Secondary Education major in Physical Science Students of Pangasinan State University, Asingan Campus during summer A.Y. 2015-2016.

Phase 1. The Module on Change Change was designed and developed by the researcher using Process Oriented Guided Inquiry Learning Activities. The developed module was evaluated by content experts using POGIL Content Rubric adapted from Bauer and Anderson (2009).

Phase 2. The module was executed for 15 hours. Concept Test on Climate Change (CTCC)[5] and Climate Change Attitude Inventory (CCAI)[5] was administered before and after the module intervention. POGIL attitudinal Survey adapted from Shatila (2007) was also administered after the module intervention to determine the attitude of students towards POGIL Activities.

Phase 3. To ensure that the lessons comply with the syllabus, three Pangasinan State University (PSU) science instructors were invited to observe the class during the module intervention. Students also evaluated the implementation of the module using POGIL Content Rubric and POGIL Process Rubric adapted from Bauer and Anderson (2009).

Data Analysis

Descriptive statistics was utilized to analyse raters' evaluation, concept test on climate change, climate change attitude inventory, and POGIL Attitudinal Survey. Paired Sample T-Test was employed to describe differences on CTCC and CCAI scores before and after instruction.

IV. RESULT AND DISCUSSION

Table 1: Summary of Evaluators Rating

Topics	Mean	Standard Deviation
Climate Change Concepts	2.13	1.36
Greenhouse Gases and Greenhouse Effect	2.94	1.12
Global Warming	4.19	0.98
Carbon Cycle and Carbon Dioxide Emission	2.63	1.02
Stratospheric Ozone Depletion	2.06	1.18

The researcher designed a module on Climate Change following the syllabus that include topics on Introduction to Climate Change, Greenhouse Gases and Greenhouse Effect, Global Warming, Carbon Cycle and Carbon Dioxide Emission, and Stratospheric Ozone Depletion. The PMCC was evaluated using POGIL Content Rubric

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(C. Bauer & K. Anderson, 2009) by three faculty members (two environmental science faculty and one faculty handling ecology). The summary of their rating was presented in table 1:

Assessment:
0 No explicit evidence regarding this indicator.
1 Some evidence of meeting this goal, but significant improvement needed.
2 Satisfactory evidence of meeting this goal, and improvements should be considered.
3 Substantial or exemplary evidence of meeting this goal. Improvements are not essential.

Table 1 shows the mean rating of faculty members on three aspects evaluated. As shown on the table, in terms of pedagogical structure, the module has a satisfactory evidence of meeting the goal and improvement is necessary with a mean rating of 2.33. In terms of content-learning objective and self-assessment, the module is substantial evidence of meeting the goal and improvement is not essential with a mean rating of 2.67 and 3.00 respectively. The module was revised based on the comments of the content experts.

Students' Conception on Climate Change Prior to Instruction

A 30 item Concept test on Climate Change adapted from Prudente, el. Al. (2015) was administered prior to instruction. CTCC focus on five topics including climate change concepts, greenhouse gases and greenhouse effect, global warming, carbon cycle and carbon dioxide emission, and stratospheric ozone depletion. Six items in every topic was included in the test.

Table 2: Students Conception of Climate Change Prior to instruction

	MEAN	INTERPRETATION
Content Learning Objective	2.67	Substantial or exemplary evidence of meeting this goal. Improvements are not essential
Pedagogical Structure	2.33	Satisfactory evidence of meeting this goal, and improvements should be considered.
Self-Assessment	3.00	Substantial or exemplary evidence of meeting this goal. Improvements are not essential

Table 2 reveals that students' conception on global warming has the highest mean score followed by greenhouse gases and greenhouse effect. Students hold a good conception on global warming having a mean of 4.19 out of 6 items. However, they have a weak conception of stratospheric ozone depletion and climate change concepts.

Students' attitude towards climate change prior to instruction

To look at students attitude towards climate change prior to instruction, a 24-item Climate Change Attitude Inventory adapted from Prudente, et.al. (2015) was administered. Dimensions of students'attitude towards climate change were concern, optimism, sense of responsibility, and commitment. Students' concern towards climate

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change was measured in items number 1-6, while optimism was assessed using items number 7-12, items number 13-18 focused on sense of responsibility, and commitment was described in items number 19-24.

Table 3: Students Attitude towards Climate Change prior to instruction

Dimension of Attitude	Mean	Std. Deviation
Concern	4.14	0.45
Optimism	3.84	0.52
Responsibility	3.56	0.56
Commitment	3.75	0.58

Note: N = 16, 1.00 - 1.80 = strongly disagree, 1.81 – 2.60 = disagree, 2.61 – 3.40 = uncertain, 3.41 – 4.20 = agree, 4.21 – 5.00 = strongly agree

Table 3 indicates the mean attitude rating of students in the pre-CCAI. It can be gleaned from the table that the students holds a positive attitude in terms of concern, optimism, sense of responsibility and commitment.

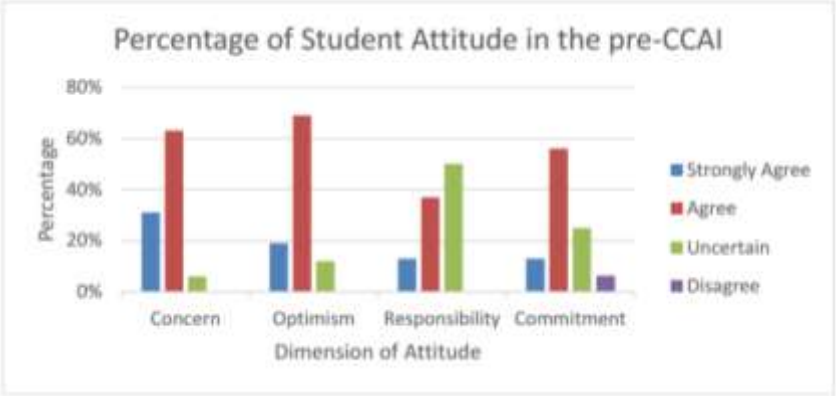

Figure 1: Percentage of Students Attitude in the Pre-CCAI

Figure 1 revealed that majority of the students show concern on the effect of climate change in the country, in which 31% of the students express strong concern. In terms of optimism, 88% (69% strongly agree and 19% agree) of the students show optimism, they believe that the initiatives to reduce climate change will lead to positive result. With regard to the sense of responsibility, it can be noted from the graph that about 50% of the respondents were uncertain in the sense of accountability to provide solution to the problem. In the commitment dimension of attitude, 69% (13% strongly agree and 56% agree) pledged to take action to help reduce climate change and lessen its impact. However, 6% of the students disagree in taking action to reduce climate change.

Students Conception after Instruction

In order to explore the effect of module on students' conception on climate change, post-CTCC were administered to the students. This was the same test which was administered to the students prior to the implementation of the module.

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Table 4: Paired Sample t-test for the Differences in Conception between the Pre CTCC and Post-CTCC Scores

Topic	Pre-CTCC (Mean Score)	Post-CTCC (Mean Score)	Mean Difference	t-Value
Climate Change Concept	2.13 (1.36)	5.50 (0.73)	-3.37	-9.59**
Greenhouse Gases and Greenhouse Effect	2.94 (1.12)	5.69 (0.48)	-2.75	-10.33**
Global Warming	4.19 (0.98)	5.37 (0.89)	-1.18	-3.34**
Carbon Cycle and Carbon Dioxide Emission	2.63 (1.02)	5.56 (0.73)	-2.93	-8.18**
Stratospheric Ozone Depletion	2.06 (1.18)	5.19 (0.91)	-3.13	-9.19**

Table 4 illustrates how students changed in the post-CTCC after a series of activities. As revealed in the table, there was an increase in the students mean score in climate change concept, greenhouse gases and greenhouse effect, global warming, carbon cycle and carbon dioxide emission, and stratospheric ozone depletion after intervention. Greenhouse Gases has the highest mean followed by Carbon Cycle and Carbon Dioxide Emission. A decrease in standard deviation shows the homogeneity of the result.

Table 4 also explicitly shows that there is a significant difference between the pre-CTCC and post-CTCC mean scores of students as reflected in the p-value which is highly significant at 0.01 level of significance. This result is verified by the absolute values of the t-statistics which are greater than the t-table value which is 2.947 at 0.01 level of significance and 15 degrees of freedom, therefore there is a significant difference between the pre-CTCC and post-CTCC. There is a change in students' conception of the five topics on Climate Change after the activity. It can be gleaned from the table that Climate Change Concepts has the highest mean difference followed by Stratospheric Ozone Depletion. Global Warming has the lowest mean difference. Negative mean difference indicates that the post-CTCC scores are higher than the pre-CTCC scores. Result suggest that the POGIL-based Material on Climate Change (PMCC) can assist students in learning salient topics on Climate Change.

Students Attitude after Instruction

In order to know the effect of PMCC on students' attitude post-CCAI were administered to the students. This was the same test which was administered to the students prior to the PMCC intervention. The POGIL Attitudinal Survey adapted from Shatila (2007) were also given to students to check if the students like the activities given to them.

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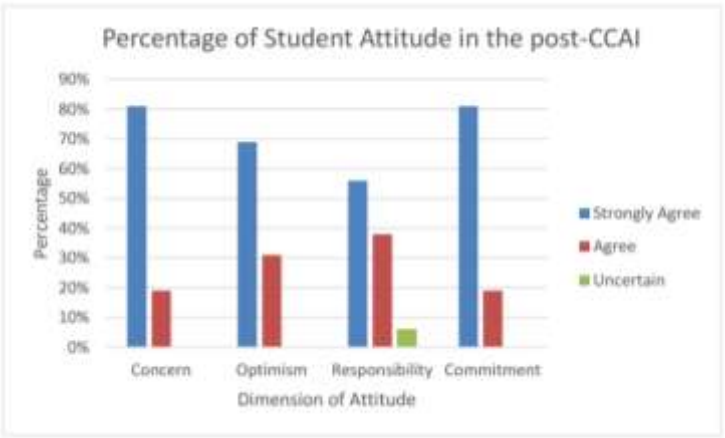

Figure 2: Percentage of Students Attitude in the Post-CCAI

Figure 2 presents the attitude of students toward climate change after instruction. It can be seen from the graph that 100% of the students shows concern (81% strongly agree, 19% agree) on the effect of climate change, develop optimism (69% strongly agree, 31% agree) believes that the initiative to reduce climate change will lead to positive result, and pledge to take action to help reduce climate change and lessen its impact (81% strongly agree, 19% agree). In terms of the sense of responsibility, 94% of the students shows the sense of responsibility (56% strongly agree, 38% agree) to provide solutions to the climate change problem, 6% of the students are uncertain in their sense of responsibility.

Table 5: Paired Sample t-test for the Differences in Attitude between the Pre-CCAI and Post-CCAI Scores

*Note: N=16, df = 15, standard deviation in parentheses, ** = p < .01, 1.00 - 1.80 = strongly disagree, 1.81 –*

Attitude Dimension	Pre-CCAI (Mean Score)	Post-CCAI (Mean Score)	Mean Difference	t-Value
Concern	4.14 (0.45)	4.56 (0.40)	-0.42	-3.46**
Optimism	3.84 (0.52)	4.48 (0.45)	-0.64	-4.98**
Sense of Responsibility	3.56 (0.56)	4.35 (0.59)	-0.79	-4.28**
Commitment	3.75 (0.58)	4.59 (0.39)	-0.84	-6.51**

2.60 = disagree, 2.61 – 3.40 = uncertain, 3.41 – 4.20 = agree, 4.21 – 5.00 = strongly agree

It can be inferred from Table 5 that the mean score of students on climate change attitude improved after the instruction. Commitment has the highest mean score followed by concern. The most improved attitude was commitment with a mean difference of -0.84. A negative mean difference means that the post-CCAI is higher than the pre-CCAI. It is also revealed in the table that there is a significant difference between the pre-CCAI and post-CCAI mean scores of students as reflected in the p-value which is significant at 0.01 level of significance.

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All of the absolute values of the t-statistics are greater than 2.947 at 0.01 level of significance and 15 degrees of freedom, therefore there is a significant difference between the pre-CCAI and post-CCAI.

Evaluation of Module Implementation

The actual module implementation was evaluated by the classroom observer and students using POGIL Content and POGIL Process Rubric adapted from Bauer and Anderson (2009). The classroom observer and the students evaluated the objectives, module outcomes, learning activities and content of the module.

Table 5. Summary of observer and students evaluation using POGIL Content Rubric

	MEAN	
	Observer	Students
Content Learning Objectives	3.00	2.63
Pedagogical Structure	2.67	2.81
Self-Assessment	3.00	2.56
Overall:	2.89	2.67

Assessment:
0 No explicit evidence regarding this indicator.
1 Some evidence of meeting this goal, but significant improvement needed.
2 Satisfactory evidence of meeting this goal, and improvements should be considered.
3 Substantial or exemplary evidence of meeting this goal. Improvements are not essential.

Table 5 shows the mean rating of the faculty-observer and students in the POGIL Content Rubric. An overall mean rating of 2.89 for the faculty-observer and 2.67 for the students means that the module is substantial evidence of meeting the goals. The objective is stated clearly on activity form. The model being explored is a reliable set of data giving students enough evidence to develop clear inferences.

Table 6. Summary of observer and students evaluation using POGIL Process Rubric

	MEAN	
	Observer	Students
Process Learning Objectives	3.00	2.63

Collaborative Structure	2.67	2.81
Self-Assessment	3.00	2.56
Overall:	2.89	2.67

Assessment:
0 No explicit evidence regarding this indicator.
1 Some evidence of meeting this goal, but significant improvement needed.
2 Satisfactory evidence of meeting this goal, and improvements should be considered.
3 Substantial or exemplary evidence of meeting this goal. Improvements are not essential.

V. CONCLUSIONS

The findings show that the developed module using the POGIL Approach could be used to enhance the learning of the students on climate change. Such a module could be used to enhance student learning especially through spiral progression (Camara, 2020) among senior high school students.

VI. REFERENCES

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