J-IAMSTEM
Journal of Innovation, Advancement, and Methodology in STEM Education
Vol. 1, No. 6, pp. 289-302, November-December 2024
https://so13.tci-thaijo.org/index.php/j_iamstem

Effects of Guided Inquiry-Oriented Modular Instruction on Grade 7 Students' Science Process Skills, Epistemological Beliefs in Science and Conceptual Understanding in Ecology

Sanaoray P.T. Canapi

Mindanao State University – Iligan Institute of Technology, Iligan City, 9200, Philippines
Tugaya Community High School, Lanao del Sur, Philippines
*Corresponding author email: sanaoray86@gmail.com

Received: 15 Nov 2024 Revised: 30 Dec 2024 Accepted: 31 Dec 2024

Abstract

This study aimed to investigate the effects of Guided Inquiry-Oriented Modular Instruction on Grade 7 students' science process skills, epistemological beliefs in science and conceptual understanding on Ecology. A quasi-experimental design, the matching only pretest-posttest control group was employed in this study. The participants of the study involved two intact sections of Grade 7 students of MSU-Tugaya High School located in the municipality of Tugaya, Lanao del Sur of school year 2016-2017. The study used one adopted instrument from A.M. Conley et al. (2000)-the Epistemological Beliefs in Science Questionnaire (EBSQ) and two researcher-made instruments- the Science Process Skills (SPS) Checklist and the Conceptual Understanding Test in Ecology (CUTE). Other sources of data are journal writings, interview guide questions, and reflection questions in the module. Quantitative data were analyzed using t-test for independent samples and Chi-square ($\chi 2$) test and were tested at 0.05 level of significance. Qualitative data were statistics free and were used to support the quantitative data to fully explain the phenomenon investigated. In the comparison between the control and experimental groups' science process skills mean score, before the intervention, the control group posted higher mean score (9.91) than the experimental group (8.30); however the difference is not significant ($t = 0.91$, $p = 0.37 > .05$). After the intervention, the experimental group posted higher mean score (14.48) than the control group (8.57) and the difference is significant ($t = -2.76$, $p = 0.01 < .05$) in favor of the experimental group. On the epistemological beliefs in science (EBS) before the intervention, students in both control and experimental groups demonstrated transitionary beliefs in all of the four dimensions. After intervention, the control group demonstrated a continuum of naïve-transitionary-informed beliefs while the experimental group demonstrated informed beliefs in two of the EBS dimensions. There is no significant difference in the EBS mean score between the control and experimental groups of students in all the four EBS dimensions before and after intervention (all p's > .05). On the conceptual understanding level before intervention, the control and experimental groups demonstrated low and average levels. After intervention, the

control group still demonstrated low and average levels while the experimental group demonstrated low, average, and high levels of conceptual understanding. In the comparison of control and experimental groups' conceptual understanding test mean score, before the intervention, the control and experimental groups posted closer mean score (28.7 vs. 29.1) and the difference is not significant ($t = -0.36$; $p=0.72 > 0.05$). After intervention, the experimental group posted higher mean score (36.6) than the control group (31.5) and the difference is significant ($t = -3.87$; $p= 0.00 < .05$) in favor of the experimental group. In the evaluation of the Guided Inquiry-Oriented Modular Instruction's features, the students rated excellent in the overall. It helped students' conceptual understandings and science processes skills improved, and promoted their epistemological beliefs in science. The findings of the study underscore the need to develop teaching approaches that promote and facilitate activation of students' science process skills, informed epistemological beliefs in science and deeper conceptual understandings in ecology. It is recommended to school administrators and science teachers to utilize guided inquiry-oriented modular teaching approach in teaching science topic domains.
Keywords: Game based learning, digital game, typhoon preparedness

1. Introduction

Teaching and learning science for scientific literacy has been a long-standing goal in science education. Science educators and teachers have agreed that the teaching of science should be inquiry-oriented that mimics how scientists work science in their day-to-day routine. Students should be exposed and confronted with real world scientific problems for them to investigate, solve, and provide explanation. One approach developed in the interactive learning situations are classes in which the instructor incorporates engagement triggers and breaks the lecture at least once per class to have students participate in an activity that allows them to work directly with the material. The goal of interactive lecture is to engage students by findings ways for the learners to interact with the content, the teacher, and their classmates. This teaching technique can be useful in imparting science lessons to the mind and heart of the students. In response to the needs and challenges of the science education at present, the inquiry- based laboratory modules are employed in foreign countries like Korea, Singapore, and United States.

Through investigations into concepts, queries, or issues, students participate in the process of inquiry-based learning. Investigations can take the shape of laboratory exercises or other information-gathering activities. Information collection, knowledge building, and gaining a thorough grasp of the subject under investigation are all steps in the process. One method of teaching that places a strong emphasis on the student's involvement in the learning process is inquiry-based learning. Students are encouraged to investigate the subject, pose questions, and exchange ideas rather than having the teacher dictate to them what they should know. A range of philosophical, curriculum-based, and pedagogical approaches to teaching are referred to as inquiry-based learning or inquiry-based science. It is necessary for the learning to be found on inquiries concerning the current content. Instead of giving students instructions directly from the teacher, pedagogy and curriculum demand that students solve problems on their own. Teachers and lecturers are viewed as learning facilitators rather than knowledge repositories. Thus, in an inquiry-based learning environment, the lecturer or teacher's job is to assist students in discovering their own knowledge rather than imparting it (Ergul et.al., 2011).

In keeping with the goal of educational institutions in the twenty-first century to help students think and learn through inquiry, the guided inquiry learning model satisfies numerous curricular criteria through motivation, engagement, and challenging learning. In guided inquiry, students are given a clear and succinct performance goal for their investigation activities, and teachers identify problems and some questions as part of a research process. The implementation of guided inquiry learning can improve scientific work and science process abilities in addition to students' comprehension of the subject matter. Modern pedagogical scientific practices are reflected in inquiry-based learning. The concept of inquiry-based learning is rooted in constructivist learning theory. These theories are constructivist learning concepts that are founded on research and the methods used by scientists itself. In a teaching approach that integrates the advantages of each field, this idea strategically links science, science education, and constructivism's findings (McDaniel and Green, 2012; Mutisya, et.al., 2013).

In this study, activity-oriented module was used as a modality of delivering guided-inquiry approach of teaching science concepts and principles. The guided inquiry-oriented learning module in teaching ecology which was developed for the purpose of this research, aimed to make the learners understand, appreciate, develop and enhance their learning skills at their own pace. The module was designed to enhance students thinking skills and serve as the intervention activities to improve the teaching- learning processes.

2. Methodology

2.1 Research Design

This study used the quasi-experimental design, specifically, the matching-only pretest-posttest control group design. The design is shown below.

Experimental Group	M	O	X	O
Control Group	M	O	C	O

Two intact sections of Grade 7 students were used and randomly assigned to control and experimental group by draw lots. M refers to the matching of students in the control and experimental groups based on their science average grades in the third grading period. Thirty (30) matched students comprised each group, a total of 60 students served as the subject participants of the study. O refers to observation. The first column of O's refers to the first observation done in the form of administering all the research instruments, namely: science process skills checklist, epistemological beliefs in science questionnaire and conceptual understanding test in ecology to both control and experimental groups. X refers to the instructional intervention given to experimental group in the form of guided inquiry-oriented modular instruction. C refers to the control or comparison group which is exposed to the traditional lecture-discussion instruction. The second column of O's refers to the second observation done in the form of administering the same research instruments administered in the pre-intervention phase to both groups of students. The quantitative aspect of the study utilized numerical data in the form of test scores and survey questionnaire rating scores. The qualitative aspect of the study utilized students' written responses on the open-ended questions in the questionnaire, verbal responses in the interview, journal writings, and class observations.

2.2 Participants of the Study

The subject participants of the study involved thirty (30) match paired Grade 7 students from two intact sections of MSU Tugaya High School. Thirty (30) students belong to Sections A (11 males and 19 females) while the other thirty (30) students to section B (14 males and 16 females). These sections were grouped heterogeneously based on their average grades in English, Math, and Science during their summer class. The basis of sectioning the students in heterogeneous manner is to avoid the feeling of insecurity among the students and assure them that they receive equal treatment and the same instruction throughout their secondary education. The students have the age range of

13 to 15 years old. Most of them graduated from public elementary schools in the different barangays of the municipality of Tugaya. Only two students came from the private school of the same municipality.

2.3 Statistical Tools

The study made used of the following statistical tools for data analysis: the frequency distribution in the form of numbers and percentages to show the occurrence of students' scores in science processes skills categories, epistemological beliefs in science categories, and conceptual understanding level categories, mean, and standard deviation. The t-test for independent samples was used to determine if there is significance between the control and experimental groups of students' mean scores in the pretest and posttest in the science processes skills, epistemological beliefs in science and conceptual understanding test in ecology, and the Pearson r to determine the influenced/relationship of students' science process skills demonstrated on their epistemological beliefs in science and conceptual understanding on the selected topic domains in ecology

2.4 Developing Module

Preparation and construction of the module & subjecting to series of editing by science experts.
Construction of the research instruments and subjecting them to validation by science experts.

Seek permission from OVCAA and the School principal
Orient the principal on the nature and purpose of the study

Establish rapport to the students; discuss the purpose of the study emphasizing the use of modular instruction

Group students into experimental and control groups.

First Administration of all the Research Instruments to both Control and Experimental Groups

Figure 1. Flowchart of the Pre-Intervention Phase

Review of the Grade 7 Science LM and books

Content Organization and write first draft

Content and Face Validity by Experts

Writing the Second Draft regarding Validators

Second Stage of Content and Face Validity

Writing the Third Draft regarding Validators

Pilot Testing and Reliability Analysis

Final Revision

Figure 2. Flowchart of Module Making

Table 1. T-test and Significance (p) Values on the Comparison of Control and Experimental Groups' Demonstrated/Observed Science Process Skills (SPS)

Period	Group	Mean	t-test value	p-value
Before Intervention	Control (n=30)	9.91	0 .911	0 .36 (ns)
	Experimental (n=30)	8.30		
After Intervention	Control (n=30)	8.57	-2.760	0 .01 (s)
	Experimental (n=30)	14.48		

Note. s=significant at .05 level; ns=not significant at .05 level

Table 2. Numbers and Percentage Distribution of the Control and Experimental Groups of Students in the Three Categories of Epistemological Beliefs in Science (EBS) before Intervention

Dimensions of Epistemological Beliefs in Science	Category of Students' EBS	Control (n=30)	Experimental (n=30)	Chi-square (x^2)	p-value
Source of Scientific Knowledge	Naive	9 (30.0%)	7 (23.33%)	0.30	5.99 (ns)
	Transitionary	10 (33.3%)	12 (40.0%)		
	Informed	11 (36.7%)	11(36.7%)		
Certainty of Knowledge	Naïve	9 (30.0%)	6 (20.0%)	2.76	5.99 (ns)
	Transitionary	9 (30.0%)	9 (30.0%)		
	Informed	12 (40.0%)	15 (50.0%)		
Development of Scientific Knowledge	Naïve	4 (13.3%)	6 (20.0%)	0.54	5.99 (ns)
	Transitionary	10 (33.3%)	11(36.3%)		
	Informed	16 (53.3%)	14 (46.7%)		
Justification of Scientific Knowledge	Naive	4 (13.3%)	5 (16.7%)	0.42	5.99 (ns)
	Transitionary	9 (30.0%)	7 (23.3%)		
	Informed	17 (56.7%)	18 (60.0%)		

Note. ns=not significant at .05 level

Table 3. Numbers and Percentage Distribution of the Control and Experimental Groups of Students in the Three Categories of Epistemological Beliefs in Science after Intervention

Dimensions of Epistemological Beliefs in Science	Category of Students' EBS	Control (n=30)	Experimental (n=30)	Chi-square (x^2)	p-value
Source of Scientific Knowledge	Naive	11 (36.7%)	7 (23.33%)	1.20	5.99 (ns)
	Transitionary	9 (30.0%)	11(36.7%)		
	Informed	10 (33.3%)	12 (40.0%)		
Certainty of Knowledge	Naïve	6 (20.0%)	7 (23.3%)	0.06	5.99 (ns)
	Transitionary	8 (26.7%)	7 (23.3%)		
	Informed	16 (53.3%)	16 (53.3%)		
Development of Scientific Knowledge	Naïve	3 (10.0%)	3 (10.0%)	0.72	5.99 (ns)
	Transitionary	10 (33.3%)	7 (23.3%)		
	Informed	17 (56.7%)	20 (66.7%)		
Justification of Scientific Knowledge	Naive	6 (20.0%)	2 (6.67%)	2.58	5.9 (ns)
	Transitionary	5 (16.7%)	4 (13.3%)		
	Informed	18 (60.0%)	24 (80.0%)		

Note. ns=not significant at .05 level

Table 4. Summary of the Control and Experimental Groups' Average Mean Scores in the Four Dimensions of EBS before and after Intervention

EBS Dimensions	Before Intervention		After Intervention	
	Control (n=30)	Experimental (n=30)	Control (n=30)	Experimental (n=30)
	Ave. Description Mean	Ave. Description Mean	Ave. Description Mean	Ave. Description Mean
Source of Scientific Knowledge	2.74 Transitionary	2.72 Transitionary	2.73 Transitionary	2.80 Transitionary
Certainty of Scientific Knowledge	2.92 Transitionary	3.16 Transitionary	2.84 Transitionary	3.14 Transitionary
Development of Scientific Knowledge	3.53 Transitionary	3.64 Transitionary	3.51 Transitionary	4.05 Informed
Justification of Scientific Knowledge	3.73 Transitionary	3.88 Transitionary	3.75 Transitionary	4.13 Informed

Note. *A) Positive (+) statements*
5.0-4.0 = Informed (I)
3.9-2.1 = Transitionary (T)
2.0-1.0 = Naïve (N)

B) Negative (-) statements
5.0-4.0 = Informed (I)
3.9-2.1 = Transitionary (T)
2.0-1.0 = Naïve (N)

Table 5.T-test and Significance (p) Values on the Comparison of Control and Experimental Groups in EBS of Students before and after Intervention

EBS Intervention	Dimensions Phase	Group (n=30)	Mean	t-test	p-value
Source of Scientific Knowledge	Before	Control Experimental	2.74 2.72	0.047	0.96(ns)
	After	Control Experimental	2.73 2.80	-0.116	0.91 (ns)
Certainty of Scientific Knowledge	Before	Control Experimental	2.92 3.16	-0.365	0.72 (ns)
	After	Control Experimental	2.84 3.14	-0.497	0.62 (ns)
Development of Scientific Knowledge	Before	Control Experimental	3.53 3.64	-0.505	0.62 (ns)
	After	Control Experimental	3.51 4.05	-2.124	0.06 (ns)
Justification of Scientific Knowledge	Before	Control Experimental	3.73 3.88	-0.397	0.69 (ns)
	After	Control Experimental	3.75 4.13	-1.055	0.30 (ns)

Note. ns=not significant at .05 level

Table 6. Students' Categorized Levels of Conceptual Understanding and the Numbers (%) Distribution of Students before and after Intervention

Period	Conceptual Understanding Levels	Number (%) of Students			
		Control Group (n=30)	Experimental Group (n=30)	X^2	p-values
Before Intervention	High	0 (0%)	0 (0%)		
	Average	10 (33.33%)	6 (20%)	1.560	3.84(ns)
	Low	20 (66.67%)	24 (80%)		
After Intervention	High	0 (0%)	2 (6.67%)		
	Average	16 (53.33%)	20 (66.67%)	6.600	5.99(ns)
	Low	14 (46.67%)	8 (26.67%)		

Note. Score range for conceptual understanding levels ; ns=not significant at .05 level
55-45 - High
44-30 - Average
29-below - Low

Table 7. T-test and Significance (p) Values on the Comparison of Control and Experimental Groups of Students' Conceptual Understanding Test Mean Scores before and after Intervention

Period	Group	Mean	t-test	p-value
Before Intervention	Control (n=30) Experimental(n=30)	28.7 29.1	-0.36	0.72 (ns)
After Intervention	Control(n=30) Experimental(n=30)	31.5 36.6	-3.87	0.00 (s)

Note. s=significant at .05 level; ns=not significant at .05 level

Table 8. Relationship between the Science Process Skills and Epistemological Beliefs in Science of the Control and Experimental Groups of Students before and after Intervention

Period	Group	Measures	Pearson r Correlation	Sig. p-values (2 tailed)
Before Intervention	Control (n=30)	Science Process Skills Epistemological Beliefs	-.262	.16 (ns)
	Experimental(n=30)	Science Process Skills Epistemological Beliefs	-.015	.93 (ns)
After Intervention	Control(n=30)	Science Process Skills Epistemological Beliefs	.075	.69 (ns)
	Experimental(n=30)	Science Process Skills Epistemological Beliefs	-.180	.04 (s)

Note. ns = not significant at .05 level; s = significant at .05 level

Table 9. Relationship between the Science Process Skills and Conceptual Understanding of the Control and Experimental Groups of Students before and after Intervention

Period	Group	Measures	Pearson r Correlation	Sig. p-values (2 tailed)
Before Intervention	Control (n=30)	Science Process Skills Conceptual Understanding	.025	.89 (ns)
	Experimental(n=30)	Science Process Skills Conceptual Understanding	.002	.99 (ns)
After Intervention	Control(n=30)	Science Process Skills Conceptual Understanding	.072	.70 (ns)
	Experimental(n=30)	Science Process Skills Conceptual Understanding	.775	.00 (s)

Note. ns = not significant at .05 level; s = significant at .05 level

Table 10. Relationship between the Module and Students' Science Process Skills, Epistemological Beliefs in Science, and Conceptual Understanding in Ecology

Correlated Variables	Pearson r values	p-values (2 tailed)
Module and SPS	.311	.049 (s)
Module and EBS	-.180	.038 (s)
Module and CUTE	.377	.040 (s)

Note. s=significant at .05 level; ns=not significant at .05 level

Table 11. Students' Mean Rating on the Different Features of the Guided Inquiry-Oriented Module

Module Features	Mean Rating	Description
Cover	4.00	Excellent
Design Appearance	3.73	Excellent
Content	3.73	Excellent
Activities	4.00	Excellent
Self-Assessment	3.87	Excellent
Average Mean	3.87	Excellent

Note. Excellent: 3.50 - 4.00 Satisfactory: 2.00 - 2.49
Very Good: 3.00 - 3.49 Fair: 1.50 -1.99
Good: 2.50- 2.99 Poor: 1.00- 1.49

Table 12. Students' Responses on the Self-Assessment Questionnaire about the Guide Inquiry-Oriented Modular Instruction

Assessment Questions	Answer	Numbers (%)
How would you rate the module?	Excellent	29 (96.67 %)
Do the cover and design of the module grab your concentration in ecology?	Yes	29 (96.67 %)
Do the activities in the module arouse your awareness about the environment?	Yes	28 (93.33 %)
Does the content of the module influence your conceptual understanding?	Yes	23 (76.67 %)
Do the topics in the module increase your interest in studying ecology?	Yes	26 (86.67 %)
What is/are the most interesting activity?	Many	23 (76.67 %)
What activity improves your conceptual understanding most?	Many	26 (86.67 %)
What activity improves your science process skills most?	Many	24 (80.00 %)
What activity changes / differ from your epistemological beliefs in science?	Many	18 (60.00 %)
Give your comments about the module.	None	19 (63.33 %)
Some comments	Easy, hard, interesting, challenging, attractive, knowledgeable, very good, exciting	

4. Results

These are the findings of the study:

1. Students' Science Process Skills. Before the intervention, the control group students' science process skills which observed as highly demonstrated was communicating (87.3%) while discovering (60.0%) and experimenting (73.0%) were fairly demonstrated. In the experimental group, only the process of experimenting (80.0%) was demonstrated fairly. After the intervention, the students in the control group demonstrated highly the process skills of communicating (90.0%), and experimenting (87.0%). Concluding (70.0%) and identifying (57.0%) were fairly demonstrated. The experimental group demonstrated highly the process skills of communicating (93.0%), concluding (93.0%), experimenting (93.0%) and identifying (80.0%) while describing (63.0%) and discovering (63.0%) were fairly demonstrated. On the average, before the intervention, the control group posted a higher science process skills mean score (9.91) than the experimental group (8.30) however, not significant at .05 level ($t = 0.911$, $p > .05$). After the intervention, the experimental group posted higher science process skills mean score (14.48) than the control group (8.57) and is significant at .05 level ($t = - 2.76$, $p < .05$).

2. Students' Epistemological Beliefs in Science. In the source of scientific knowledge EBS dimension, before intervention, the control group posted a slightly higher mean score (2.74) than the experimental group (2.72) however not significant at .05 level ($t=0.047$, $p > .05$). After intervention, the control group posted lower mean score (2.73) than the experimental group (2.80) however not significant at .05 level ($t=-0.116$, $p >.05$). In the certainty of scientific knowledge EBS dimension, before the intervention, the control group posted lower mean score (2.92) than the experimental group (3.16) however not significant at .05 level ($t= -0.365$, $p> .05$). After the intervention, the control group posted lower mean score (2.84) than the experimental group (3.14) however not significant at .05 level ($t= -0.497$, $p>.05$). In the development of scientific knowledge EBS dimension, before the intervention, the control group posted a slightly lower mean score (3.53) than the experimental group (3.64) however not significant at .05 level ($t= -0.506$, $p> .05$). After the intervention, the control group posted lower mean score (3.51) than the experimental group (4.05) however not significant at .05 level ($t= -2.124$, $p> .05$). In the justification of scientific knowledge EBS dimension before the intervention, the control group posted lower mean score (3.73) than the experimental group (3.88) however not significant at .05 level ($t= -0.397$, $p> .05$). After the intervention, the control group posted lower mean score (3.75) than the experimental group (4.13) however not significant at .05 level ($t= -1.055$, $p> .05$).

3. Students' Conceptual Understanding Levels in Ecology Selected Topic Domains. Before the intervention, none (0%) of the students in both the control and experimental groups demonstrated high level of conceptual understanding. In the average level of conceptual understanding, 33.3% of the control group demonstrated while there was only 20% of the experimental group. In the low level of conceptual understanding, 66.7% of the control group demonstrated it while only 80% of the experimental group. After the intervention, none (0%) of the students in the control group demonstrated high level of conceptual understanding while there was 6.67% of the experimental group. In the average level of conceptual understanding, 53.3% of the students in the control group demonstrated it while there was only 66.67% of the experimental group. In the low level of conceptual understanding, 46.7% of the students in control group demonstrated it while there was 26.7% of the experimental group. Before the intervention, the experimental group posted a higher conceptual understanding test mean score (29.1) than the control group (28.7), however not significant at .05 level ($t\text{-test} = -0.36$, $p >.05$). After the intervention, the experimental group posted a higher conceptual understanding test mean score (36.6) than

the control group (31.5) which is significant at .05 level (t-test = -3.87, $p < .05$) in favor of the experimental group.

4. Science Process Skills that Influenced the Development of Control and Experimental Groups of Students' EBS and Conceptual Understanding on Ecology. Before intervention, the control group of students demonstrated the science process skills specifically communicating, concluding, discovering, and identifying. These skills did not have a significant association/ influence on their epistemological beliefs in science (Pearson r = -0.262, p >.05) and conceptual understanding (Pearson r = .025, p >.05). The experimental group of students demonstrated the science process skills of communicating, concluding, describing, discovering, experimenting and identifying. These skills did not have a significant association/ influence on their epistemological beliefs in science (Pearson r = -0.015, p >.05) and conceptual understanding (Pearson r = - .002, p >.05). After intervention, the control group of students demonstrated the science process skills of communicating, experimenting, concluding and identifying. These skills did not have a significant association/ influence on their epistemological beliefs in science (Pearson r = .075, p >.05) and conceptual understanding (Pearson r= .072, p >.05). The experimental group of students demonstrated the science process skills of communicating, concluding, describing, discovering, experimenting, and identifying. These skills have a significant association/ influence on their epistemological beliefs in science (Pearson r= -.180, p <.05) and conceptual understanding (Pearson r= .775, p < .05).

5. Ways on which the Module Facilitate Improvement on the Experimental Group of Students' Science Process Skills, Epistemological Beliefs in Science, and Conceptual Understanding in Ecology. 1) Science Process Skills. The module had significant associations with the students' science process skills (Pearson r= .311; p < .05) as observed and declared by the students in their indoor and outdoor activities. 2) Epistemological Beliefs in Science. The module had significant associations with the students' epistemological beliefs in science (Pearson r= -.180; p < .05), as they shared and negotiated ideas while performing investigative activities. 3) Conceptual Understanding in Ecology. The module had significant associations with the students' conceptual understanding (Pearson r=.377; p< .05), as subject participants performed inquiry activities. The students' conceptual understanding has been developed in performing the guided- inquiry modular activities as it required the subject participants to observe and investigate the natural scenario in their locality.

5. Conclusions

The following conclusions of the study were drawn:

1. Students possessed so distal (so distant from professional scientists'- like) scientific process skills. Students' science process skills can be improved even to a professional scientist-like level through explicit and constant exposure to scientific investigations activities-oriented instruction and engagement in scientific investigation activities even at non-authentic and contextualized classroom-based menu type level. Students' proximal (close to professional scientists'-like) scientific process skills can be attained through constant practice of scientific works in the same way scientists did in their day to day business with science.

2. Students possessed limited and distal (distant from professional scientists'- like) science process skills knowledge however this can be improved to proximal level even to a professional scientist-like level through constant and explicit exposure of scientific investigations activities-oriented instruction and engagement in scientific investigation activities even at non-authentic and contextualized classroom-based menu type level.

3. Students demonstrated both uninformed (naïve-transitionary state) and informed levels of their epistemological beliefs in science. Students' epistemological knowledge

and beliefs can be improved to proximal one or even to a professional scientists-like level through explicit and constant exposure to scientific investigation activities-oriented instruction and engagement in scientific investigation activities at non-authentic and contextualized classroom-based menu type level.

4. Before and after intervention, both control and experimental groups demonstrated the same level of knowledge, understanding, and beliefs on the epistemologies of science (covering the four dimensions) based on their measured test mean scores. Students of the same cultural background, living in the same locality, exposed to the same learning environment, and whose parents' occupation were farming and business had the same epistemological beliefs in the processes of science.

5. Prior to any explicit instruction, students possessed limited knowledge on the topic domains of the subject; hence, most of them are in the average and low levels of their conceptual understandings. Students' level of knowledge information and conceptual understanding can be raised even to higher level through explicit instruction by exposing them through investigative activity-oriented science instruction and engaging them even in classroom-based menu type scientific investigative activities.

6. The nature of instruction affected and influenced students' epistemological beliefs in science (EBS) and conceptual understanding. Science instruction that highly and constantly exposed and engaged students in investigative-oriented science activities that required students to construct their understandings based on their experiences reflect their experiences, and reconstruct their understanding enabled students to gain deeper and solid understanding of the topic domain taught.

7. The students perceived the different parts of the guided-inquiry learning module in science such as its cover, design appearance, content, modular activities, and the self assessment questions as excellent. Well-organized learning modules help students to ignite their interest in learning science as they attract them to read the content of the modules.

References

Allison, E. B. & Goldston, J.A.(2016). An exploration of two 'modern classrooms': *Elementary science and technology in the shadows of time, standards, and testing.* The Electronic Journal of Science Education, 20(7): 26 - 49

Aniscal, R. V. (2011). *The effect of cooperative learning methods in developing the reading comprehension of grade six students* (Unpublished doctoral dissertation). University of Southeastern Philippines, Davao City.

Barthlow, M. J. (2011). *The effective of process oriented guided inquiry learning to reduce alternative conceptions in secondary chemistry*. Retrieved from www.narst.org/publications/

Braten, I. & Stromso, H. (2013) *The relationship between epistemological beliefs, implicit theories of intelligence, and self-regulated learning among Norwegian postsecondary students*. Retrieved from www. ncbi.nlm.nih.gov/pmc.

Cagas, B.L. (2011). *Science high school students' understanding on the nature of science* (Unpublished doctoral dissertation). De La Salle University. Taft Ave., Manila.

Cano, F. (2011). *Epistemological beliefs and approaches to learning: their change through Secondary school and their influence on academic perf*ormance. Retrieved from www.tojned.net.

Compton's Britannica. (2008). *Earth's changing environment.* New York, Encyclopedia Britannica, Inc.

Concepcion, J.R. (2012*). Effectiveness of understanding UBD in teaching English, science and mathematics for sophomore students as perceived by teachers*

(Unpublished doctoral dissertation). University of Southeastern Philippines, Davao City.

Conley, A.M. , Pintrich, P.R., Veriki, I. & Harrison, D. *Changes in epistemological beliefs in elementary science students*. Retrieved from www.recsam.edu.my.

Cunningham, W.P. & Cunningham, M. (2006). *Principles of environmental science inquiry and applications (2nd ed.).* New York, McGraw Hill Co. Inc.

Dandan, M.E. L. (2013). *Effect of collaboration learning activities on the academic achievement of sophomore students in Maco National High School in mathematics 2* (Unpublished doctoral dissertation). University of Southeastern Philippines, Davao City.

De Guzman-Santos, R.P. (2007). *Assessment of learning*. Quezon City, Lorimar Publishing, Inc.

Deauna, M.C. & Lamayo, F.C. (2003). *Science and technology: The natural world 1.* Quezon City, *SIBS* Publishing House,Inc.

Ergul, R., Semsikli, Y., Calis, S., Ozdilek, Z., Gocmencelebi, S., & Sanli, M. (2011) The effects of inquiry-based science teaching on elementary school students' science process skills and science attitudes. *Bulgarian journal of science and education policy,* 5, (1), 49-63. Retrieved from www.narst.org/publications/

Felicerta C.N. & Pinar, L.B. (2011).*Breaking through integrated science 1*. Quezon City, C & E Publishing, Inc.

Flores, J. & Knowles, T. (2012). Using the theory of multiple intelligences to understand guided inquiry. *Physics department, university of notre dame*. NSF/REU Program. Retrieved from www.dfes.gov.uk.

Fraenkel J.R. & Wallen, N.E. (2010). *How to design and evaluate research in education (7th ed.),* New York, McGraw-Hill Companies.

Hans, N., Esma, H., & Greg, M. *Epistemological beliefs of students in high school physics*. Retrieved from www. tojned.net.

Ismal, W., Ereveles, N., & Seales, S. *Epistemological beliefs of students at high school: A survey study in Malaysia*. Retrieved from www. tojned.net.

Jamwal, G, (2012). *Effective use of interactive learning modules in classroom study for computer science education.* Retrieved from http://digitalcommons.usu.edu/grad/225.

Leonor, J.P. (2014). *Exploration of conceptual understanding and science process skills: A basis for differentiated science inquiry curriculum model*. De La Salle University, Manila, Philippines. Retrieved from www.narst.org/publications/

MaFerriols-Paviod, J. & Faraon, G.D. (2010). *Integrated science exploring life through science (2nd ed.).* Quezon City, Phoenix Publishing House.

Manosa,S.D. & Talaue, F.T. (2009). *Breaking through biology*. Quezon City, C & E Publishing, Inc.

McDaniel, S.N. & Green, L. (2012). Independent interactive inquiry-based learning modules using audio-visual instruction in statistics. *Technology innovations in statistics education* 6(1) Retrieved from https:/eschoalrship.org/uc/items/322385

Mutisya, S., Rotich, S. & Rotich K.P. (2013). Conceptual understanding of science process skills and gender stereotyping: A critical component for inquiry teaching of science in Kenya's primary schools. Asian journal of social sciences and humanities, 2(3), 359-367.

Peer, J. & Atputhasamy, L. Students' epistemological beliefs about science: The impact of school science experience. *Journal of Science and Mathematics Education in Southeast Asia*, 28(2), 81-95. Retrieved from www.recsam.edu.my.

Reliogioso T. & Vengco, L. (2010). *Integrated science 1*. Quezon City, Phoenix Publishing House, Inc.

Sadi, O. and Miray Dağyar, M. (2015). High school students' epistemological beliefs, conceptions of learning, and self-efficacy for learning biology: A study of their structural models. *Eurasia journal of mathematics, science & technology education*. 11(5), 1061-1079.

Saricayir, H.S., Ay, S., Comek, A., Canzis, J., & Uce, M. (2016). Determining students' conceptual understanding level of thermodynamics. *Journal of Education and Training studies*, 4, (6), 69-70. Retrieved from http:/www. getting smart.com/2016/08.

Wang, L., Bruce, C. & Hughes, H. (2011). Sociocultural Theories and their Application in Information Literacy Research and Education. *Australian Academic & Research Libraries*. 42 (4), 296-308. Retrieved from http:/verywellmind.cpm