Open Inquiry Process in Special Science Class in Grade 8

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Abstract: *This study investigated the Open Inquiry Process (OpInPro) in Special Science Class in Grade 8. It also identified the perception of teachers and students on science process skills (SPS), approaches and drew the flow of the Open Inquiry Process in Science Investigation (OpInSI). Mixed Method Design was used in the study. Science teachers and grade eight students answered the survey questionnaire. The data were analyzed using Mann-Whitney U-test for the test of significance and conducted qualitative analysis of data to arrive at themes. Themes were formulated through analysis of students' Meta cards in class and students' responses during the Focus Group Discussions. Results revealed that there is no significant difference between the perception of teachers and students on the science process skills and open inquiry approaches. It was also found out that some integrated science process skills were less emphasized due to complexity and lack of practice. This study suggests reformed science learning and teaching emphasizing the need for focused open inquiry approach particularly hypothesizing, measuring, and concluding.*

Keywords: *Open Inquiry Approach, Open Inquiry Process, Science Process Skills*

INTRODUCTION

The process in teaching science is as rapid as the advancement of science and technology. This poses a challenge to the entire science teachers to keep up with the fast societal development. Tracing the date back on 2003 in the Trends in International Mathematics and Science Study (TIMSS), out of 45 countries Philippines ranked 42nd in Science. In the National Achievement Test (NAT) taken by fourth year students S.Y. 2011-2012, Science obtained the lowest Mean Percentage Score (MPS) of 40.53 among all the subjects [1].

The demand of current curriculum cannot meet the needs and learning styles of the millenials. The learning preferences of millenials area; open to new ideas, at ease with group activities, demand immediate feedback; experiential activities; and active learners [2].

This gap could be bridged by the inquiry approach, promoted by the Department of Education (DepEd) and the Department of Science and Technology-Science Education Institute (DOST-SEI).

OBJECTIVES OF THE STUDY

The study was conducted to; address the gap between learning styles of millennial students and method of science teaching, link science lessons to real life situations, develop science process skills and realize the objectives of the K to 12 Curriculum. Recent results from international research indicate that students learning from inquiry-based teaching perform better than students in traditional teaching [3].

To this effort, this study addressed the following science concerns such as (1) process skills and approaches involved in conducting Open Inquiry Science Investigation (OpInSI) as perceived by: a. teachers; b. students (2) test the

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significant difference between the perception of teachers and students on the process skills and approaches in conducting Open Inquiry Science Investigation (OpInSI) (3) draw and describe the common process flow practiced by the students in conducting Open Inquiry Science Investigation and (4) proposed new scientific process flow to be used by students in conducting Open Inquiry Science Investigation.

MATERIALS AND METHODS

This study made use of the Mixed Method Design. The respondents of this research were 20 teachers who handled special science class and 72 Grade 8 special science students of Dagupan City National High School (DCNHS). Purposive sampling, a non-probability sampling technique was used in this study.

The researchers collected data using survey questionnaire developed from the Graduate School of Education, Chiba University, Japan and PSU. It was revised to align the content to the problems of this study. Other methods of data collection used in this study were; 5E lesson plans, focus group discussion (FGD) guide, video and audio recordings of students.

The quantitative part of the study, the respondents answered a survey questionnaire and the qualitative part; the students were randomly selected and grouped into five. Both group performed the two science investigations. There were two sessions for every science investigation. The teacher who was also the researcher used the 5E model teaching for the implementation of the science investigations. The first session of the open inquiry process started by posing a situation, materials were identified and prepared and students designed their own experiment to solve the problem.

The second session included presentation of the step by step procedure written on Meta cards and the results. The groups had Focus Group Discussions. The discussions were fully transcribed and analysed, the results were aligned to create a theme and an evolving pattern.

RESULTS AND DISCUSSION

The results presented include the perceived Science Process Skills (SPS) and Approaches involved in conducting Open Inquiry Science Investigation (OpInSI) by students and teachers. The significant perceptions established the practices, skills and process flow.

Science Process Skills (SPS) Involved in Conducting OpInSI

In Table 1 and 2, “Rarely” and “Never” were not included in the analysis because there were no responses in all items. Statements with 50% and above were marked in red on both tables to emphasize the result of the SPS utilized and practiced by teachers.

Table 1
Science Process Skills Involved in OpInSI as Perceived by the Teachers
N=20

Process Skills	Sometimes		Often		Very often	
	F	%	F	%	F	%
Measuring	1	5	6	30	13	65
Observing	0	0	8	40	12	60
Asking questions	1	5	8	40	11	55
Communicating	0	0	9	45	11	55
Inferring	2	10	8	40	10	50
Hypothesizing	3	15	8	40	9	45
Interpreting data/drawing conclusion	3	15	9	45	8	40
Classifying	2	10	11	55	7	35
Defining variables operationally	6	30	7	35	7	35
Experimenting the plan	3	15	10	50	7	35
Summarizing	5	25	8	40	7	35
Predicting	2	10	12	60	6	30
Modelling	4	20	10	50	6	30
Controlling variables	7	35	10	50	3	15
Research/manuscript writing	7	35	11	55	2	10

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The data in Table 1 implies that five out of 15 science process skills are only given emphasis in science classes. Measuring, observing, asking questions and communicating are basic scientific skills [4] which are easier to master than integrated skills. These skills are among the basic essential skills to be taught for the 21st century skills [5]. Science process skills which fall under "often" require "hands on" analytical experiential learning. Thus, it proves that teachers are less involved in "hands on", analysis of data and experiential learning of their students.

Table 2 on Process Skills in conducting OpInSI among students shows 10 out of 15 skills are very often used in science class.

Table 2
Process Skills Involved in Conducting OpInSI as Perceived by the Students
N = 72

Process Skills	Sometimes		Often		Very often	
	F	%	F	%	F	%
Measuring	0	0	17	23.61	55	76.38
Observing	4	5.56	13	18.06	55	76.38
Asking questions	0	0	19	26.39	53	73.61
Communicating	12	16.67	14	19.44	46	63.89
Inferring	5	6.94	24	33.33	43	59.72
Hypothesizing	1	1.39	29	40.28	41	56.94
Interpreting data/drawing conclusion	11	15.28	20	27.78	41	56.94
Classifying	10	13.89	22	30.56	40	55.55
Defining variables operationally	11	15.28	24	33.33	37	51.38
Experimenting the plan	9	12.5	26	36.11	37	51.39
Summarizing	6	8.33	33	45.83	33	45.83
Predicting	10	13.89	30	41.67	32	44.44
Modelling	10	13.89	31	43.06	31	43.06
Controlling variables	9	12.5	34	47.22	29	40.28
Research/manuscript writing	9	12.5	34	47.22	29	40.28

The ten skills marked red are being used by the teachers and in their daily lessons. Ayogdu [4] and this study, found out that according to the students, science teachers frequently use these skills in classroom and the level of science process skills of students are also high. The rest of the science process skills were found to be "often" involved in science investigation. Based on FGD, students agreed that sometimes they do not know the skill until the teacher defines the term for the skill itself. This could be due to the complexity of these skills and term used spontaneously.

The differences on the ranks of the science process skills perceived by teachers and students can be explained by the experiential involvement of both students and teachers. The proposed Process Skill model [6] is not all about the teacher doing the task and the students are watching. This strategy will be effective if the teacher allows the students to do the skills repeatedly which positively affect students' academic performance [7].

Research/Manuscript writing got low percentage among students. There might be a misconception in which students think that going to the library and finding the definition of scientific terms as researching however, this is just simply reading or copying. Table 1 and Table 2 show that both teachers and students have mastered the basic open inquiry skills due to the occurrence of using them in class than the integrated SPS.

Approaches Involved in Conducting Open Inquiry Science Investigation

For table 3 and 4, "Disagree" and "Strongly Disagree" were removed from the analysis since there are no responses in all items. Statements with 50 percent and above were marked in red to emphasize the result of the majority responses among the respondents for both tables.

Based from Table 3, the approaches marked red under "strongly agree" point out to the role of teachers as facilitators in the student-centered classroom. Kelly [8] emphasized that facilitating learning involves teaching students to think critically and understand how the learning process works. This is evident because high percentage of teachers claimed that they allow students to use science process skills.

The approaches with high percentage under "agree" imply that the roles played by teachers have minimal impact on the students' individualized learning, trying trial and error, and reflection. The interaction of teachers to students affects students' achievement. Group and individual monitoring where the students are in the learning process is also important to assess whether they are on the right track.

Table 3
Approaches Involved in Conducting Open Inquiry Science Investigation as Practiced by the Teachers
N=20

Open Inquiry Approaches	Moderately agree		Agree		Strongly agree	
	F	%	F	%	F	%
Encouraging self-directed learners	0	0	4	20	16	80
Designing the procedures and data tables for investigations	1	5	4	20	15	75
Students share ideas and information during class	1	5	5	25	14	70
Eye to eye contact with the students	0	0	6	30	14	70
Explore ideas around questions which students are interested in	0	0	7	35	13	65
The content of the curriculum is structured around learning concepts that are relevant and based on students' personal experiences	2	10	5	25	13	65
Provision of resources and manipulatives to stimulate students' curiosity and thinking skills	2	10	6	30	12	60
Planning of own investigation	2	10	6	30	12	60
Cooperative learning relationships among students	2	10	6	30	12	60
Findings are supported by evidence	0	0	8	40	12	60
Report/communicate results in the class	0	0	8	40	12	60
Interdisciplinary/Integration	1	5	8	40	11	55
Units begin with a highly motivating, situational problem, question or demonstration	1	5	8	40	11	55
Positive reinforcement for correct answers	3	15	6	30	11	55
Engaging in investigations, discourse, and reflection	3	15	6	30	11	55
Using of probing statements, prompt, and redirecting questions to solicit students' understanding	1	5	8	40	11	55
Lesson begins with assessing students' prior knowledge	1	5	9	45	10	50
Students' questions, ideas and observations are at the center of the lessons	3	15	7	35	10	50
Lessons are both hands-on and minds-on	1	5	9	45	10	50
Emphasizing process skills as part of the lesson	3	15	7	35	10	50
Open ended questions for higher level of thinking	1	5	10	50	9	45
Teacher's role is facilitator	2	10	9	45	9	45
Follow up students' responses extension questions	0	0	11	55	9	45
Students learn from their experiences in the class	1	5	10	50	9	45
Students solve problems	1	5	11	55	8	40
Students identify what are the needs to be known in the problem or an issue	0	0	12	60	8	40
Allowing trial and error as part of the experiment	1	5	11	55	8	40
Using wait time strategies during discussions	3	15	9	45	8	40
Students learn science in practical way at the shortest time possible	0	0	12	60	8	40
Teacher is talking to students by group or individually	2	10	12	60	6	30

All the approaches included in the survey are being utilized by the teachers in their classes. Therefore, it is expected that students gain proficiency of the science process skills through these approaches. However, approaches must be varied to cater different learning styles of diverse learners. Highlighted in this article implies that teachers must consider that not all students respond well to one particular approach [9].

These approaches focus on helping the students reach their full potential. In a learning plan, teachers play an important role in choosing an approach that can give students the opportunity to use the SPS as widely as possible [10].

Table 3 shows 20 out of 30 approaches are strongly practiced by teachers in the science class. Approaches one to twenty are approaches basic to a science open inquiry approach. However, practices which are moderately used in the classroom signify higher order thinking skills, analytical, innovative and need hands on experience. Individualized and group instruction, intensify teacher-student contact that fits needed action.

Table 4 also shows approaches involved in conducting OpInSI as perceived by students.

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Table 4
Approaches Involved in Conducting OpInSI as Perceived by Students

Open Inquiry Approaches	Moderately agree		Agree		Strongly agree	
	F	%	F	%	F	%
Report/communicate results in the class	3	4.17	6	8.33	63	87.5
Design the procedures and data tables for our own investigations	1	1.39	11	15.28	60	83.33
Allows trial and error as part of the experiment	2	2.78	12	16.67	58	80.56
Identify what are the needs to be known in the problem or an issue	2	2.78	13	18.06	57	79.17
Explore ideas around questions which we are interested in	5	6.94	10	13.89	57	79.17
Consistently asks open-ended questions to encourage students to think at higher levels	3	4.17	13	18.06	56	77.78
Cooperative learning relationships among students	5	6.94	11	15.28	56	77.78
My teacher makes eye to eye contact with us	3	4.17	13	18.06	56	77.78
Positive reinforcement for correct answers	2	2.78	15	20.83	55	76.39
Using of probing statements, prompt, and redirecting questions to solicit students' understanding	3	4.16	14	19.44	55	76.39
Students learn from their experiences in the class	6	8.33	11	15.28	55	76.39
Emphasizing process skills as part of the lesson	5	6.94	13	18.06	54	75
Findings are supported by evidence	3	4.17	15	20.83	54	75
Units begin with a highly motivating, situational problem, question or demonstration	10	13.89	9	12.5	53	73.61
Students share ideas and information during class	5	6.94	13	18.06	53	73.61
Students solve problems	1	1.39	19	26.39	52	72.22
Students' questions, ideas and observations are at the center of the lessons	6	8.33	14	19.44	52	72.22
Provision of resources and manipulatives to stimulate students' curiosity and thinking skills	2	2.78	17	23.61	52	72.22
Students learn science in practical way at the shortest time possible	4	5.56	16	22.22	52	72.22
Engaging in investigations, discourse, and reflection	5	6.94	16	22.22	50	69.44
Interdisciplinary/Integration	1	1.39	22	30.56	49	68.06
The content of the curriculum is structured around learning concepts that are relevant and based on students' personal experiences	2	2.78	20	27.78	49	68.06
Encouraging self-directed learners	4	5.56	19	26.39	48	66.67
Planning of own investigation	4	5.56	20	27.78	48	66.67
Lessons are both hands-on and minds-on	8	11.11	16	22.22	48	66.67
Follow up students' responses extension questions	5	6.94	19	26.39	48	66.67
Teacher is talking to students by group or individually	4	5.56	21	29.17	47	65.28
Lesson begins with assessing students' prior knowledge	11	15.28	15	20.83	46	63.89
Teacher's role is facilitator	3	4.17	22	30.56	46	63.89
Using wait time strategies during discussions	4	5.56	24	33.33	44	61.11

Table 4 implies that students "strongly agree" on all approaches which were involved in science investigation. This means that the approaches are being observed in the class. These approaches are proofs that science research processes take place in the classroom. It is also evident that science research processes can be taught using science process skills [11]. Teachers lead classes with more effective and innovative teaching methods [12] following the Open Inquiry Approach.

Data from Table 5 reveals that perception on the involvement of science process skills and approaches in open inquiry science investigation of teacher is not statistically significant higher than student group. It is reliable to say that what teachers employ in the classroom could be clearly observed by students. This implies that teachers' goals for students are communicated well and that students know what is expected for them to accomplish. This also suggests that teachers need

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to be actively engaged in interactions students for learning to occur [13].

Table 5
Difference in the Perception of Students and Teachers on the Process Skills and Approaches in Conducting OpInSI

Compared group	Mean	sd	Mean rank	Sum of ranks	Mann - Whitney	sig
Process skills Teachers Students	4.2267 4.4435	.49954 .43251	38.10 48.83	762.00 3516.00	552.0	.111
Open inquiry approaches Teachers Students	4.4650 4.6602	. 43949 .35404	37.13 49.10	742.50 3535.50	532.50	.075

Open Inquiry Process Practiced by Students

In order to describe the inquiry process flow that students' practice, two open experiments were done, *The Self-watering Plant Bottle* and *The Respiration of Yeast*. Evidences on the observed pattern and process were described and not evident process were marked red.

The two conducted experiments arrived at common process flow of OpInSI as described by the students. Open Inquiry Process flow still needs some emphasis on scientific skills such as: formulating hypothesis, measuring, analysing accurate data, making inference and formulating the conclusion. The qualitative (descriptions) data derived from the actual experiment and FGD with students suggest missing links to the standard science process flow.

Common Process Flow of Open Inquiry Science Investigation

Figure 1 is the summary of all themes developed after thorough comparison and analysis. This implies that the missing processes were the scientific skills which essentially need higher ordered thinking skills (HOTS) in science. They are less emphasized process skills necessary in problem solving for everyday life. These are; formulating hypothesis, predicting, analyzing accurate data, inferring and drawing accurate conclusion. These skills were included in the proposed process flow for Open Inquiry Science Investigation as shown on Figure 2.

Process Flow for OpInSI

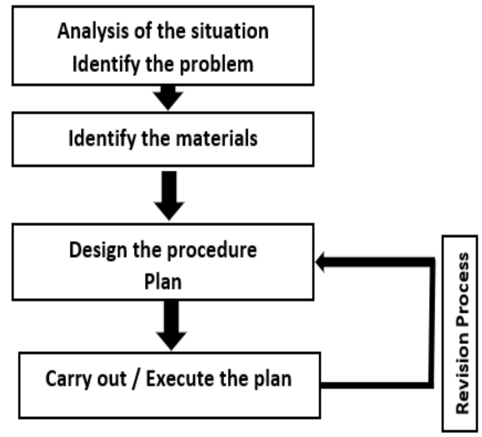

Figure 1. Common Process Flow for OpInSI

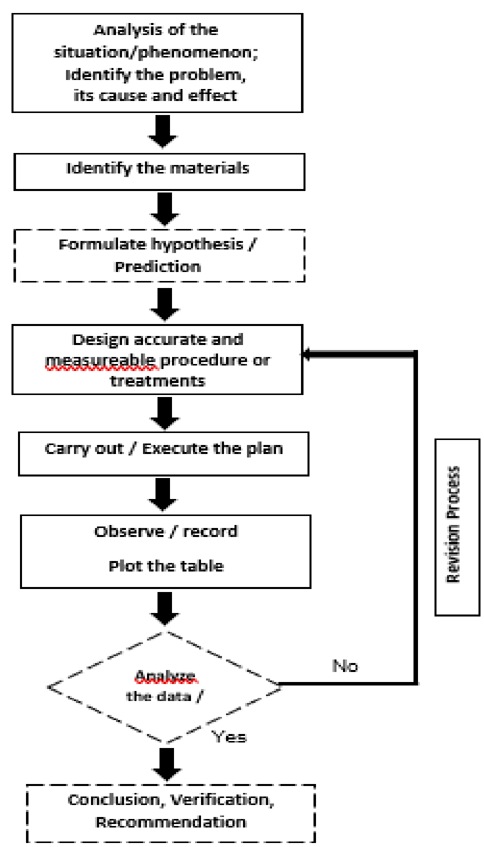

Figure 2. Proposed Open Inquiry Process in Science Investigation

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Conclusion And Recommendation

There is no significant difference between the perception of teachers and students on the science process skills and open inquiry approaches

The common process skills for both teachers and students include communicating, observing and asking questions. All process skills and approaches are involved in conducting open inquiry science investigation however; these process skills have different arrangement of utilization among teachers and students.

The scientific skills on hypothesizing, measuring, inferring and drawing conclusion which are essential needs for higher ordered thinking skills (HOTS) in science shall be emphasized in daily class.

The reform in science learning and teaching should emphasize the need for focusing on inquiry. OpIn Science Investigation should be often used in the science class by following the process skills and approaches required for it.

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