Enhancing the Scientific Literacy of Junior High School Biology Students

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Abstract— This study investigated the scientific literacy of Grade 7 Junior High School biology students along the five domains of framework set by the Department of Education. Specifically, it sought to determine the level of scientific literacy of the students in biology along: (a) Informed Decision Making; (b) Stewardship of Nature; (c) Effective Communication; (d) Innovative / Inventive Thinking; (e) Creative/ Critical Problem Solving. The study employed a descriptive-developmental research design with the belief that using descriptive-developmental research measures will yield useful information about the outcomes, the additional collection of quantitative data will develop a more in depth understanding of the quantitative data obtained (Cresswell, 2008). This study utilized experimental design or pre-posttest design. Qualitative data were gathered from designed hands-on structured inquiry activities and on the students' journal. Descriptive method was used to reveal how effective the effect of the developed lessons is. The results showed that the general performance of Grade 7 students is in the "advance" level in the entire learning competency in Grade 7 Biology. It was recommended that the use of other resources may be developed among schools. A more comprehensive audit on school resources may be done to address the scarcity in some areas like in unprivileged schools.

Index Terms— Creative/ Critical Problem solving, Effective communication, Informed decision making, Innovative/ Inventive thinking, K-12 Science Framework, Science concept, Scientific literacy, Stewardship of nature

1 INTRODUCTION

THE Scientific literacy has been the goal of science education at the national and global scope. Educational researchers implied vast literature review that scientific literacy is important for the success of individual and the society in making rational decisions; engaging in public discourse and improving problem solving skills and well-being which are necessary in the changing and challenging world. Promoting and developing scientific literacy is an understanding of science concepts and principles (AAAS, 2003). It also includes teaching the concepts and processes, method of science inquiry, application and environmental implications (NCEE, 1981; Miller, 2008); pertaining to the knowledge of concepts and processes, participation in civic and cultural affairs, including economic productivity (NRC, 1996). Likewise, an assessment along the five domains of education framework: set with the standard, competency and performance tasks (DepEd, 2003) and the premise of this study all consist the aspect of scientific literacy. Science literacy covers wide descriptions, perspective and scope (Miller, 2008); NCEE, USA; Yager and McCormack, 1989, DepEd, 2013). Miller (2008) defined science literacy as understanding the norms and methods in science, its key concepts and impact of it to science and technology and society. The National Commission and Excellence in Education in the United States advances the teaching of science in high school to provide the graduates with concepts process, methods of inquiry in science and reasoning, application of science knowledge to everyday life and social and environmental implications of science and technological development. The K to 12 science curricula will provide learners with a repertoire of competencies important in the world of work and in a knowledge-based society. With science literacy being the "holy grail" of science education, there should exist some means of assessing progress towards the goal. Unfortunately, the instrument does not exist. Supported by different findings of the investigation on the scientific literacy rate the different domains in education were formed. This was strengthened by the core learning area standard by Department of Education stating that "the learners demonstrate understanding of basic science concepts and application of science-inquiry skills. They exhibit scientific attitudes and values to solve problems critically, innovate beneficial products, protect the environment and conserve resources, enhance the integrity and wellness of people, makes informed decisions, and engages in discussions of relevant issues that involve science, technology, and environment".

2 Objectives of the Study

This study aims to look into the scientific literacy of Grade 7 biology students. Specifically, this study aims to answer the following sub-problems: (1) What is the level of scientific literacy of the students in biology along: a. Informed Decision Making; b. Stewardship of nature; c. Effective communication; d. Innovative/ Inventive thinking; e. Creative/ Critical problem solving (2) What lessons may be developed to enhance scientific literacy of students? (3) What are the significant experiences of the students that they consider to contribute to scientific literacy? (4) What is the effect of the developed lessons in improving the following: a. Understanding of Scientific Concepts b. Scientific Literacy c. Values Development.

3 Materials and Methods

The study employed descriptive-developmental research design with the belief that using descriptive-developmental research measures will yield useful information about the outcomes, the additional collection of quantitative data will develop a more in depth understanding of the quantitative data obtained. The study is quantitative in nature since the question posed was answered by numerical data. Specifically, this investigation is utilizing experimental design or pre-posttest design. In a pre-posttest design a pre-test was given to grade 7

students of Universidad de Sta. Isabel Pili Campus. Then, after the pretest, an intervention method was conducted for them to have a grip on the topic to execute also through activities, performances after the teacher discussed the topics. The following research instruments was used in this study to assess the research specific problems they are: (a) Construction of the Scientific Literacy Questionnaire (SLQ); (b) Conceptual Understanding test used as pre-test and post-test; (c) Developed Lessons in Biology. The course of the study undergoes four (4) phases; (a) Phase I- Organization, Development, Revision and Validation, (b) Phase II- Intervention, (c) Phase III- Pre-Evaluation, (d) Phase IV- Final Evaluation. Descriptive-developmental research design including pre-test- post-test, paired t-test and weighted mean was used in the analysis of the data. This study will adopt Likert scales in several levels.

Organization, Development, Validation, and Revision This phase includes the following steps: Identifying the level of scientific literacy of the students in biology along: (a) Informed Decision Making; (b) Stewardship of Nature; (c) Effective Communication; (d) Innovative / Inventive Thinking; (e) Creative/ Critical Problem Solving . (2) What lessons may be developed to enhance scientific literacy of students? (3) What are the significant experiences of the students that they consider to contribute to scientific literacy? (4) What is the effect of the developed lessons in improving the following: (a) Understanding of Scientific Concepts; (b) Scientific Literacy; and (c) Values Development, then the following tests were subjected to validation, these tests were validated by set of jurors then pre-tested. The Lessons developed were assessed based on the Learning Objectives, Learning Experience, and learning Assessment. Revisions, recommendations from the jurors and results from the pre-test were considered to the revision of the tests, lessons and activities. The final version of every test was prepared.

Intervention Phase

The study lasted for twenty school days. Standard approach was applied to the control group (CG) and the developed lessons for grade seven with Biological concept was applied to the experimental group (EG).

Pre-Evaluation Phase

This Phase involves the sharing of learner's experience in developed lessons and activities. It is the time to showcase the output made by the Students. Also, the revised test was administered like the post-test on literacy in biology domain.

Final Evaluation Phase

This phase involved the evaluation of the effectiveness of the developed lessons in biology and development of scientific literacy of students. Statistical treatments were used in this phase to answer every specific question presented in the study.

4 Results and Discussion

Scientific Literacy Lesson Plan (SLLP) Description and Features Scientific Literacy Lesson Plan is the term given by the researcher referring to the set of developed lesson plans aiming to assess the scientific literacy of the Grade 7 students of Universidad de Sta. Isabel Pili Campus. To ensure its efficiency and reliability, the competency and standards found in the four lesson plans are aligned with what is set by the Department of Education.

Table 1. Scientific Literacy Level: Informed Decision Making

Task Lesson	Average	TG	PL
Formative and Summative Small and Big group analysis	9.44	94.40	Advance

Table shown above interpreted the level of scientific literacy of the students in informed decision making, the researcher used the average of the all the formative and summative tasked of the students. In the computation of percentage to get the performance level, the researcher gets the average of all the tasks divide it by ten as the highest possible score for all the tasks multiply by forty as weight of the score then add by sixty served as the base transmuted to get the percentage of the performance level of the students as a whole. Together with the interpretation of performance level, the scale was interpreted as the same as the level of scientific literacy level of the students as the researcher believed that the level of scientific literacy has great impact on the performance level of the students.

Table 2. Scientific Literacy Level: Stewardship of Nature

Task Lesson	Average	TG	PL
Formative and Summative Community Engagement Clean Up drive	8.21	82.10	Approaching proficiency

The same process was employed by the researcher in determining the level of scientific literacy of the student in light with stewardship of nature. The different sets of activities were assessed to have emphasized resilience on the part of the organisms in the system. In connection with the sub-topic on biotic and abiotic components of the ecosystem, which got 8.21 mean rating, the stewardship of nature is evident on the clean-up drive conducted on the lotus pond inside the school. Apart from that, a group sharing activity was followed to confirm the solidarity of the immersion.

Table 3. Scientific Literacy Level: Effective Communication

Task Lesson	Average	TG	PL
Formative and Summative Group Sharing Article analysis	9.58	95.80	Advance

In the goal of providing the students with a high quality of prepared lesson plans that would lead to high performance of the students in terms of literacy in science, effective communication was one of the factors considered and focused to. The effectiveness of the teaching strategies in developing the ability of the learners to interact, to send and receive valuable information. The students were able to communicate well during the course of activities which needs comprehensive analy-

sis that triggers their emotions to tell what's inside of them. They are also given freedom to express their thoughts in some issues that needs careful observations and were able to deliver it with convection as they are grounded by their self-thoughts and courage. The level of their scientific ability to reason out was highly observed as they from time to time given the real deal of the given activities set before them by the researcher.

Table 4. Scientific Literacy Level: Inventive/ Innovative Thinking.

Task Lesson	Average	TG	PL
Formative and Summative Community Engagement Clean Up drive	9.46	94.60	Advance

This ability on how to process of translating an idea or invention into a good or service that creates value. It leads to introduction of new ideas or methods on how something can be done. The students were encouraged to be resourceful, inventive, and innovative in crafting their outputs and base their works with their underlying knowledge from observation they made in the environment.

Table 5. Scientific Literacy Level: Creative/ Critical Problem Solving

Task Lesson	Average	TG	PL
Formative and Summative Essential Questions Exploration Extension	8.10	81.00	Approaching proficiency

Being creative and critical thinker are two of the scientific skills present in people known to excel in Science. As Wissam declared, "Another goal is to teach them a way of thinking scientifically and to have a scientific approach for them to act in one way or another like a scientist." Creative/ critical problem-solving ability leads to insights, approaches, fresh perspectives, and whole new ways of understanding and conceiving things. In this study, the jurors rated whether or not the lesson plans sum up the fluency, flexibility and original thinking of the students in answering and analyzing science problems. On the students' part, during the conduct of the study they were able to express it with high level of critical analysis of each in every situation in the performance tasks they are given by the researcher. They even meet higher than the expectations of the researcher knowing that they are grade 7 their abilities are a bit limited as they are adjusting to the junior high school life. One great example is when the researcher tasked them to create a diorama by themselves within a group; it was to the surprise of the researcher that the students create it with detailed and vibrant appeal that aside from doing so they explained it very well as they received high numeric grades for each diorama they have made.

Table 6. Average of 5 Domain Scientific Literacy Level

Total	Average	TG	PL
5 Domain of SL	8.95	89.50	Proficient

The scientific literacy lesson plans showed full conceptual understanding of the students' level of scientific literacy with correct application situations towards components of scientific literacy. It is pertinent for the implementer of the developed lessons to consider the factor of understandability of the concepts so that the result of the objectives will be clearly attained. The researcher found the learning plans to be adhering with its concepts, the established objectives, and the learning and teaching strategies used.

To summarize, the Scientific Literacy Lesson Plans did not only cover the conceptual understanding (cognitive domain) of the students but also encompassed the skills (psychomotor domain), and most importantly, the values (affective domain.) These were shown by the conceptual understanding test, the experiential learning activities, and the journal-making experiences of the students. Going back to the standards set before the start of the treatment of SLLP's, the students demonstrated an understanding of the interaction among organisms and with their environment to survive through the increase in the mean scores of pre- and post-test; conducted a collaborative action to preserve the ecosystem in the locality, shown by their clean-up drive and the partnership with their barangay activity; and, developed the appreciation, respect, and the responsiveness towards nature, which is evident in their journal insights. As a result, the desired outcome of science education that students must describe, explain, and understand natural phenomena; exhibit methods and principles with tangible actions; and process the informed decision-making, stewardship of nature, effective communication, innovative and inventive thinking, and creative/ critical problem-solving, in short, the scientific literacy, is thusly achieved. Those who attempt to develop and/ or alter values development including character in their different studies employ different pedagogy in doing so. A teacher should have ethical concerns about such approaches, at first glance, seem unlikely to have any However, the teacher should realize that any single approach can be used ineffectively as well as effectively (Ryan, 2000).

To further develop the validity of the developed lessons a conceptual understanding test was used as the pre- and post-test. This is to determine the change in knowledge and understanding of scientific concepts after the intervention of the developed lesson plans. The 65-item multiple-choice type of test contains questions divided into four contents namely: components of an ecosystem, ecological relationships, symbiotic and non-symbiotic relationships, and, transfer of energy through trophic levels. Each of these four topics has a specific learning competency to achieve; which is anchored on the questions catering on the dimensions according to the Bloom's Taxonomy of Learning: the remembering, understanding, application, analysis, and evaluation.

Table 7. Results of the conceptual understanding test administered before and after the implementation of developed lessons in biology to enhance scientific literacy of the students

Measures	Mean Score	PL	Interpretation	Mean Gain
Pre-test	31.85	49.00	Beginning	14.98
Post-test	46.83	72.05	Beginning	

The use of the Scientific Literacy Lesson Plans leads to 14.98 difference on the mean scores of pre- and post-test. This relatively small difference is due to the presence of outliers in the scores obtained by the learners ranging to 34 points. The standard deviation of 7.74 proves that the students' scores are scattered, thus high in heterogeneity. The t-value of 13.41 α= 0.05 level of significance (2.25) p= 0.10 has an interpretation of that there is a significant difference in the mean scores. A 95% C.I. about Mean Difference (12.73, 17.23). Although one of the assumptions for using the paired t-test is there must not be outliers in the variables, the developer believed that it is the most appropriate test to employ since this is a statistic test for before and after scenario, validating that there is indeed a change between the performance of the class through the aid of the SLLP's. Therefore, the mean difference is still significant with reference to learning acquisition in cognitive aspect that will develop or enhance the Scientific Literacy of the students. Looking into the main gain as the result of pretest-posttest, significantly the scientific literacy of the students before it was conducted were not good enough as they are not fully aware of those topics posted before them as a form of assessment while after the conduct of the study, the result shows that increase in their scientific literacy level in comprehending and understanding issues confronting their abilities to precisely answer those questions given to them. This significant increase has a great impact on the researcher because it goes to show that the students able to develop and enhance their abilities in the scientific literacy level of the study. Furthermore, the idea of Department of Education was attained through the necessary action taken by the researcher and his study.

5 Conclusion

In the light of the findings, these conclusions were drawn: (1) The Scientific literacy of grade 7 students is high along the (a) informed decision making; (b) stewardship of nature; (c) effective communication; (d) innovative/ inventive thinking; (e) creative/ critical problem solving, furthermore highly positive attitudes as they carry with them the spirit of Vincentian students and the Daughters of Charity core values. (2) The school, Universidad de Sta. Isabel Pili Campus is following the implementation of Department of Education which governs the new curriculum, the K to 12 Curriculum which allows the holistic development of students aiming the main goal in science education which is scientific literacy. (3) The understandability of the students in terms of the lesson in biology is high; significantly it gives the researcher the developed sense of pride knowing that the students are able and competent enough to be called 21st century students. (4) The scientific literacy level of the students is geared towards the aim of the Department of Education which to further enhance and develop scientific literate inclined students facing the challenges of the today.

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