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SCIENTIFIC LITERACY OF GRADE 7 STE, SPA, AND REGULAR CLASSES

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A R T I C L E I N F O.

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Abstract

The study determined the level of scientific literacy of Grade 7 STE, SPA, and Regular classes along five domains namely; informed decision-making, stewardship of nature, effective communication, innovative/inventive thinking, and creative/critical problem-solving. The descriptive-comparative method was used specifically for the pre-test and post-test design, utilizing both quantitative and qualitative techniques in collecting and analyzing the data. Study revealed that the level of scientific literacy among STE, SPA, and Regular classes along with informed decision-making, stewardship of nature, effective communication, innovative /inventive thinking, and creative /critical problem solving indicated as Advanced for STE class, Proficient for SPA class and Approaching Proficient for the Regular class. Furthermore, the use of the adapted Scientific Literacy lesson plan has a significant difference in scientific literacy pre-test and post-test results. Thus, further development of lessons in Biology is recommended to further observe positive effects on students' performance and to realize the real value of the assessment tools for developing and transforming into 21st-century students.

Introduction

The 21st-century education plays an important role in producing a highly transformed society in our country. The ceaseless growth of technology has been part of the developing system of teaching Science subject that encourages teachers to craft instructional and technological techniques driven to make science modern, relevant and timely in its discipline. The root knowledge and skills in handling the instructional and technological practice for the classroom setting demand a greater challenge for every teacher to offer a highly productive output that could transform an individual to a world and advanced knowledge and skills setting. The significant approaches in the quality of science education are a pervasive concern in all educational improvements' effort. Cognitive orientation provides an avenue to begin with the idea towards the understanding and acquiring of new knowledge, one must integrate it with already existing knowledge schemata in order to realize the essence of science as part of education.

Despite the growing concerns accorded to the increasing demand of technology, there exists no firm sense of exactly what teachers would like students to acquire from science education. Over the years many models of curriculum and the learning process have been researched and developed to improve the quality of science education, in which all of these are associated with building scientific literacy (Lederman et al., 2013) and critical thinking (Masigno, 2014). Lederman et al., (2013) proposed a learning process to develop scientific literacy through scientific inquiry procedure. In addition, the rapid advancement in communication instantly brings the current trends which result in a knowledge explosion going on around the world, and more than decades, reports from the expert panels have called for improvement in science education.

Scientific literacy is one of the key components of science education which aims at preparing future generations to function as responsible citizens for the advancement of the world affected by Science and Technology and understanding its impact (Vieira & Tenreiro-Vieira, 2014). In higher education, scientific literacy and critical thinking are phrases that have become policy initiatives and educational purposes today (Heinsen, 2016). Scientific literacy and critical thinking trigger the development of knowledge, attitudes/values, and thinking ability, and foster ability to take responsible action in the context and circumstances on lives and their social environment (Kek & Huijser, 2011).

Most of the goals that science teaching has been expected to accomplish over the years remain with us today. As educators, teachers may use varied types of strategies and languages to cater all the needs within this context. Some may take on more or less importance, but most of them continue and are determined. This may include the intellectual goals of creative and critical thinking, personal goals of wise decision-making or reasoning, life's work and fulfillment of our role as inventive and intelligent citizens, and the futuristic goals of innovation and ingenuity. There is a general agreement that Science courses consisting of traditional lectures and cookbook laboratory exercises need to be changed. What is required instead is "the scientific teaching", teaching that mirrors education on the optimum through experimental, rigorous, and evidence-based instruction (Jo Handelsman, 2004).

To meet the challenges of sustaining productive learning, the K to 12 Curriculum was designed to improve learner achievement, emphasizing the teachers' critical role as a designer of student learning, by working within the standard-driven curriculum to help teachers classify learning goals, devise revealing assessment of students understanding, and craft effective and engaging learning activities. Thus, it focuses more on the learners and not on the teachers. This approach promotes real learning experiences for the students, discourages memorization but rather encourages critical thinking. Understanding must be "earned" by learners even without the teachers' supervision, teaching for understanding partakes "meaning making" by the students' interest in acquiring a vast sum of information and to enhance the higher-order thinking skills needed for solving problems and making decisions (Beltran, 2018).

With science literacy being the "holy grail" of science education, there should exist some means of assessing progress towards achieving its goal and ensuring development. Unfortunately, is valuable had instrument not existed yet. The failure to have the instrument for science development is probably due to: (1) definitions of science can incorporate a wide range of types, dimensions and degrees; (2) a comprehensive assessment instrument would be of unacceptable length; and (3) no single "high stakes" instrument could provide all the information needed by teachers, schools, administrators and agencies to make decisions to improve student's learning (Wenning, 2006).

As specified, scientific development and its relevance to every individual have become more of a concern of the K to 12 Science Curriculum. Having a full grasp of the lesson with appropriate knowledge that can provide information and able to work according to the needs of the 21st century, scientifically timed and literate students are just source of the required competencies of a student. It is always necessary to have an overall assessment on their performance especially on their hands-on performance and skills. The study reinstates performance-based to test in public school leading to the comparison of the existing developed instructional lessons to the locale of the researcher such as San Rafael National High School.

In recent years, Black & William (2001) and other have argued eloquently that the most important aspect for assessment – dubbed “assessment for learning” – is also the most neglected and certainly tends to have the least support financially. Hence, the purpose of research is highly significant since it seeks to transform an individual into a productive citizen in a society by applying the knowledge and skills to solve problems with developed values which is the ultimate goal of science education.

Methodology, Purpose and Objectives

Generally, this study determined the Level of Scientific Literacy in Science Biology of Grade 7 students in San Rafael National High School. It looked into the level of scientific literacy among STE, SPA, and Regular classes and the significant difference in scientific literacy of STE, SPA, and Regular classes. The study used the Descriptive-Comparative method of research, specifically pre-test and post-test design. The descriptive method was used to: (1) determine the level of before and after adapting the Scientific Literacy Lesson Plans along the following domains: (a) informed decision making; (b) stewardship of nature; (c) effective communication; (d) innovative/inventive thinking; and (e) creative/critical problem solving, and (2) determine student’s teaching method preferences among STE, SPA and Regular classes in science subject. Comparative method was used to determine the significant difference on scientific literacy based on the results of pre-test and post-test among STE, SPA and regular classes.

The pre-test was given to the respondents. Then, adapting of the scientific literacy lesson plan was administered through lessons for them to have a grip on the topic. After the conduct of the lessons, post-test was given to the same respondents. The difference between the pre-test and post-test was determined whether there is a learning gained due to the interventions given. The primary source of the data for this study was the results of the pre-test and post-test, results of the different activities conducted and the result from the survey questionnaire on student’s teaching preferences. The respondents of the study were the 32 students from STE, 32 from SPA and 50 students from regular classes, a total of 114 from the Secondary School of San Rafael National High School, academic year 2019-2020.

Results and Discussions

Level of Scientific Literacy of the Grade 7 Biology Students

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.

Table 1. Level of Scientific Literacy

DOMAINS	STE Class			SPA Class			REGULAR Class		
	Ave	TG	PL	Ave	TG	PL	Ave	TG	PL
1. Informed decision making ✓ Small and big group analysis of the related articles in the discussion	9.34	93.40	A	8.34	83.40	AP	8.14	81.40	AP
2. Stewardship of Nature ✓ Community engagement ✓ Pledge of Commitment ✓ Clean-up drive	9.57	95.65	A	9.12	91.20	A	9.04	90.40	A
3. Effective Communication ✓ Group sharing/analysis	9.47	94.70	A	8.81	88.10	P	8.04	80.40	AP

✓ Article analysis									
4. Innovative/inventive thinking ✓ Diorama ✓ Surveying ✓ Roleplaying	9.39	93.90	A	8.61	86.10	P	8.32	83.20	AP
5. Critical/Creative Problem Solving ✓ Essential questions ✓ Exploration ✓ Extension	9.22	92.20	A	8.67	86.70	P	8.43	84.30	AP
General Average	**9.40**	**93.97**	**A**	**8.71**	**87.10**	**P**	**8.39**	**83.94**	**AP**

Legend: *A – Advanced, 90% and Above*

P – Proficient, 85%- 89%

AP – Approaching proficiency, 80%- 84% D – Developing, 75%- 79% B – Beginning, 74% and Below

Along the five domains of scientific literacy, the STE class got the general average of 9.40 with 93.97 as the transmuted grade signifies that the performance level is Advanced while the SPA class got the general average of 8.71 with 87.10 as the transmuted grade indicates that the performance level is Proficient. Then, the Regular class obtained 8.39 as the general average with 93.94 as the transmuted grade this means that the performance level is Approaching Proficient, following the set of norms from the performance level the of Department of Education to assess the performance of the students in the domains of literacy, these means that the levels of cognitive, affective and psychomotor of the students are attained throughout the conduct of the study. With its unique compositions in the formation and integration of the adapted lessons, these kinds of presentations will surely have a developed target, in this study- Scientific Literacy. In any activity, it is a prerequisite to provide guide questions to ensure that the learners know what they are expected to do (Beltran, K., 2018).

The questions were explained since students do well if they fully understand the task at hand. Through this guide questions that the students already have prepare in mind their first action would be. Thus, clearing the destination both the learners and the teacher anticipate to achieve. Constructivism is the approach used in the development of the Scientific Literacy Lesson Plans. In the constructivist classroom, the teacher's role is to facilitate learning while the learners are the active doers. The goal was to provide a constructivist classroom linked to the enrichment of scientific literacy among the learners. The constructivist teacher sets up problems and monitors student exploration, guides student inquiry, and promotes new patterns of thinking. Working mostly with raw data, primary sources, and interactive material, constructivist teaching asks students to work with their own data and learn to direct their own explorations. Further, (Beltran, K., 2023) indicated that for science education materials to be effective, it has to be pro-for students and utilized for contextualized learners.

In line with the SPA class, it got 8.34 with 83.40 as the transmuted grade. It shows that the scientific literacy of the class is Approaching Proficiency. While the Regular Class got an average of 8.14 with 81.40 as the transmuted grade (PL- Approaching Proficiency). The performance level of the SPA and Regular classes indicated their ability to understand and to think logically by assessing the present scenario and choosing the appropriate alternative possibilities. As the study was conducted rigorously along the course of transitions of the new curriculum, the students were able to cope up greatly as they fulfill all the activities pertaining to the information of the subject matter. This is supported by the study of Craven and Penick (2001) that scientific literate students develop higher-order cognitive thinking identity and evaluate ill-defined problems, to make informed decisions and to provide a variety of solutions to any particular problem.

The STE class got an average of 9.57 and 95.65 as their transmuted grad while the SPA class gained an average of 9.12 and 91.20 as the transmuted grade. The Regular class obtained an average of 9.04 and 90.40 as the transmuted grade. It clearly shows that the ability of the three classes to protect and use responsibly the natural environment through conservation and sustainable practices may be interpreted as Advanced. This was manifested in valuing part of the conducted lessons and its integration to the value-laden system of Education which is Makakalikasan wherein the students got experienced to improve and enhance the school ground, garden and pond with willingness. This conforms to the study of Merenlender et al. (2016) that broadening one's participation in environmental science and stewardship is an important priority in acknowledging the role of man's behavior in determining environmental conditions and achieving literacy. Youth may be motivated by the opportunity to contribute as valued members of the community (Olitsky, 2007) and by seeing how their actions lead to changes in their environment (Chawla, 2008). Aside from this, a group sharing activity was conducted to confirm the solidarity of the immersion.

Table 2. Informed Decision-Making

Significant difference on scientific literacy along Informed decision-making before and after adapting scientific literacy lesson plan.

Class	Mean Pretest	Mean Posttest	Mean Difference	t - value	p - value	Interpretation
STE	20.0	27.30	7.30	13.064	0.000	Significant
SPA	8.70	18.90	10.20	12.134	0.000	Significant
Regular	12.80	30.60	17.80	5.509	0.000	Significant

Based on the results in table 2 along informed decision making, the STE class obtained the mean difference of 7.30 with the t- value of 13.064. The SPA Class got the mean difference of 10.2 with 12.134 as t- value. Then, the Regular Class got the mean difference of 17.80 with 5.509 as the t- value. The computed values above indicate that there is a significant difference on scientific literacy among STE, SPA and Regular classes along with informed decision-making.

Table 3: Stewardship of nature

Significant difference on scientific literacy along Stewardship of nature before and after adapting scientific literacy lesson plan

Class	Mean Pretest	Mean Posttest	Mean Difference	t - value	p - value	Interpretation
STE	22.90	29.30	6.40	8.913	0.000	Significant
SPA	18.00	26.90	8.90	11.835	0.000	Significant
Regular	14.20	32.80	18.60	4.689	0.001	Significant

The STE class obtained a mean difference of 6.4 (t-value= 8.913 and p-value=0.000) while the SPA class obtained a mean difference of 8.9 (t-value= 11.835 and p-value=0.000). Then, the Regular class obtained biggest mean difference of 18.60 (t-value= 4.689 and p-value=0.001). The computed values above indicate that there is a significant difference on scientific literacy among STE, SPA and Regular classes along Stewardship of nature.

Table 4: Effective communication

Difference on scientific literacy along Effective communication before and after adapting scientific literacy lesson plan

Class	Effective Communication Domain			
	PRE-TEST		POST TEST	
	Mean	Interpretation	Mean	Interpretation
STE	2.23	Effective communicator	2.49	Highly effective communicator
SPA	2.05	Effective communicator	2.40	Highly effective communicator
Regular	2.05	Effective communicator	2.08	Effective communicator

From the results obtained, students' progress along the effective communication skill as shown in the Table 4 for pre –test and post – test.

Before the intervention, the students got a mean 2.38, 2.05 and 2.05 for STE, SPA and Regular Classes respectively which means that the effective communication of the students is not yet fully developed. This is supported by the study of Gulikers, Bastiaens & Kirschner (2006) that effective oral communication cannot be simply "studied" by reading. It needs to be planned, strategized, practiced and assessed, preferably in an "authentic" setting. However, after the interventions, students in STE, SPA and Regular classes got a mean of 2.49, 2.50 and 2.08 respectively. Students exposed in the different activities can perform better and developed scientific literacy skills like effective communication leading to the ability of learners to interact, to send and to receive valuable information. During the intervention, effective communication was used in every activity specifically if it is all about small and big group sharing of ideas and motivational learning. From the results obtained, it can be inferred that students need adequate practice to further develop communications skills by engaging in different presentations and by substantially participating in every class discussion parallel to the scientific concepts.

Table 5: Innovative/ inventive thinking

Significant difference on scientific literacy along with Innovative/inventive thinking before and after adapting scientific literacy lesson plan

Class	**Mean Pretest**	**Mean Posttest**	**Mean Difference**	**t - value**	**p - value**	**Interpretation**
STE	22.20	30.80	8.60	6.108	0.000	Significant
SPA	5.16	8.84	11.80	4.294	0.002	Significant
Regular	3.37	6.39	14.80	3.353	0.008	Significant

Based on the results in table 5, the innovative/ inventive thinking skill of the students is improved through the activities provided such as surveying and constructing a diorama. The STE class obtained a mean difference of 8.60 (t-value= 6.108 and p-value=0.000) while the SPA class obtained a mean difference of 11.80 (t-value= 4.294 and p-value=0.002). Then, the Regular class obtained biggest mean difference of 14.80 (t-value= 3.353 and p-value=0.008). The computed values indicate that there is a significant difference on scientific literacy among STE, SPA and Regular classes along innovative/ inventive thinking.

The learning activities given during the intervention helped the students in improving their scientific literacy leading to become innovative/inventive thinker. For instance, after conducting the lesson, students could already construct a diorama and could investigate how ecological balances occur using the identified living organisms from the observations made. They could also determine the role of each organism to one another.

The conceptual knowledge of the learners about abiotic and biotic factors of the environment was used as the backbone ideas in constructing their dioramas to improve the innovative and inventive thinking of the learners. The diorama was used more of a learning tool than being a teaching tool. This conforms to the study of Abdullaha & Osman (2010), an innovative and inventive thinker able to set goals related to learning, plan for the achievement of those goals, independently manage time and effort, and independently assess the quality of learning and any products that result from the learning experience. It can be inferred that broadening students' participation in different activities is an important priority in acknowledgment of one's idea or invention on how the availability of indigenous materials/resources transformed into new and meaningful outputs.

Table 6: Critical/ creative problem solving

Significant difference on scientific literacy along with Critical/creative problem solving before and after adapting scientific literacy lesson plan. The table is below.

Class	Mean Pretest	Mean Posttest	Mean Difference	t - value	p - value	Interpretation
STE	18.50	37.40	8.90	7.164	0.000	Significant
SPA	12.50	22.00	9.50	6.746	0.000	Significant
Regular	13.40	32.60	19.20	14.892	0.000	Significant

The STE class obtained a mean difference of 8.90 (t-value7.164 and p-value=0.000) while the SPA class obtained a mean difference of 9.50(t-value= 6.746 and p-value=0.000). Then, the Regular class obtained biggest mean difference of 19.20 (t-value= 14.892 and p-value=0.000). The computed values indicate that there is a significant difference on scientific literacy among STE, SPA and Regular classes along Critical/ creative problem solving.

Although numerically there are differences in the weighted mean on the three teaching methods as assessed by STE, SPA and regular students, results of Kendall Coefficient of Concordance test revealed no significant differences on the preferences on student's teaching methods. This means that, students can accommodate any teaching method used by the teachers. This conforms to the study of MacKinnon (2011) that the wide range of individual differences surely must mean that there is no single method for nurturing creativity; ideally the experience teachers provide should be tailor-made, if not for individual students, at least for different types of students.

Table 7. Kendall Coefficient of Concordance test results

Teaching Methods	Computed Value	Critical Value	Interpretation
Teacher - Centered Method	9.09	16.92	No significant differences on the preferences/agreement/ concordance as evaluated by STE, SPA and Regular classes
Learner - Centered Method	1.91		
Content – Based Method	6.91		

Legend: Kendall Concordance: There is significant differences on the agreement/preferences if computed is greater than critical value, otherwise no significant differences on agreement/preferences

From the results given, there is no enough evidence to conclude which among the three methods is mostly preferred by students. The study showed that these three methods are equally preferred by STE, SPA and Regular classes. It can be inferred that, different approaches to teaching and assessment are required to accommodate the various ways in which students construct knowledge in social setting for the continuous improvements to attain scientific literacy of the students.

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