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BASIC AND INTEGRATED SCIENCE PROCESS SKILLS ACQUISITION AND SCIENCE ACHIEVEMENT OF SEVENTH-GRADE LEARNERS

Reymund C. Derilo[i]
Instructor, College of Teacher Education,
Nueva Vizcaya State University,
Bambang, Nueva Vizcaya,
Philippines

Abstract:
For effective science inquiry and hands-on science learning, students should have a good mastery of the science process skills (SPS) before applying the processes. SPS are the building-blocks of critical thinking and inquiry in science. This study sought to investigate students' SPS acquisition level and its relationship with their academic performance in science. The Science Process Skills Test, a 24-item test intended to quantify students' basic and integrated SPS, was administered to the 100 randomly selected Grade 7 students of a private secondary school in Northern Luzon, Philippines. The data were analyzed using descriptive and correlational research methods. The results of the study revealed that the students have an average level of basic science process skills, and a low level of integrated science process skills. A significant correlation between students' performance in science and basic SPS was reported. On the other hand, students' integrated SPS was found not significantly related to their performance. Furthermore, there was a highly significant, positive correlation between the students' overall science process skills and science achievement. Hence, it was recommended that students' science process skills be improved through proper designs of inquiry-based experiments and activities to enhance and elevate students' achievement in science.

Keywords: science process skills, integrated SPS, basic SPS, science achievement

1. Introduction

One of the goals of the new Philippine science education framework is the development of 21st century science process skills. Nurturing confident life-long learners, with skills, attitudes and capacities to thrive in complex societies is a high priority (Science

[i] Correspondence: email rcderilo@nvsu.edu.ph

Education Institute-Department of Science and Technology, 2011). The purpose of secondary science education is to equip young learners with scientific process skills, to enable them to define existing problems, observe events in their society, analyze and hypothesize possible solutions, conclude and generalize and apply gathered information for the betterment and advancement of his community (Aktamis, & Ergin, 2008). A scientifically literate individual, who mastered these skills, can comprehend the very nature of science which could increase the standard and quality of his life and survive the challenges of everyday life. Hence, these process skills influence the personal, societal and global lives of an individual because these skills provide the necessary tools to combat everyday problems, perform scientific researches, and produce novel scientific knowledge and information. These skills can be acquired by an individual through well-designed science activities (Huppert, Lomask & Lazarorcitz, 2002).

According to Ngoh (2009), a student should possess mastery of the necessary science process skills (SPS) in order to succeed in science inquiry and hands-on science activities. These skills encompass the 12 basic science process skills, which were further classified into two, namely basic and integrated. These two classes of SPS form the foundation and method of actual scientific inquiry that are often used in science classes. The basic SPS include observing, classifying, communicating, measuring and using numbers, predicting, making inferences, and using spacetime relationship. On the other hand, the integrated SPS include identifying and controlling variables, making hypotheses, interpreting data, defining operationally, and experimenting.

Mbewe, Chabalengula, and Mumba (2010) and Huppert, Lomask, and Lazarowitz (2002) reiterated that the SPS acquisition is the chief objective of science education because of the fact that SPS is needed by every individual in whole citizenry, and not just the scientific community. Huppert and colleagues further pointed out that since SPS are applicable to all elements of the community, everyone should be knowledgeable on how it could be applied in everyday living. Furthermore, Olufunminiyi and Afolabi (2010) stipulated that SPS enable learners to become more creative problem-solvers, reflective thinkers, innovative and inventive individuals, which are needed qualities for national development in terms of science and technology.

A common problem, however, as observed in the school settings, is that SPS acquisition is impeded due to some factors such as the ways on how SPS is developed in the science classrooms. International studies (NRC, 1996), for instance, reveal that students were not given the chance to develop their thinking skills because they are not allowed to think fully by themselves. Concepts, knowledge and theories were already provided in the students' books. Moreover, Aktamis and Ergin (2008) revealed that students were first lectured by the teachers with the necessary concepts and information before proceeding to experiments. This impedes the development of SPS among learners, and this type of educational setting is exactly the opposite of what the science education framework aims to develop among the learners.

This could also be the reason behind the failure of the country in the international assessments. In terms of quality of science education, the Philippines placed far behind neighboring ASEAN countries based on Global Competitiveness Reports from 2010 to 2017 (Schwab, Sala-i-Martín, & Brende, 2013; Swab, Salai-i-Martin, Eide, & Blanke, 2014; Schwab, Sala-i-Martín, Samans, & Blanke, 2015, 2016; Swab, Salai-i-Martin, & Samans, 2017). Likewise, the country's rankings in the TIMSS also brought alarm among educational reformists in the country. Ranking 42nd out of 46 countries in the secondary level, and 23rd of 25 countries in the elementary level (Torregoza, 2014), the country now faces a huge challenge in terms of science education. Moreover, in 2008 Advanced TIMSS, even with only the Science High Schools in the country participated in the Advanced Sciences category, the Philippines ranked last among all other countries who joined the assessment (Department of Education, 2013).

Consistently, the National Achievement Test (NAT) results likewise reveal a fading image of science education in the country. The data from DepEd-NETRC showed that secondary school students have acquired average to low mean percentage scores (MPS) in Science from 2006 to 2015.

Moreover, in the province of Nueva Vizcaya, found in the Northern Philippines, findings of local researches such those of Cajimat (2015), Derilo (2017), Madronio (2015), Medula, Jubay and Aban, (2013) and Saldivar (2015) revealed a similarly discouraging situation of scientific literacy among Filipino secondary school learners.

Several literatures support the notion that there is a positive relationship between SPS and academic success in science subjects (Beaumont-Walters & Soyibo, 2001; Farsakoglu, Sahin & Karslı, 2012; Delen and Kesercioglu, 2012). Could the SPS acquisition be the answer to this failing science education in the country?

Hence, this deteriorating situation of Philippine science education and claims from literatures led the researcher to hypothesize the possible reason of students' failure. The researcher examined how students' level of SPS acquisition relate with their academic achievement in science. Specifically, this study sought answers to the following research questions:

1) What is the level of science process skills of the Grade 7 students?
2) What is the general academic performance the high school students?
3) Is there a significant relationship between the students' level of science process skills and academic performance in science

2. Literature Review

2.1 Scientific Literacy in the Philippines: Current Problems in Basic Science Education of the Country

International assessments such as the Trends in International Mathematics and Science Study (TIMSS) and WEF competitiveness reports (Schwab, Sala-i-Martín, & Brende, 2013; Swab, Salai-i-Martin, Eide, & Blanke, 2014; Schwab, Sala-i-Martín, Samans, & Blanke, 2015, 2016; Swab, Salai-i-Martin, & Samans, 2017) and local examinations such as the National Achievement Tests (NAT) (NETRC, 2013) continue to reveal that aside

from mathematics, science is one of the most difficult discipline of study in the basic education (Batamalaque, 2007). From 2005 to 2010, secondary schools in the country demonstrated low level of scientific literacy as reflected from the students' performance in the NAT. The NAT results reflect that graduates of basic education have insufficient mastery of the fundamental competencies of basic science education. Moreover, the 2003 TIMSS indicated the country's poor performance being ranked 42nd out of 46 participating countries. Which further provides an impression of a poor science education system in the country. With such results reflect that the Filipino learners' scientific literacy is far behind other neighboring countries in Asia. As a response to this alarming situation, the Department of Education crafted a new curriculum which was enacted as the K to 12 Law, or otherwise known as the Enhanced Basic Education Act of 2013. The new K-12 curriculum aimed to gear towards the development of holistically developed Filipino students who possess the 21st century skills and are ready for employment, entrepreneurship, middle level skills development, and higher education upon graduation from Grade 12 (Department of Education, 2013).

However, 5 years after the enactment of the law, the problems seem to persist. Derilo (2017) cited some researches (Medula, Jubay and Aban, 2013; Cajimat, 2015; Saldivar, 2015; and Madronio, 2015) regarding scientific literacy in the province of Nueva Vizcaya. Medula, et al. (2013) conducted a study to explore the standing of scientific literacy of Filipino high school students educated under the 2010 Secondary Education Curriculum. The findings revealed a second-rate lifelong scientific literacy among secondary students which suggests the immediate requisite to take a wide-ranging and highly impartial second look into the implementation of secondary school curriculum to reassure the attainment of its ensuing objectives and competencies. Medula and colleagues (2013) showed that there is reduced application of scientific ways of thinking to real-world contexts by secondary school students. Cajimat (2015) found similar trend of scientific literacy in the province. He found that the Fourth Year and Grade 9 students have beginning level of proficiency in the fundamental scientific literacy. Analogous findings were obtained by Madronio (2015) and Saldivar (2015) revealing that high school students in the province have very low proficiency in Science. Similarly, the findings of Derilo (2017), suggest a very low scientific literacy in the province.

2.2 Science Process Skills and Academic Achievement

According to Çepni, Ayas, Johnson and Turgut (1997), science process skills facilitate science learning, allow students to become more active, enhance learning sense of responsibility, and intensify permanence of learning.

A number of studies have already ventured on the acquisition of basic process skills among young learners. Padilla, Cronin and Tweist (1985) found that only 10% of the 700 students scored higher that 90% in the science process skills test. Similarly, Walters and Soyibo (2001) found a low level of SPS among students. Moreover, Ekon and Eni (2015) study on SPS reveal that most students acquired very low and little

above average level of basic science process skills. They also found that students who acquired SPS performed better than those who did not. Aydogdu (2006), cited by ÖztÜrk, Tezel and Acat (2010), found students' SPS weak. Beaumont-Walters & Soyibo (2001) found a low and inadequate science process skills acquisition among high school students. Other studies such those of Aydınlı (2007), as cited in Gürses, Çetinkaya, Doğar, and Şahin, (2015), Böyük, Tanik, & Saraçoğlu (2011) and Oztürk, Tezel and Acat (2010), found significant differences of secondary school students' SPS in terms of several demographic variables.

The study of Oloyede and Adeoye (2012) had shown how SPS relate with students' achievement. His findings reveal that students who utilize SPS have higher tendency to achieve higher compared to those who did not utilize such skills. He likewise posited that those who had lower level of reasoning capabilities had difficulties in understanding concepts, which leads to lower performance and achievement. Moreover, he said that those students who possess SPS are more capable of reasoning out things intelligently, by effectively tackling problems and situations leading to higher achievements. Furthermore, SPS enhanced learners have higher tendency to think critically and analytically, leading to higher success rate, than those students who do not possess SPS. Aktamis et al. (2008) also found that students who had SPS trainings succeed more. These results were similar to what other researchers had previously known. Ardaç and Mugaloglu (2002), for instance, found that students achieve better when they acquire SPS.

Many studies support the notion that there is a positive relationship between SPS and academic success in science subjects (Beaumont-Walters & Soyibo, 2001; Farsakoğlu, Şahin, & Karsli, (2012); Oloyede & Adeoye, 2012). Delen and Kesercioglu (2012) studied secondary school students' SPS and its possible relationship with academic achievement. They found that students acquired below average SPS and that there was a positive relationship between SPS and academic achievement.

3. Material and Methods

3.1 Research Sample and Design

This study employed descriptive and correlational research designs. Descriptive methods were used in determining the mean level of SPS acquisition among the respondents. Correlational method, on the other hand, was applied in determining the association of respondents' science process skills and science academic achievement. One hundred randomly selected Grade VII students in a private university in Northern Luzon, Philippines were selected as sample for this study. The school offers the K to 12 Education Curriculum which is in accordance to the curriculum mandated by the Department of Education. This curriculum is enacted by the RA 105533, known as the Enhanced Basic Education Act of 2013.

3.2 Measures

The study utilized two significant sets of data, namely the students' level of science process skills, and their academic achievement in science.

A. Science Process Skills

This study utilized an adapted questionnaire from Ngoh's (2009) Science Process Skills Test (SPST). The SPST aims to measure the level of science process skills acquisition of secondary school students. There are 13 items on the basic process skills, 11 items on the integrated process skills. The SPST was modified by the author to fit within the Philippine context. Hence, some names and settings were changed. However, no major changes were done in the instrument. The distribution of items was shown in Table 1.

Table 1: Item Distribution of the Science Process Skills Items in the SPST

Science Process Skills Items	Basic	Integrated
1,2,3,6,7,23	Observing	
4,11,12	Making Inference	
5	Classifying	
13	Predicting	
21,24	Measuring and Using Numbers	
8,9,18,20		Making Hypothesis
14,15,17		Controlling Variables
19,		Defining Operationally
16,22		Interpreting Data

B. Students' Academic Achievement

The study utilized the students' academic grade in science. To determine the achievement of the students in science, their final grade in the subject was obtained from the school registrar, with the consent from the students, the teacher and the school authorities and were treated with utmost confidentiality. The students' cumulative grade in science subject (from the first to the fourth quarter) was used to determine their overall achievement in science. These were computed based on the grading system of the school as stipulated in their Student Handbook, which was based from the mandate of the Department of Education.

3.3 Statistical Treatment of Data

The study used both descriptive and inferential statistics. The responses were summarized and analyzed using SPSS and Microsoft Excel in determining the frequencies, means, standard deviations, and some tests for associations. In determining the normality of the distribution, Kolmogorov Smirnov Test for normality was used. Also, skewness and kurtosis were analyzed. In determining the correlation between students' SPS acquisition and academic achievement, Pearson correlation coefficient was employed. All inferential tests were set at 95.0% confidence level. Students' scores in the Science Process Skills Test were categorized based on their mean scores range. The categorization of students' SPS acquisition level is shown in Table 2.

Table 2: Score Range for Basic, Integrated and Overall Process Skills and their Corresponding Qualitative Descriptions

Process Skills	Score Range	Qualitative Description
Basic	0-2.60	Very low
	2.61-5.20	Low
	5.21-7.80	Average
	7.81-10.40	High
	10.41-13.0	Very high
Integrated	0 -2.20	Very low
	2.21-4.40	Low
	4.41-6.60	Average
	6.61-8.80	High
	8.81-11.0	Very high
Overall SPS	0-4.80	Very low
	4.81-9.60	Low
	9.61-14.40	Average
	14.41-19.20	High
	19.21-24.00	Very high

The students' cumulative grade in Science and Technology VII were used to determine their overall performance in science. These were qualitatively described using the following qualitative descriptions:

Grades		Qualitative Descriptions
90 – 100	-------	Passed: Outstanding
85 – 89	-------	Passed: Very Satisfactory
80 – 84	-------	Passed: Satisfactory
75 – 79	-------	Passed: Fairly Satisfactory
Below 75	-------	Failed: Did not meet expectations

4. Results and Discussion

Problem 1. What is the level of science process skills of the Grade 7 students?

The respondents' scores were summarized and were categorized into five levels, namely *very high*, *high, average*, *low* and *very low*. This categorization served as an assessment of the science process skills of the selected seventh-grader junior high school students. Table 3 shows the summary of the categorization.

Table 3: Mean Scores and Level of Seventh-Graders SPS Acquisition

Science Process Skills	Mean Score	Std. Dev.	Level
Basic Science Process Skills	6.72	1.627	Average
Integrated Science Process Skills	4.25	1.403	Low
Overall Science Process Skills	10.97	2.148	Average

It can be observed in Table 3 that the respondents have an average level of basic science process skills (M=6.72, SD=1.672). On the other hand, their integrated science process skills (M=4.25, SD=1.403) was categorized as low. The overall score for Science Process

Skills (SPS), however, revealed that most respondents had an average level (*M*=10.97, *SD*=2.148) of SPS acquisition. This suggests that most respondents have medium level of the acquired science process skills. The findings imply that the junior high school students' integration of fundamental science process skills was low. Hence, they failed to develop their skills in interpreting of data, controlling variables, experimenting, formulating hypothesis, defining operationally, and modelling.

These results corroborate with the findings of Cajimat (2015), Madronio (2015) and Saldivar (2015) regarding the low scientific literacy in the province of Nueva Vizcaya, Philippines. Similarly, the results offer support to the claims of Aydogdu (2006) who found SPS of students weak and Beaumont-Walters & Soyibo (2001) who found SPS of high school students low and inadequate.

Problem 2. What is the general academic performance the high school students?

To determine the general academic performance of the students in science, their cumulative grades in their subject Science and Technology VII were taken. Frequency and percent distribution of students' performance is shown in Table 4.

Table 4: Frequency and Percent Distribution of Students' Performance in Grade VII Science

Level of Performance	Frequency	Percent
Did not meet Expectations	0	0
Fairly Satisfactory	19	19.0
Satisfactory	30	30.0
Very Satisfactory	36	36.0
Outstanding	15	15.0
Total	100	100.0

Mean Grade (M=83.97, SD=5.353)

Table 4 shows that most of the respondents have very satisfactory (36%) performance in science. About one-thirds of the respondents got satisfactory (30%) performance and 19% percent have fairly satisfactory performance. Only 15% have outstanding performance in the subject. The overall performance of the students in their science subject can be classified under satisfactory level (*M*=83.97, *SD*=5.353). The result implies that the learners have mastered the basic objectives of science and that they have met the basic grade level content standards. However, the results also indicate that though the learners' performance is satisfactory, generally, they did not excel in the subject. The result of this study, serve as an additional support to the findings of Cajimat (2015), Derilo (2017), Madronio (2015), Medula, *et al.* (2013), and Saldivar (2015) and regarding the level of proficiency of high school students in Nueva Vizcaya.

Problem 3. Is there a significant relationship between the students' level of science process skills and academic performance in science?

To determine whether there is a significant relationship between the students' level of science process skills and academic performance in science, Pearson's product moment correlation was determined. Table 5 shows the result of the analysis.

Table 5: Correlation Between Seventh-Graders' Science Process Skills and Academic Performance in Science

Science Process Skill	Academic Achievement
Basic SPS	.334*
Integrated SPS	.152
Overall SPS	.352**

**Correlation was found significant at $p<.005$ * Correlation was found significant at $p<.05$
Note: Strength of Correlation by Evans (1996): very weak (.00-.19); weak (.20-.39); moderate (.40-.59); strong (.60-.79); and very strong (.80-1.0).

The table shows that students' knowledge of the basic SPS was significantly related to the students' grade in science (r =.334, $p<.05$). Their integrated SPS however, was not significantly related to their grades (r =.152, $p>.05$). The table also shows that there was a positive, highly significant correlation between the students' overall science process skills and science academic achievement (r=0.352, $p<.005$). This result suggests that students' science process skills mastery may lead to better performance in science. Though causal relationship is not indicated, it can be implied that the better the comprehension of the science process skills, the higher the performance in science will be.

The results of the study support previous research findings such that of Feyzioğlu (2009) who found that there exists a positively significant and linear relationship between science process skills taught in laboratory applications and efficient laboratory use of the students and their science process skills and academic achievement. Similarly, this study offer support to Aktamis et al. (2008) who found that the students who had undergone SPS training succeeded more than those who students who did not receive SPS training. Aktamis and colleague found that giving scientific process skills training increased the academic achievements of the students. Similar results show that there was an increase on the achievement levels of the students at the end of the SPS training done in science courses (Ardaç and Mugaloglu, 2002, as cited in Aktamis et al., 2008). Similar findings were revealed by studies such those of Beaumont-Walters and Soyibo (2001) and Farsakoglu, Sahin and Karslı (2012) who showed that there is a positive relationship between SPS and academic success in science courses.

5. Recommendations

In light of the findings of this study, it is advised that the science teachers integrate the development and enhancement of the different basic and integrated science process skills in their design of various classroom- and laboratory-based activities to elevate students' level of SPS. The use of inquiry-based learning is also encouraged for it is directed towards the cultivation of SPS among K to 12 learners.

Science as a process will not run properly without adequate science process skills. The low level of SPS at the junior high school maybe the cause of students' inability to perform various experiment-based activities, such as inquiry and discovery, and could even be the reason behind failures in the national and international

assessments. Therefore, it is recommended that science teachers address these skills through proper designs of inquiry-based, outcome-based learning opportunities and activities that would foster the development and enhancement of SPS. School administrators, in coordination with the institutions' science department, need to develop a training program anchored towards the development of students' SPS. Also, the school may provide institutional access to related studies and journals about SPS.

6. Conclusion

The study established that most seventh-grader students have medium level of the acquisition of the different science process skills. Their science performance indicates that they have met the basic grade level content standards as stipulated in the Enhanced Basic Education Curriculum. However, the results also indicate that, though the learners' performance is satisfactory, generally, they did not excel in the subject. The highly significant, positive correlation between students' SPS acquisition and science achievement reveals that students' science process skills mastery may lead to better performance in science.

About the Author

Reymund C. Derilo is a Science Instructor of Nueva Vizcaya State University, Bambang Campus, Bambang, Nueva Vizcaya, Philippines. He graduated Master of Arts in Teaching Chemistry at Saint Mary's University, Bayombong, Nueva Vizcaya, Philippines in 2017. His research interests include scientific epistemological beliefs and pedagogy of science. He also does research in natural science, such as UV-Vis spectrophotometric quantitative determination of heavy metal ions in aqueous solutions using Philippine plants as a chromogenic reagent, phytochemical screening and in-vitro screening of biological activities of ethnomedicinal plants, and characterization of phytofabricated silver nanoparticles (AgNPs) using spectrophotometry. He is currently involved in a project under the Department of Science & Technology – Philippine Council for Health Research and Development (DOST-PCHRD) which focuses on the development of microfluidic paper-based analytical devices (μPADs) for the detection of diarrhea-causing pathogens in water.

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