SCIENCE PROCESS SKILLS AND PROFICIENCY LEVELS AMONG THE JUNIOR AND SENIOR HIGH SCHOOL SCIENCE TEACHERS

EDILYN A. TOMAS
tomas.ea@pnu.edu.ph
Quirino General High School, Cabarroguis, Quirino, Philippines +
Philippine Normal University, Taft Avenue, Manila, Philippines

DOI: https://doi.org/10.54476/ioer-imrj/231565

ABSTRACT

This research advocates for the integration of scientific literacy into teachers' instructional methodologies to enhance critical thinking skills for both educators and students. The study aims to identify deficiencies in science education in the Philippines and assess gaps in science process skills among teachers across various educational levels. Employing a descriptive-comparative research design, the study utilizes a validated instrument with five independent variables and two dependent variables. The reliability of the Science Process Skills (SPS) test was evaluated using the Kuder-Richardson formula 20 (KR_20). Additionally, proficiency levels of participants were compared through a Multivariate Analysis of Variance (MANOVA) across educational attainment and career stages. Respondents were selected through clustered sampling based on career stages outlined by the Philippine Professional Standard for Teachers. Findings reveal a highly reliable Science Process Skills standardized test, with no correlation between SPS levels and academic attainment. Teachers demonstrated consistent science process skills across various career phases, indicating effectiveness in science instruction. The Department of Education is encouraged to support teachers' professional development, aligning with the Reskilling and Upskilling program under the Sulong Edukalidad initiative, considering the majority of teachers have completed master's degree units. Moreover, this study recommends conducting a comparative analysis of response rates across different professional phases. A notable issue identified is the shortage of master teachers nationwide. Therefore, it is suggested to allocate additional resources to empower scientific master teachers, enhancing their capacity to mentor and support fellow science educators.

Keywords: Educational Attainment, Science Process Skills, STEM teachers, Standardized Test

INTRODUCTION

In 2003, the Philippines became a participant in the Programme for International Assessment (PISA), a significant International Large-Scale Assessment designed to evaluate the effectiveness of educational policies and curricula across nations. Over the past two decades, the Philippine education system has exhibited minimal improvement in implementing diverse curricula. This stagnation is evident in the country's performance in Science, Mathematics, and Reading Comprehension, as reflected in the PISA scores since 2003. The urgency for enhancing the quality of education is underscored by the findings of Cordon & Polong (2020). Their study emphasizes the imperative of educational reform, capacity building for teachers through professional programs, and a transformation in school leadership. These proposed solutions are crucial for addressing the challenges and shortcomings within the Philippine education framework.

One of the problems of STEM education in the Philippines is the lack of STEM teachers in the country. According to the study by Anito and Morales (2019), the low performance of Science Education was due to the insufficient STEM teachers that were crucial in the global development and economic growth of the country. Moreover, it was found that there is a need for qualified science teachers teaching science in the Philippines. According to the OECD, most teachers have attained master's degrees in science education which is one of the needs of the teachers in pursuing professional growth. It was suggested in their study that pursuing professional growth may contribute to improving scientific literacy among teachers. It implies that teachers should be aligned with the educational background of the subjects being taught. This will rapidly increase the quality of the teaching-learning process in the public institutions. The insufficient number of STEM practitioners led to the poor performance of Filipino learners in science, which was also supported by the result of PISA last 2018. Moreover, the Basic Education Exit Assessment (BEEA), administered to all or any graduating SHS Grade 12 students, has received reports of subpar performance. On the 2019 BEEA, the mean percentage score for science was 36.2%, and the mean percentage score for mathematics was 27.9%. STEM sectors like agriculture, forestry, fisheries, sciences, and mathematics, engineering, and technology are where 28.7% of the 2 million college and university students studying pedagogy are majoring (CHED Statistics, 2019). The Department of Education already offers a substantial platform for the development of human capital in the areas of creativity and collaboration through its STEM curriculum in high school. Moreover, teachers should also undergo professional development that will benefit them in terms of content, pedagogy as well and the personal growth of teachers in the Philippines. Science Framework for teachers should also be reformed and policies that will help science teachers to practice their expertise and give assistance that will support their needs (Cordon & Polong, 2020). Institutional Policies should also be reformed to eliminate job exploitation among teachers and school leaders. This will help the teachers and leaders to play their role in nation-building effectively (Ramos, 2018).

STEM education is recognized for providing authentic experiences that cultivate essential skills, preparing learners for a lifelong pursuit of knowledge. Within this context, the integration of Science Process Skills (SPS) into the science curriculum emerges as a pivotal element for enhancing the application of knowledge and skills among students. This integration aligns with the current science curriculum design, emphasizing the comprehension and application of scientific knowledge across diverse learning domains while fostering scientific attitudes and values (Pawilen, 2021).

Science Process Skills encompass two distinct categories: basic and integrated processes. The basic processes constitute essential skills for scientific investigations, including observation, communication, classification, the use of measurement scales, inference, and prediction of phenomena. Proficiency in these skills enables learners to master the foundational aspects of scientific inquiry. On the other hand, integrated skills involve the ability to address problem-based phenomena, conduct scientific investigations, identify and control variables, formulate and test hypotheses, and interpret data. Thus, Science Process Skills are deemed intellectual competencies that both teachers and students should possess (Santos & David, 2017).

The significance of Science Process Skills is further underscored by the interconnection between categorization ability and understanding relationships among elements, as noted by Mustafa et al. (2021). Moreover, Rauf et al.'s (2013) study highlights the benefits of incorporating diverse teaching pedagogies within a single science session for the development of science process skills. Every student and teacher must acquire fundamental science process abilities, enabling the application of scientific methods to generate new knowledge or build upon existing understanding (Prajoko et al., 2017).

In this context, the cultivation of scientific literacy among teachers becomes crucial for effective teaching practices, fostering thinking skills in both educators and students. This underscores the need for educational policies and institutional practices to evolve in response to the specific requirements of learners and teachers, considering cultural nuances and institutional gaps. This study aims to identify disparities in Science Process Skills among teachers, irrespective of their educational attainment, and pinpoint weaknesses in science education within the Philippines.

OBJECTIVES OF THE STUDY

This study seeks to assess Science Process Skills (SPS) among teachers with a focus on the following objectives:

1. Identify the potential highest level of educational attainment among the respondents.
2. Validate the Science Process Skills (SPS) standardized test employed in the study.
3. Analyze and compare proficiency levels in Science Process Skills across different levels of educational attainment.
4. Examine and compare the proficiency levels of Science Process Skills among respondents in career stages 2 and 3.

METHODOLOGY

This study uses a descriptive-comparative research design. The level of educational attainment was described based on the highest educational attainment of teachers and the SPS standardized test was tested on its validity. The proficiency level was also compared to its educational attainment and the teachers' Career stages. Inferential statistics were employed to analyze data from the experiment's sample of participants to compare the treatment groups and draw conclusions about the subject population. Inferential statistics come in a wide variety, and each form is suitable for a particular study methodology and set of sample characteristics. The instrument was validated by three experts in the field of science education. This study has five dependent variables (i.e., proficiency level in observing, classifying, inferring, measuring, and predicting) and two dependent variables (i.e., educational attainment and career stage) that were being compared to determine the level of educational attainment and their proficiency level. In total, there are 35 respondents, 29 for Career Stage 3, and 6 for Career Stage 3. Clustered sampling was used to determine the samples, Career Stage 2 and Career Stage 3 of PPST were the basis of determining the samples. Clustered sampling is being used to determine the samples from Career Stages of the Philippine Professional Standard for Teachers (PPST).

Kuder-Richardson formula 20 KR_{20}) was used to assess the reliability of the SPS test. This statistic was computed manually using Equation 1. The computation was automated using Microsoft Excel. Values above .70 are considered reliable (Glen, n.d.). For the second and third objectives, multivariate analysis of variance (MANOVA) was used to compare the proficiency level of the participants across educational attainment and career stage. This procedure was appropriate for the data since there were five dependent variables (i.e., proficiency level in observing, classifying, inferring, measuring, and predicting) and two dependent variables (i.e., educational attainment and career stage). Pillai-Bartlett's test (V) was used to quantify the multivariate difference across each independent variable, the significance of which was determined using the F-statistic. As a follow-up, univariate analysis of variance (ANOVA) for each dependent variable across each independent variable was used to explore the multivariate differences. Also, F-statistics was used to determine its significance. Partial eta squared (η_p^2) was used as an effect size index. Cohen's (1988) guidelines were used in describing the effect size: .01 means *small* difference; .06 means *moderately large* difference; and .14 means *large* difference.

RESULTS AND DISCUSSION

1. Profile of the Respondents

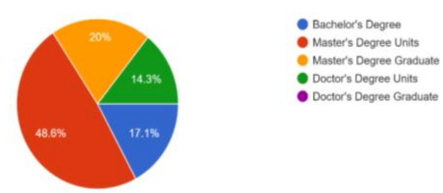

Figure 1. Educational Attainment of Career Stage 2 and 3 respondents

Most of the respondents finished their master's degree units, followed by the master's degree graduates, bachelor's degree graduates, and lastly, the Doctorate Degree units. This implies that most of the science teachers finished Master's degree units or master's degree programs. Most teachers, according to OECD (2018), hold master's degrees in scientific education, which is one of the requirements for instructors looking to further their careers. In their study, it was hypothesized that pursuing professional development may help teachers' scientific literacy. It suggests that the educational background of instructors should match the subjects they are teaching (Cordon & Polong, 2020).

2. Validity of the Science Process Skills

Kuder- Richardson formula KR_{20} was used to assess the reliability of the SPS test. According to Glen, n. d. values above are considered reliable. The reliability was analyzed using the formula below.

$$KR_{20} = \frac{n}{n-1}\left(1 - \frac{\sigma_c^2}{\sum pq}\right)$$

Based on the result, the test was conducted using KR_{20} and was interpreted as highly reliable which has a .924 value. Thus, the reliability of the instrument is highly reliable.

3. Proficiency level across educational attainment

Table 1
Multivariate Inferential Statistics on the Difference in the Proficiency Level in Science Process Skills Across the Profile of the respondents

Profile	V	F	p	η^2_p
Educational Attainment	0.45	1.00ᵃ	.467	.151 †††
Career stage	0.17	1.06ᵇ	.406	.169 †††

Note. ᵃ $df_H = 15$, $df_E = 84$. ᵇ $df_H = 5$, $df_E = 26$.
††† Large difference.

Based on the result of Table 1, there was no statistically significant difference in the proficiency level in SPS across the respondents' educational attainment, $V = 0.45$, $F(15, 84) = 1.00$, $p = .467$, $\eta_p^2 = .151$, and career stage, $V = 0.17$, $F(5, 26) = 1.06$, $p = .406$, $\eta_p^2 = .169$.

The effect size indices, however, indicate that there were large differences in some of the science process skills. One of the possible reasons for non-significance is the association of the small group of sample size across the independent variables.

Table 2
Inferential Statistics on the Difference in the Proficiency Level in the Five Science Process Skills Across the educational attainment of the Respondents

SPS	Fᵃ	p	η^2_p
Observing	1.31	.290	.116 ††
Classifying	1.14	.349	.102 ††
Inferring	1.31	.289	.116 ††
Measuring	1.58	.215	.136 ††
Predicting	0.28	.839	.027 †

Note. ᵃ $df_M = 3$, $df_R = 30$.
† Small difference. †† Moderately large difference.

Effect size indices, on the other hand, detected moderately large differences in the observing, classifying, inferring, and measuring skills and a small difference in the predicting skill across the educational attainment of the respondents. Once again, the non-significance may be associated with the small group sample sizes across each level of educational attainment.

4. Proficiency Level in the Five Science Process Skills Across the Career Stages of the Respondents

Table 3
Inferential Statistics on the Difference in the Proficiency Level in the Five Science Process Skills Across the Career Stage of the Respondents

SPS	F2	P	η^2_p
Observing	0.10	.755	.003
Classifying	0.42	.523	.014 †
Inferring	0.24	.630	.008
Measuring	2.13	.155	.066 ††
Predicting	0.25	.621	.008

Note. [a] $df_M = 1$, $df_R = 30$.
† Small difference. †† Moderately large difference.

Based on the results in Table 3, there was no statistically significant difference in the science process skill of observing, $F(1, 30) = 0.10$, $p = .755$, $\eta_p^2 = .003$, classifying, $F(1, 30) = 0.42$, $p = .523$, $\eta_p^2 = .014$, inferring, $F(1, 30) = 0.24$, $p = .630$, $\eta_p^2 = .008$, measuring, $F(1, 30) = 2.13$, $p = .155$, $\eta_p^2 = .066$, and predicting, $F(1, 30) = 0.25$, $p = .621$, $\eta_p^2 = .008$, across the career stage. This means that the science process skills of the teachers were the same regardless of their career stage.

However, effect size indices detected a moderately large difference in the measuring skill and a small difference in the classifying skill across the career stage of the respondents. Again, the non-significance may be associated with the small group sample sizes across each level of educational attainment.

CONCLUSIONS

Most of the respondents finished their master's degree units. The instrument created, which is the Science Process Skills standardized test, is highly reliable. The Science Process Skills of the teachers were the same regardless of their career stages and there is non-significance in the SPS level and Educational Attainment. Hence, teachers are efficient in teaching Science.

RECOMMENDATIONS

Since most of the teachers finished master's degree units, the Department of Education may provide support for the professional development of teachers in line with their Reskilling and Upskilling program for teachers under *Sulong Edukalidad* program development and capacity building for teachers. This study also recommends equating the number of respondents to the career stages. One of the problems encountered was the small number of Master teachers in the country, hence, it will also recommend creating more items for the Science master teachers to aid and mentoring among the science teachers in the country.

REFERENCES

Cohen, J. W. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Cordon, J. M., & Polong, J. D. (2020). Behind the science literacy of Filipino students at PISA 2018: A case study in the Philippines' educational system. *Integrated Science Education Journal*, *1*(2), 72-78. https://doi.org/10.37251/isej.v1i2.59

Kuder-Richardson formulas (20 and 21). (2005). *Dictionary of Statistics & Methodology*. https://doi.org/10.4135/9781412983907.n1018

Pawilen, G. T. (2018). Home environment of selected Filipino gifted individuals. *IAFOR Journal of Education*, *6*(2). https://doi.org/10.22492/ije.6.2.05

Morales, Marie Paz E.; Anito, Jovito C.; Avilla, Ruel A.; Abulon, Edna Luz R.; Palisoc, Caesar P. (2019). Proficiency Indicators for Philippine STEAM (Science, Technology, Engineering, Agri/Fisheries, Mathematics) Educators. https://eric.ed.gov/?id=ED605786

Mustafa, N., Khairani, A. Z., & Ishak, N. A. (2021, December 1). Calibration of the science process skills among Malaysian elementary students: A Rasch model analysis. *International Journal of Evaluation and Research in Education (IJERE)*, *10*(4), 1344. https://doi.org/10.11591/ijere.v10i4.21430

Prajoko, S., Amin, M., Rohman, F., & Gipayana, M. (2017, March 1). The usage of recycle materials for science practicum: Is there any effect on science process skills? *International Journal of Evaluation and Research in Education (IJERE)*, *6*(1), 1. https://doi.org/10.11591/ijere.v6i1.6340

Pawilen, G. A., (2021). Integrating indigenous knowledge in the Philippine elementary science curriculum. *International Journal of Curriculum and Instruction*, *13*(2).

Santos, M. D. & David, A. P. (2017). Self- and teacher-assessment of science process skills. *The Normal Lights*, *11*(1), 91 – 108.

Susanti, R., Anwar, Y., & Ermayanti. (2018). Profile of science process skills of Preservice biology teacher in general biology course. *Journal of Physics: Conference Series*, *1006*, 012003. https://doi.org/10.1088/1742-6596/1006/1/012003

Ramos, J. (2018). Critical Thinking Skills Among Senior High Students and its Effect in their Academic Performance. International Journal of Social Sciences and Humanities *3*(2).

Rauf, R. A. A., Rasul, M. S., Mansor, A. N., Othman, Z., & Lyndon, N. (2013, April 25). Inculcation of Science Process Skills in a Science Classroom. *Asian Social Science*, *9*(8). https://doi.org/10.5539/ass.v9n8p47

Shahroom, A. A., & Hussin, N. (2018). Industrial Revolution 4.0 and education. *International Journal of Academic Research in Business and Social Sciences*, *8*(9). https://doi.org/10.6007/ijarbss/v8-i9/4593

Trends in International Mathematics and Science Study (TIMSS). https://nces.ed.gov/timss/participation.asp

AUTHOR'S PROFILE

Edilyn A. Tomas is a Senior High School teacher in Quirino General High School, Cabarroguis, Quirino. She graduated from Philippine Normal University- North Luzon Campus with the course of Bachelor of Secondary Education major in General Science, she also finished her Master of Arts in Education – Science Education in the same institution. She also published works in different journals in the field of science education. She presented her works at various regional, national, and international conferences. At present, she is pursuing the degree of Doctor of Philosophy in Science Education at Philippine Normal University, Philippines.

COPYRIGHTS