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Psychology behind Elementary Educators' "Science Process Skills"

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Abstract

The ability to apply scientific processes, known as "science process skills", is crucial for teachers who instruct science as it is an integral part of science instruction. Teachers with strong "science process skills" are believed to help students comprehend and use scientific principles correctly. The purpose of this research was to evaluate the degree of proficiency in "science process skills (SPS)" of 71 elementary Science 6 teachers in Surigao City Division, Surigao City, Philippines. A modified researcher-made test questionnaire was administered to collect data. The data were treated statistically utilizing the mean, standard deviation, box plot, and Fisher's exact test. The study discovered that the teachers had learned basic "science process skills", whereas integrated "science process skills" were "almost mastered." Moreover, male teacher-respondents were rated higher in controlling variables than female teacher-respondents. This research found a significant connection between the teachers' age and sex and their level of competency in observing and controlling variables. Additionally, their level of mastery in "science process skills" such as observing, classifying, measuring, making hypotheses, and interpreting data was related to the type of school they attended.

Keywords: "science process skills"; Elementary Science education; Level of competency

Introduction

The objective of the K-12 Science Curriculum in 2013 aims to develop scientifically literate citizens by enhancing the three learning domains of students. One of these domains includes the demonstration of "science process skills (SPS)", which pertains to the skills and abilities required for individuals to engage in scientific inquiry. Research conducted by Maranan in 2017 emphasizes the importance of SPS in enhancing students' cognitive development and promoting their active engagement in the teaching and learning process. However, despite numerous attempts made to enhance educational achievements, the Philippines has become a country that lags behind in education, with poor rankings in three global assessments that evaluated the performance of students in "science, technology, engineering, and mathematics (STEM)", as reported by the UNESCO Bangkok, Asia and Pacific Regional Bureau for Education in 2022. In the 2018 "National Achievement Test (NAT)" results, as corroborated by Albano (2019), indicated that the "mean percentage score (MPS)" for the Grade 6 NAT, the national average, continued to decline for a third year in a row, marking the lowest performance in the history of the "Department of Education's (DepEd)" standardised test.

In a recent international test highlighted by Villegas (2021), the "Program for International Student Assessment (PISA)" conducted by the Organization for Economic Cooperation and Development (OECD) revealed a disheartening outcome for Filipino students. The 2018 results placed them at the bottom among 79 participating countries in the field of science. Specifically, the Caraga region of the Philippines ranked the lowest within the country, with Surigao City being one of its divisions. This alarming data serves as evidence of an ongoing issue that casts a shadow on the state of science education in the country, indicating the urgent need for improvement.

The development of students' SPS undeniably influenced by the proficiency and instructional competence of their teachers in teaching SPS (Artayasa et al, 2017). Eya (2015) elucidated that teacher play a critical role in students' acquisition of SPS. Gultepe (2016) supported this statement that science teachers with sufficient SPS can teach efficiently. This will only be realized if teachers handling science are equipped and knowledgeable to achieve or at least reach the goal of science curriculum. Maranan (2017) on the other hand reiterated that understanding science lessons meant that teachers could prepare, implement, and evaluate science learning better, they could pick and choose methods and resources which are precise and accurate. In a study of Rohaeti et al., (2019) The findings showed that pre-service chemistry instructors' critical thinking and SPS mean scores were below average. This can be the outcome of passive, teacher-centered learning. This is in line with the findings of Irwanto and Rohaeti (2016), who hypothesised that educators' poor efforts in developing inquiry-based learning may be the cause of the students' low SPS.

Corollary to those findings, it is necessary to carry out a study to view and analyze the mastery level of in-service elementary teachers' "science process skills" and investigate how their profile affect their performance in Science. It is hypothesized that at a 5% margin of error, there is no significant relationship between the level of mastery of elementary science educators in "science process skills" (SPS) and their profile. Specifically, it sought to identify the respondents' age, sex, years of teaching science, highest educational attainment, number of science-related seminars attended, and type of school. The second question focused on determining the mastery level of the respondents in various "science process skills", such as observing, classifying, measuring, predicting, inferring, defining operationally, making hypotheses, controlling variables, interpreting data, and experimenting.

Methodology

This study utilized a descriptive quantitative research method to determine the "science process skills" mastery of Grade six elementary science teachers in Surigao City Division during the 2021-2022 school year. The study included 71 teacher-respondents from different districts, considering their demographic information such as age, sex, years of teaching science, highest educational attainment, number of science-related seminars attended, and type of school affiliation

A validated questionnaire, modified from a researcher-made instrument and Shahali et al. (2017), assessed the mastery of "science process skills" among teachers. Part II of the questionnaire focused on assessing the teachers' "science process skills" mastery. Content validity was ensured through expert review, and reliability was assessed through a test.

The questionnaire comprised 40 items, covering basic (observing, measuring, classifying, predicting, inferring) and integrated (defining operationally, making hypotheses, controlling variables, experimenting, interpreting data) "science process skills". Each skill had four equivalent questions, aligned with DepEd elementary science components.

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DepEd Order No. 55 s. 2016 adjectival descriptions ("unmastered," "nearly mastered," "mastered") were used to determine teachers' mastery levels. The respondents' characteristics were summarized using frequency and percentage, while mean, standard deviation, and box plots were used to describe mastery levels and visualize performance distribution. Fisher's exact test investigated the relationship between “science process skills” mastery and educators' profile.

Results and Discussion

On the Respondents’ Profile

Table 1 displays the profile of the respondents. The suitability of elementary teachers belonging to the age bracket of 31-40 years old, in comparison to their younger counterparts, is not solely determined by their age but rather by a combination of factors including psychological maturity and experience. It is important to note that individual differences exist within any age group, and age alone cannot guarantee psychological maturity or teaching effectiveness. Nonetheless, certain advantages may be associated with teachers in the 31-40 age bracket.

Psychological maturity refers to an individual's emotional and cognitive development, which can positively influence their teaching abilities. As teachers gain experience in the profession, they tend to develop better self-regulation, empathy, and a deeper understanding of students' needs. Consequently, they may possess a more stable emotional state and be better equipped to handle classroom challenges and student interactions effectively.

Experience is another critical factor that contributes to a teacher's effectiveness. Teachers who have been in the profession for a longer period tend to have accumulated a wealth of knowledge and strategies, which can enhance their instructional skills. With years of teaching experience, they may have encountered a variety of situations and developed a repertoire of effective teaching techniques that they can draw upon to support student learning.

It is worth noting that younger teachers can also bring valuable qualities to the classroom, such as enthusiasm, fresh perspectives, and familiarity with modern teaching technologies. They may also have a stronger connection to current educational research and pedagogical trends.The weight of statistical evident showed that, there is a significant difference between age, experience, and teacher effectiveness (Rahida Aini, Rozita, & Zakaria, 2018).

Table 1. Summary of Respondents’ Profile

Profile		Frequency	Percent
Age	20-30	16	22.5
	31-40	30	42.3
	41-50	18	25.4
	51-60	7	9.9
Sex	Male	7	9.9
	Female	64	90.1
Years in Teaching Science	1-10	49	69
	11-20	18	25.4
	21-30	4	5.6
Highest Educational Attainment	College Graduate	26	36.6
	MA unit’s earner	32	45.1
	MA graduate	10	14.1
	PhD graduate	3	4.2
Science-related Seminars Attended	1-10	49	69
	11-20	18	25.4
	21 and above	4	5.6
Type of school	Island	20	28.2
	Mainland-central	24	33.8
	Mainland-noncentral	27	38

The data further indicates that the teaching profession is predominantly occupied by women, with 90.1% of the teachers being female. The over-representation of women in teaching has been widely recognized and attributed to gender differences in occupational preferences and social roles, as Tani (2019) noted. Interestingly, studies suggest that having more female teachers can positively impact student outcomes. Nestour and Moscoviz (2020) found that female teachers can increase girls' test scores, encourage them to stay in school, inspire them to have higher aspirations, and reduce their risk of being victims of violence. This highlights the significance of promoting gender diversity in the teaching profession to ensure that all students have access to diverse role models and mentors.

Regarding the teaching experience of science teachers, the data indicates that the majority have been in service for 1 to 10 years. Concerning science-related seminars attended by the respondents, most of them have only participated in 1 to 10 seminars. These findings suggest a correlation between the number of years of service and the amount of professional development opportunities pursued by science teachers. However, the quality and relevance of the seminars attended can have a more substantial impact on the effectiveness of teaching than their quantity.

Meanwhile, Table 1 shows that a significant proportion of teacher-respondents have a Bachelor's degree, with some having earned Master's degree units. The prevalence of educators with advanced degrees may suggest that they pursued further education to qualify for reclassification or promotion, as mandated by the DBM Budget Circular No. 2018. Additionally, it reveals that most of the teacher-respondents are from mainland non-central schools. This finding implies that the majority of elementary science educators are located in schools outside the city center, where resources and opportunities may be limited. Therefore, it is crucial to provide additional support to these educators to enhance their teaching proficiency.

The study revealed that the science process skill of students has an impact on their critical thinking ability in science education. Additionally, the analysis of “science process skills” and critical thinking of students from different school locations indicated that the students from urban areas exhibited higher levels of these skills compared to their rural counterparts (Tanti et al., 2020).

On the Respondents’ Level of Mastery in SPS

Table 2 shows that elementary science teachers have "mastered" the basic “science process skills” of observing, classifying, and predicting. These skills are typically developed during early childhood, as children use their senses to observe the world around them. Observations can be used as a basis for classifying facts and predicting future events. As cited by Maranan (2017), observing is a fundamental science process skill that is essential to the development of other “science process skills”. Therefore, it can be inferred that the mastery of observing, classifying, and predicting among teachers greatly affects their mastery of other process skills. This finding suggests that elementary teachers have effectively developed the basic process skills of their students in the early years. However, the teacher-respondents have only nearly mastered the skills of measuring and inferring, indicating that further improvement in these areas may be necessary.

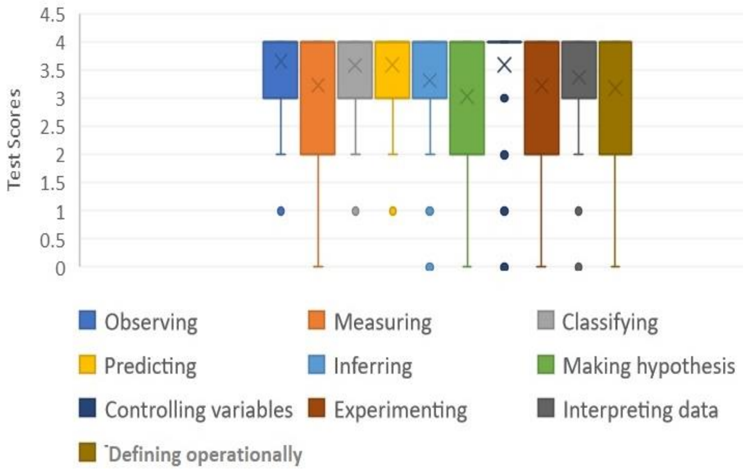
Table 2. Mean and standard deviation of level of mastery in SPS of the respondents

Process skills	Mean	SD	AD
Basic Science Process Skills			
Observing	4	0.65	Mastered
Measuring	3	1.14	Nearly mastered
Classifying	4	0.77	Mastered
Predicting	4	0.75	Mastered
Inferring	3	1.09	Nearly mastered
Integrated Science Process Skills			
Defining operationally	3	1.28	Nearly mastered
Making hypothesis	3	1.38	Nearly mastered
Controlling variables	4	0.89	Mastered
Experimenting	3	1.24	Nearly mastered
Interpreting data	3	1.06	Nearly mastered

0-1– Not mastered; 2-3 – Nearly mastered; 4 – Mastered

On the other hand, they have exhibited mastery in the integrated skill of controlling variables, but not in making hypotheses, defining operationally, experimenting, and interpreting data. These findings align with those of previous studies conducted on secondary school teachers that have shown a moderate level of mastery in integrated processing science skills, particularly in defining operationally, identifying hypotheses, interpreting data and graphs, and designing experiments, with operational defining skills at the lowest level (Ongowo, 2017). These findings are also supported by the work of Lue (2020) and Utami et al. (2017), which found that teachers and students have difficulty in mastering the skills of experimenting and interpreting data. Therefore, to enhance their understanding and application of the concepts, elementary teachers should develop these skills through hands-on experience to be at par with the standards.

Figure 1. Distribution of the level of mastery in SPS of the respondents



Based on Figure 1, the x mark in the diagram represents the average score of the teachers. This indicates that the teachers exhibited higher performance in observing, classifying, predicting, and controlling variables. However, they demonstrated lower performance in measuring, inferring, making hypotheses, experimenting, interpreting data, and defining operationally.

Additionally, the process skills, such as observing, classifying, predicting, inferring, and interpreting data, are represented by shorter boxes and are positioned at the top of the diagram. This suggests that the scores of the participants in these skills are closely clustered together, indicating high performance levels. In fact, most scores in these areas are at the mastered level.

Meanwhile, the “science process skills”, such as measuring, making hypotheses, experimenting, and defining operationally, are characterized by longer boxes and whiskers in the diagram. This indicates that the performance of the teachers in these skills is more dispersed, with a wide distribution of scores. Notably, the whiskers extend to a score of 0, suggesting that several teachers achieved lower performance in these areas.

Furthermore, the presence of data points outside the whiskers in the box plots indicates the presence of outliers. These outliers represent scores that significantly deviate from the majority of the data, further highlighting the challenges or exceptional performance observed in measuring, making hypotheses, experimenting, and defining operationally.

The longer boxes and whiskers in these process skills suggest greater variability among teachers, implying a need for targeted support and improvement in these specific areas. Understanding and addressing the reasons behind the lower performance and scattered distribution can help inform strategies to enhance the teachers' proficiency in measuring, making hypotheses, experimenting, and defining operationally.

Overall, the data presented in Figure 1 highlights the strengths and weaknesses of the teachers' performance in various skills, with a clear indication of areas that require improvement and areas where they excel.

On the Significant Relationship Between the Mastery Level in SPS of the Elementary Science Educators and their Profile

Table 3 presents the results of the Fisher's exact test, examining the relationship between the profile of elementary educators and their “science process skills”. The variables considered in the analysis include years of experience in teaching science, educational attainment, and the number of science-related seminars attended. The findings indicate that these variables do not exhibit a significant difference in relation to both basic and integrated “science process skills”.

The results suggest that the number of years in teaching science, educational background, and participation in science-related seminars do not play a significant role in influencing the level of proficiency in “science process skills” among elementary educators. These factors alone may not be reliable indicators of a teacher's competence in these skills.

It is important to note that while these specific variables did not show a significant association, other factors not considered in this study may still impact the “science process skills” of elementary educators. Further research and investigation are needed to explore additional factors that may contribute to the mastery of “science process skills” in the teaching profession.

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Table 3. Relationship between the Respondents' Mastery Level in SPS and their profile

Profile	Process Skills	Value*	p	Remark
Age	*Observing*	*10.77**	*0.046*	*Significant*
	Classifying	5.47	0.839	Not significant
	Measuring	9.44	0.703	Not significant
	Predicting	9.64	0.328	Not significant
	Inferring	8.96	0.764	Not significant
	Defining operationally	10.24	0.517	Not significant
	Making hypothesis	12.816	0.293	Not significant
	Controlling variables	10.16	0.601	Not significant
	Experimenting	8.661	0.717	Not significant
	Interpreting data	9.989	0.621	Not significant
Sex	Observing	1.078	1	Not significant
	Classifying	0.74	1	Not significant
	Measuring	1.618	1	Not significant
	Predicting	1.488	1	Not significant
	Inferring	1.957	0.908	Not significant
	Defining operationally	1.218	0.919	Not significant
	Making hypothesis	2.063	0.801	Not significant
	Controlling variables	*10.852**	*0.028*	*Significant*
	Experimenting	2.74	0.513	Not significant
	Interpreting data	2.431	0.646	Not significant
Years in Teaching Science	Observing	5.051	0.635	Not significant
	Classifying	4.427	0.619	Not significant
	Measuring	7.348	0.515	Not significant
	Predicting	3.98	0.758	Not significant
	Inferring	7.347	0.519	Not significant
	Defining operationally	4.872	0.774	Not significant
	Making hypothesis	11.083	0.151	Not significant
	Controlling variables	3.968	0.983	Not significant
	Experimenting	4.074	0.873	Not significant
	Interpreting data	6.915	0.576	Not significant
Highest Educational Attainment	Observing	6.256	0.855	Not significant
	Classifying	4.051	0.974	Not significant
	Measuring	7.82	0.919	Not significant
	Predicting	7.815	0.625	Not significant
	Inferring	12.525	0.378	Not significant
	Defining operationally	5.59	0.97	Not significant
	Making hypothesis	12.792	0.371	Not significant
	Controlling variables	11.836	0.51	Not significant
	Experimenting	7.876	0.819	Not significant
	Interpreting data	11.391	0.514	Not significant
Science-related Seminars Attended	Observing	2.903	0.972	Not significant
	Classifying	5.205	0.473	Not significant
	Measuring	6.415	0.64	Not significant
	Predicting	3.405	0.88	Not significant
	Inferring	3.466	0.99	Not significant
	Defining operationally	4.288	0.868	Not significant
	Making hypothesis	3.85	0.984	Not significant
	Controlling variables	5.354	0.823	Not significant
	Experimenting	6.043	0.619	Not significant
	Interpreting data	5.082	0.844	Not significant
Type of School	*Observing*	*12.012**	*0.018*	*Significant*
	Classifying	*9.123**	*0.047*	*Significant*
	Measuring	*15.867**	*0.013*	*Significant*
	Predicting	8.351	0.153	Not significant
	Inferring	10.357	0.17	Not significant
	Defining operationally	10.399	0.171	Not significant
	Making hypothesis	*12.702**	*0.05*	*Significant*
	Controlling variables	9.5	0.169	Not significant
	Experimenting	8.41	0.345	Not significant
	Interpreting data	*18.622**	*0.002*	*Significant*

*Association is significant at $p < 0.05$ level.

The **age** of elementary teachers is an important factor to consider when examining their observation skills. Susanti, Anwar, & Ermayanti, (2018) conducted a study that revealed in-service teachers, ranging from 25 to 40 years old, exhibit a higher level of observation skills compared to pre-service science teachers, aged 19 to 24. This further suggests that teachers in Surigao City Division possess a solid foundation of knowledge and skills in observation, which can greatly benefit their students. However, it is important to note that the study did not establish a statistically significant association between teachers' age and their mastery level in "science process skills" such as measuring, classifying, predicting, inferring, making hypotheses, controlling variables, experimenting, interpreting data, and defining operationally.

Therefore, while age appears to have a suggestive connection to the mastery level of teachers in terms of observing skills, the current study does not provide evidence of a significant relationship between teachers' age and their mastery level in other "science process skills".

Regarding the association between teachers' **sex** and their "science process skills", the results indicate a statistically significant correlation between sex and mastery level, particularly in controlling variables. This finding aligns with the study conducted by Inayah and Ristanto (2020), where male students achieved a higher mean rating in the acquisition of “science process skills” compared to their female counterparts.

The impact of gender on the understanding of controlling variables is evident in a study supervised by Tairab (2016). The research revealed that male students were more likely to select correct answers and provide justifications for their responses compared to female students. This indicates a greater proficiency among male students in comprehending the concept of control of variables. Conversely, Zeidan and Jayosi's (2015) study found that gender differences in “science process skills” favored females and villages students.

It is worth noting that while there is evidence of a statistically significant association between teachers' gender and their mastery level in “science process skills”, the results from different studies are not always consistent. The influence of gender on “science process skills” may vary across different contexts and populations. Further research is necessary to gain a more comprehensive understanding of how gender may impact the acquisition and mastery of “science process skills” among teachers.
s of the study indicated that there were significant differences in “science process skills”
due to gender favoring females; and due to residence favoring villages students.

The **type of school** to which teachers belong was found to have a statistically significant correlation with their mastery level in certain “science process skills”, including observing, classifying, measuring, making hypotheses, and interpreting data. However, no significant difference was observed in predicting, inferring, defining operationally, controlling variables, and experimenting. This suggests that whether teachers are assigned to island schools or mainland schools (central or non-central) may play a role in the level of mastery they attain in “science process skills”. One reason why the type of school matters in acquiring mastery of “science process skills” is the quality of learning support and facilities available. Well-equipped facilities make teachers more enthusiastic about teaching and facilitating learning. In island schools, despite the lack of advanced equipment, teachers have the advantage of a rich learning environment. They can easily observe natural phenomena, classify weather patterns, make educated guesses about upcoming weather events, and explain various phenomena based on their immediate surroundings, such as the absence of water from a well, among other examples.

The researcher believes that a school environment with more science involvement leads to a better understanding of “science process skills”, reinforcing the importance of school context in developing these skills.

Conclusion

The study uncovered several significant findings regarding the mastery level of elementary science teachers in “science process skills”. Firstly, the results indicated that age, particularly in relation to the observing skill, and gender can influence the mastery level, with a notable impact observed in the area of controlling variables, where male teachers achieved significantly higher scores.

Secondly, the study found that neither the length of teaching experience, educational advancement, nor attendance at science-related seminars had any significant bearing on the teachers' mastery of science process abilities, whether in basic or integrated skills. These factors did not contribute to noticeable differences in the teachers' proficiency.

Thirdly, the teacher-participants demonstrated competence in basic “science process skills” such as observing, classifying, and predicting. However, they faced challenges in the measuring skill and in acquiring the integrated skills of defining operationally, making hypotheses, experimenting, and interpreting data. These integrated skills proved to be more difficult for the teachers to master.

Lastly, the study revealed that teachers assigned to both island and mainland areas performed well in “science process skills” such as observing, classifying, predicting, and controlling variables. This suggests that the type of school assignment has an impact on the elementary teachers' “science process skills”.

In summary, the study's key findings highlight the influence of age and sex on mastery level, the lack of association between teaching experience, educational advancement, and seminar attendance with skill mastery, the teachers' competence in basic skills, and the challenges they face in acquiring certain integrated skills. Furthermore, the study indicates that type of school assignment can impact the elementary teachers' “science process skills”. These findings provide valuable insights into the factors that influence the mastery of “science process skills” among elementary science teachers and can inform strategies for enhancing their proficiency in these skills.

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