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SCIENCE PERFORMANCE AND SCHOLASTIC APTITUDE OF GRADE 9 LEARNERS

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Abstract:
This study determined the relationship between scholastic aptitude comprised of reading comprehension, verbal ability, mathematical ability, logical reasoning ability, and visual manipulative skills and Science performance of Grade 9 learners in a privately run basic education institution in Lapu-lapu, Cebu, Philippines during the school year 2015-2016. Descriptive and correlational research designs were carried out to assess the relationship among the identified variables. The study anchored its framework on the Multiple Intelligence Theory and the Primary Mental Abilities Theory. Secondary data on learners' Science performance, scholastic aptitude and selected demographic profile were considered. Findings revealed a strong association in reading comprehension and Science performance of both sexes between scholar and non-scholar leaners. Moderate direct correlations were noted between learners' scholastic aptitude pertaining to verbal ability, mathematical ability, logical-reasoning ability and visual manipulative skills, and their science performance. Science performance statistically differed between male and female, and between scholar and non-scholar learners. Female scholar learners performed better than their male non-scholar counterparts in science. In conclusion, scholastic aptitude has bearing on achievement of female scholar learners with respect to their science performance. There is enough evidence to conclude that scholastic aptitude goes hand in hand with science performance. It is imperative then that parents and teachers should work together to develop learners' scholastic aptitude particularly in reading comprehension to reduce if not eliminate, the sex gap in science performance of learners in the study area.

Keywords: science performance, scholastic aptitude, sex, scholarship status

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1. Introduction

Improving science literacy among learners is the aim of science education. It equips learners the necessary knowledge and life skills for them to be able to make intelligent decisions and judgements in real-life experiences (DepEd, 2013). Its basic scientific concepts are foundations of individuals' success and societal development (Abocejo and Padua, 2010). However, learners nowadays are having hard times towards performing well in their science classes.

Martin, Mullis, Foy and Stanco (2012) noted that the "*Trends in International Mathematics and Science Study (TIMSS)*" findings released in 2011, global trend of science achievement of learners is stable in some countries showing large improvements while exhibiting a downtrend for some other countries. The Philippines participated in the TIMSS during the years 1999 and 2003, got scores of 345 and 378 out of 800, respectively. In 2011, the Philippines selected only the City Science High Schools to participate in the assessment and obtained a score of 355. The scores are relatively low compared to other countries which reached the average achievement of 500. The result indicated that Filipino learners are weak in terms of mathematical and scientific concepts.

Academic achievement is frequently associated with learners' skills and abilities (Jolejole-Caube, Dumlao and Abocejo, 2019). In fact, some of these skills were found to be correlated with learners' science performance (Espinosa, Monterola and Punzalan, 2013) in school. They are considered predictors of learner's achievement. Relatedly, learners' aptitude, with emphasis on science process skills, serves as a tool for better understanding on concepts related to science.

Scientific process skills are requisite for successful learning in science because these skills build strong foundation for effective application of scientific method to daily life (Espinosa, Monterola and Punzalan, 2013). Accordingly, it is important that learners develop these skills not only for attaining good standing in science class (Pehlivan and Köseoğlu, 2010) but for a heavier reasons of maximizing learning (Cuñado and Abocejo, 2018), making effective decisions (Rodriguez and Abocejo, 2018) and solving real-life problems (Fernandez and Abocejo, 2014).

The authors argue that assessing the science performance of grade 9 learners provides substantive evidences toward authentic assessment of educational progress in the learning process. The study is seen to provide knowledge on how much students are learning compared to standard performance in the national and international levels. The study findings offer valuable inputs for education policymakers, educators, parents and concerned stakeholders towards achieving success in the implementation of aligned programs and activities supportive to the improvement of learners' performance in science.

In the school under review, science is considered as one of the difficult subjects since it is associated with the concepts of mathematics and other related fields. In fact, about 25 percent of the entire Grade 9 learners manifested the below-average performance level in Science. This translate to about one-fourth of the students' population exhibiting below the expected average of 80. This scenario indicates a gap in

knowledge of what factors contribute to the low performance among learners particularly in the field of science, hence this study.

1.1 Study Objectives

This research determined the relationship between science performance and scholastic aptitude by sex and scholarship status among Grade 9 learners of a basic education institution. Specifically, the study assessed the correlation between science performance and scholastic aptitude through the following independent sub-variables: verbal ability; reading comprehension; logical reasoning skills; mathematical ability; and visual manipulative skills.

2. Literature Review

Several researches have determined the association of multiple intelligences to academic achievement of learners (Kaya, Juntune and Stough, 2015; Othman, 2013; Ayesha and Khurshid, 2013; Ghazi et al., 2011). A significant correlation between self-perceived linguistic, logical-mathematical intelligence and learners' academic achievement was revealed by Ghazi et al. (2011). Other researchers (Siti et al., 2013) showed that there was a moderate correlation between perceived linguistic, visual-spatial intelligence and academic achievement while very weak correlation for the logical-mathematical intelligence and academic performance in school. These findings suggest that academic achievement is associated with the kind of intelligence possessed by the learner.

In science education, in order to achieve a level of scientific literacy, one has to effectively employ science process skills. Science process skills is defined as "the basis for scientific thinking and research". These skills are the "thinking skills" that an individual used in order to arrive with a certain learning (as cited in Aydogdu, 2015, p. 583). There are a lot of identified science process skills presented from different sources. A study identified the five important science process skills – manipulating, calculating, recording, observing and communicating (Akinbobola and Afolabi, 2010). Other science process skills include observation, communication, classification, measurement, inference and prediction which are important in developing the concept of scientific method (Espinosa, Monterola and Punzalan, 2013).

The level of learners' science process skills could have a significant relationship with their science performance in school. Gadzama (2012) used science process skills approach on learners during teaching-learning process. His findings showed that learners exposed with science process skills strategy better perform in school than those learners that were not exposed to the strategy. This implies that learners equipped with science process skills perform better in school and produce good academic performance especially in the field of science. Accordingly, Stanly (2016) concluded that there was a moderate positive correlation between science achievement and science aptitude (skills and abilities), hence learners could get good scores if they have good scientific aptitude.

Linguistic intelligence is the ability of an individual to be able to use language efficiently in attaining certain goals (Shazada et al., 2014; Trazo and Abocejo, 2019). Its

scope includes verbal ability and reading comprehension (Saraspe and Abocejo, 2020). It is also found that verbal ability and reading comprehension have significant relationship with academic achievement (Flanagan, Andrews and Genshaft as cited in Kaya, Juntune and Stough, 2015). Through the use of a cognitive test, they discovered that the level of verbal ability determined the academic achievement and school performances of the learners. Furthermore, Lee, Olszewski-Kubilius and Peternel (2010) found out strong correlation between verbal ability and general intelligence factor. In addition, females manifested better verbal skills compared with males, yet males exhibited better spatial skills compared with their female counterpart (Lin, 2010).

Chege (2012) concluded that reading comprehension has significant relation with academic performance. Imam et al., (2014) stated that reading skills is complementary with science process skills because their interrelation is used for application during the learning process. Specific skills such as identifying main ideas and details and skills on classifying are used by both areas similarly. Science literacy could be developed though an inquiry-based curriculum (Fang and Wei, 2010) that infused explicit reading strategy instruction (Trazo and Abocejo, 2019) to learners. O'Relly and McNamara (as cited in Imam et al., 2014) conveyed that there is moderate to high correlation between reading skills and science achievement. Results of the study showed that higher grades come from learners who have both scientific and reading skills. Moreover, it was found out that females' reading comprehension development in English is better than males since females got better marks in getting specific information, getting general information, understanding textual structures and deducing meaning from the context (Arellano, 2013).

Another type of multiple intelligences is the Logical-mathematical Intelligence. According to Gardner (as cited from Ayesha and Khurshid, 2013, p.22) "*logical-mathematical intelligence is the ability to show aptitude for numbers, reasoning and problem solving*". This involves the mathematical ability and the logical reasoning of the learners. Haveys (as cited in Oyedeji, 2011), reported that in conveying scientific concepts, mathematics is used mainly because mathematics is essential for science literacy. In line with this statement, a comparative study was conducted by Wang and Santos (as cited in Oyedeji, 2011) to determine the relationship of Math and Science achievement. It was found that there was a significant correlation between mathematics and science success among eighth graders. Moreover, the Program for International Student Assessment (PISA) assessments from the years 2000-2009 showed figures in which males got higher scores compared with females in mathematics across nations (Stoet and Geary, 2013). This implies that males excel more on mathematics than females.

One study also stressed on the effect of logical reasoning skills to science achievement of learners (Sadi and Cakiroglu, 2014). In relation with this, Yenilmez, Sungur and Tekkaya (as cited in Sadi and Cakiroglu, 2014) learners' reasoning ability as one of the main predictors of performance on learners' achievement in specific topics on biology. Visual or spatial intelligence is the ability to see things through the mind (as cited in Shahzada et al., 2014). This includes the skill of visual manipulation. It has been found that spatial ability predicts learners' science achievement (Bolen, 2011). Ganley, Vasilyeva

and Duloney (2014) suggested that in order to improve performance among science, learners (as well as to diminish the sex difference in science scores in school), the teachers along with the parents should teach learners to develop their spatial skills in order to train their thinking for science learning.

The sex variable was also being associated with the science performance of learners in school. Researches were made in order to determine the relationship among sex, scholarship status and Science performance in school. According to Pehlivan and Koseoglu (2010), male and female high school science learners indicates a significant difference on attitudes towards Biology course. They also found out that Biology course is more favourable to female learners. In addition, Othman (2013) found no significant difference between male and female learners in obtaining science concepts and science process skills and this cannot affect their achievement in school, specifically in the field of science. Similarly, Olasehinde and Olatoye (2014) reported no significant difference between male and female in their overall science performance in secondary level.

2.1 Theoretical Background

Gardner's Theory (2006) of Multiple Intelligences is based on the learners' ability and skills (Ayesha and Khurshid, 2013). In lined with this, a related theory by Thurstone (as cited in Marais, 2007) which is the Theory of Primary Mental Abilities discussed that intelligence is merely a combination of common abilities that functions as one.

The study is anchored with Gardner's Multiple Intelligence Theory (2006) which argues that an individual has the ability to learn through different kinds of intelligence of varying levels. In his theory, he identified the seven kinds of individual intelligences, these are: linguistic, spatial, logical-mathematical, musical, intrapersonal, interpersonal, and bodily kinaesthetic, however this study focused only on linguistic, logical and spatial intelligences. It is also said that successful academic achievement in all disciplines depends on the level of intelligence of the learner in class and in extra-curricular activities (Ayesha & Khurshid, 2013), thus implies that the level of intelligence determines the student's achievement in school.

Learners' individual intelligences comprise the combinations of specific abilities including the science process skills which are crucial in achieving scientific literacy among learners. Accordingly, Thurstone's Theory of Primary Mental Abilities (as cited in Gustafsson, 1982) posits that the idea of intelligence is not general, rather a combination of different abilities which make up a person's intelligence. The abilities that he identified were the: spatial, perceptual, numerical, verbal relations, word, memory, inductive reasoning, restrictive reasoning and deductive reasoning abilities (Marais, 2007). Hence, the learners' specific abilities that are related with science make up their overall general complex intelligence, and this intelligence is considered to be the basis of their science performance where scientific literacy among learners is being developed.

2.2 Conceptual Framework

Learners with a certain level of intelligence may differ in their science performance due to some demographic variables such as sex and scholarship status in school. The study

of Leitenberg, Rothblum and Cole (as cited in Lewine, 2011) disclosed that female learners are more susceptible to negative consequences of fear of success than male learners. Essentially, creating difference in the level of motivation which may result to dissimilarity of academic performance of learners.

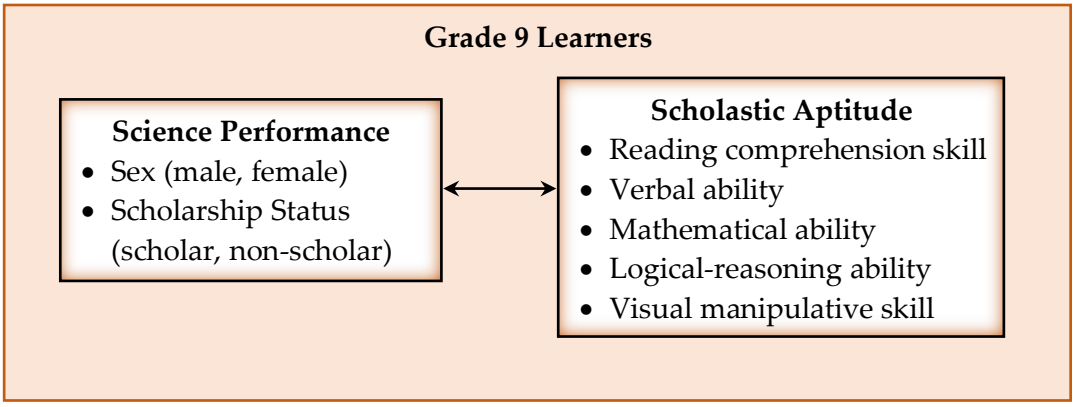

Figure 1: Conceptual Framework of the Study

For the scholar and non-scholar academic achievements, a study explained that success is evident to those scholar learners who got high test scores than those non-scholar learners after a standardized test was conducted. This may suggest that scholar learners are more motivated and therefore achieves great academic performance in class (Ganem and Manasse, 2011). Overall, learners' Science performances as well as their scholastic aptitudes and level of intelligences are said to be associated with their sex and scholarship status in school.

3. Research Methodology

3.1 Research Design

A correlational research design was used to carry out the research. Secondary data were gathered from the school under study pertaining to the records of the grade 9 leaners who were the focus of this research endeavour. Association of predetermined study variables on science performance and scholastic aptitude by sex and scholarship status were derived for analysis and discussion. Insightful information of the variables that attributed to the learners' science performance were also gathered and discussed.

3.2 Research Locale

The study was conducted at Saint Dominic Savio International School located in New Road Sangi, Pajo Village, Lapu-Lapu City, Cebu, Philippines. The school consists of three departments: pre-school; elementary; and junior high school. The junior high school department was linked with the Private Education Assistance Committee (PEAC), a government agency which aids public high school learners for financial assistance in private education.

3.3 Ethical Considerations

Prior to the conduct of the study, written permission was sought from the school Directress. The names of the learners, whose National Career Assessment Examination (NCAE) results were taken, were held confidential. Full consents from the parents of the learners were also obtained. The purpose of the study was clearly explained. All the information derived from the study were dealt with utmost confidentiality and were solely used for the purpose of the study.

3.4 Data Sources

There were 115 grade 9 learners in SDSIS who took the NCAE in August 2015. The examination was an aptitude test to determine the level of learners' scholastic aptitude for their favoured future career. Aptitude areas include reading comprehension, verbal ability, mathematical ability, logical reasoning, and visual manipulative skills of learners. These learners were categorized according to sex and scholarship status. Sixty-nine percent (69%) of the learners were boys and thirty-one percent (31%) were girls. Eighty-two percent (82%) of the learners availed the PEAC scholarship from the government while eighteen percent (18%) of them were non-scholars.

Secondary data were collected on the learners' demographic profile, their science performances and their scholastic aptitude. Demographic data of learners were gathered from the Learners' Information Profile, data on the Scholastic Aptitude were gathered from the learners' NCAE result and the science performances were got from the encoded grades of the science teacher.

3.5 Data Gathering Procedure

Strict protocol was followed to ensure observance of research ethics in the study. The researcher sent a letter of permission to the School Assistant Directress on accessing data from the office were the NCAE results. Electronic class records and learners' information sheet were also examined upon approval by the school head.

Permission was granted and as promised, study findings and results were shared with the school for further interventions. To ensure confidentiality of the learners' information, only the sex and scholarship status were obtained from their information sheets. The names of the learners were not reflected on the study data since they were each assigned with a specific number in adherence to data privacy.

3.6 Treatment of Data

The gathered data where statistically treated and analysed using descriptive statistics and inferential statistics. The Pearson product moment correlation coefficient (r) was used to examine the relationship between science performance and the learners' scholastic aptitude with respect to sex and scholarship status.

4. Results and Discussion

4.1 Correlation between Science performance and scholastic aptitude by sex

Based on the data calculation results, the correlation between science performance of both male and female learners and their scholastic aptitude indicators were directly and highly associated at moderate level. On the upper end of the moderate level association between sex and scholastic aptitude were reading comprehensions and visual manipulative skills indictors among male learners. However, their female counterparts only exhibited the same situation for the reading comprehension skills. Indicatively, learners with higher reading comprehension skills have correspondingly higher science performance in class.

O'Relly and McNamara (as cited in Imam et al., 2014) showed the same results of moderate positive correlation between the two variables. The relationship between the variables is direct, meaning, the higher is the level of learners' reading comprehension, the higher is their science performance in class. It was revealed that specific skills such as identifying and classifying were used both in reading comprehension and scientific literacy (Imam et al., 2014).

Table 1: Correlation of science performance and scholastic aptitude by sex

Sex	Test Statistic and p-value	Reading comprehension skill	Verbal ability	Mathematical ability	Logical-reasoning ability	Visual manipulative skill
Male	Pearson r	0.631**	0.535**	0.578**	0.452**	0.613**
	(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Female	Pearson r	0.634**	0.403*	0.561**	0.458**	0.404*
	(p-value)	(0.000)	(0.015)	(0.000)	(0.004)	(0.015)

* - significantly correlated at $\alpha < 0.05$

** - highly significantly correlated at $\alpha < 0.01$

The correlation between verbal ability and science performance is positively moderate in both male and female learners. The findings however revealed that male learners' verbal ability has higher positive correlation with their science performance compared to female learners. Same result was observed on the correlation between mathematical ability and science performance in both male and female learners. These results correspond with the results of Wang and Santos (as cited in Oyedeji, 2011) correlating Science and Math success among eight graders. However, there is much higher correlation between science performance and mathematical ability of males compared with female learners. This shows that the association of math and science performances of male learners is stronger compared with the female learners.

Logical-reasoning ability of both male and female learners were found to have a moderate to weak correlation with their science performance. This means that the level of logical-reasoning ability of both male and female learners is not highly related with their science performance. On the other hand, visual manipulative skills of males were evidently moderate to strong correlation with their science performance than females.

This suggest that male learners with higher visual-manipulative skills tend to have the same level of science performance in their class.

4.2 Correlation between science performance and scholastic aptitude by scholarship status

The result showed that there is strong positive correlation between reading comprehension and science performance among scholar learners. In the other hand, correlation between reading comprehension and science performance among non-scholar learners is just moderate.

Table 2: Correlation between science performance and scholastic aptitude by scholarship status

Scholarship Status	Test Statistic and p-value	Reading Comprehension skill	Verbal Ability	Mathematical Ability	Logical-Reasoning Ability	Visual manipulative Skill
Scholars	Pearson r (p-value)	0.707** (0.000)	0.578** (0.000)	0.585** (0.000)	0.536** (0.000)	0.557** (0.000)
Non-scholars	Pearson r (p-value)	0.519* (0.016)	0.548* (0.010)	0.444* (0.044)	0.395^{ns} (0.077)	0.632** (0.002)

ns – not significantly correlated
* - significantly correlated at $\alpha < 0.05$
** - highly significantly correlated at $\alpha < 0.01$

As for the verbal ability and science performance, there is almost the same correlation value for both scholars and non-scholars with 0.58 and 0.55 respectively. These values suggest that the association of learners' science performance and verbal ability for both scholar and non-scholar learners are moderate.

The correlation between mathematical ability and science performance among scholar learners is relatively higher compared to that of the non-scholar learners with the values of 0.58 and 0.44 respectively. The result implies that there is moderate to weak relationship between science performance and mathematical ability among scholar and non-scholar learners. Same result was observed with the correlation between logical-reasoning ability and science performance among scholar and non-scholar learners.

However, the correlation between visual manipulative skills and science performance among non-scholar learners is higher than the scholar learners. This suggest that there is strong positive relationship between visual manipulative skills and science performance among non-scholar learners while there is a moderate relationship of the two variables among scholar learners.

4.3 Science performance of learners by sex and scholarship status

The average science performance of Grade 9 learners during the school year 2015-2016 are presented in Figure 2. It reflects that female learners have higher science performance than male learners with a mean performance of 89 and 83 respectively. This finding suggests that female learners in the locale under study performed well in science classes

than their male counterpart. It should be noted however that the veracity of such result is confined only to the study area and may be otherwise in another research setting.

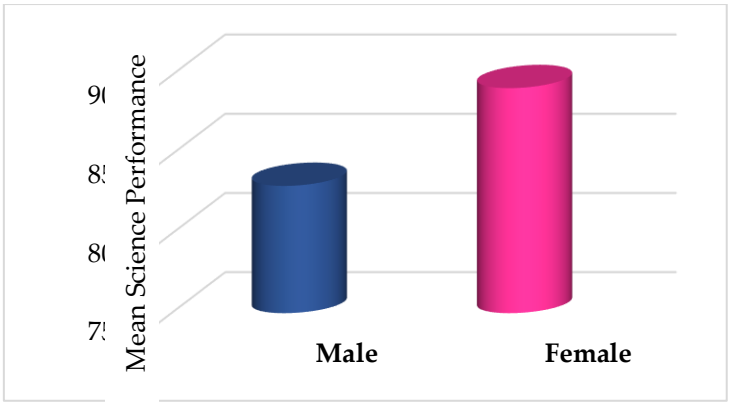

Figure 2: Mean Science performance of grade 9 learners by sex, School Year 2015-2016

In terms of science performance by scholarship status, Figure 3 shows that scholar learners exhibited a higher mean performance in their science classes compared with the non-scholar learners, posting a mean performance of 85.54 and 82.41 respectively. This shows that scholar learners performed well in their science classes than non-scholar learners.

Another contributing factor is that those learners who availed of the science scholarships receive regular monetary allowance and other benefits which provide them with resources for any school projects that may be required by the learning institution. Ganem and Manasse (2011) reported, based on their study findings, that science scholar learners were more motivated than non-scholar learners. In effect, they exhibited commendable performance in science classes.

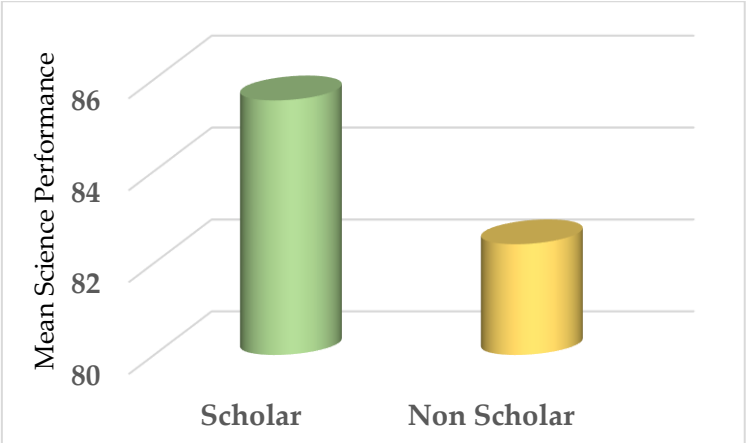

Figure 3: Mean Science performance of grade 9 learners by scholarship status, School Year 2015-2016

4.4 Scholastic Aptitude by sex

Scholastic aptitude among grade 9 learners by sex is presented in Figure 4. The scholastic aptitude in focus is composed of the learners reading comprehension skill (RC), verbal ability (VA), mathematical ability (MA), logical-reasoning ability (LRA), and visual-manipulative skill (VMS). The female group consistently outperformed their male counterpart in all the scholastic aptitude areas under review. Scholastic aptitude of females registered average percentages of 79, 80, 61, 73, and 69 for their RC, VA, MA, LRA and VMS respectively. Whereas, the scholastic aptitude of males has a corresponding mean percentages of 58, 60, 51, 57, and 55 which are relatively lower compared to that of the females' average percentages. The results revealed that female learners have higher scholastic aptitude compared to that of males.

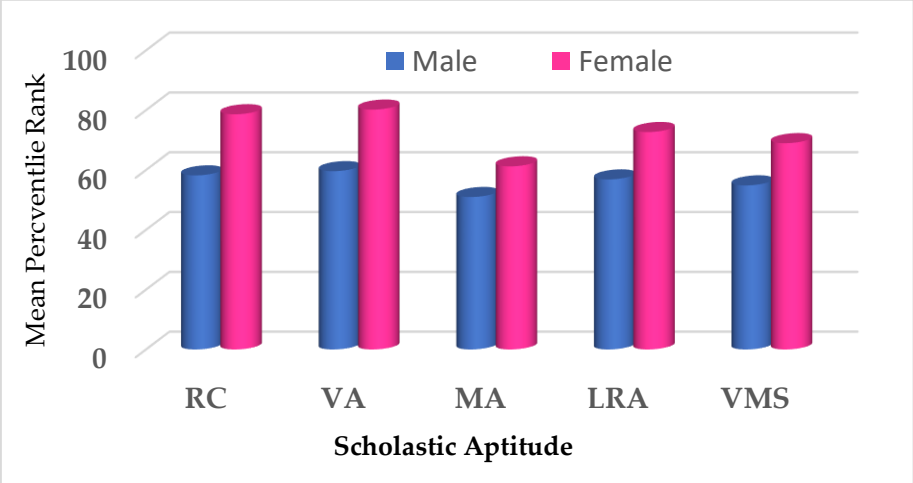

Figure 4: Scholastic aptitude of grade 9 learners by sex, School Year 2015-2016

A previous study conducted by Akpotor and Egbule (2020) revealed that gender difference exists in the scholastic achievement test (SAT) between male and female senior high school learners in their physical science subject. However, their results indicate that male students outperformed their female counterpart, contrary to the present study finding. Nonetheless these previous and present results do confirm that gender gaps exist in science performances among high school learners. Accordingly, Akpotor and Egbule (2020) recommended for the adoption and inclusion of motivational strategies which could stir up female high school leaners physical science thereby enhance career prospects in science-related discipline.

4.5 Scholastic Aptitude by scholarship status

As shown in Figure 5, differences in the average percentile rank exists among the different scholastic aptitude among scholars and non-scholars. Scholar learners have higher average percentile rank than non-scholar learners on their scholastic aptitude. In reading comprehension, scholar learners got the average percentile rank of 65 which is slightly higher than the average percentile rank of 61 achieved by the non-scholar learners. Same result was observed with the average percentile ranks of both scholars and non-scholars in their mathematical abilities and logical-reasoning abilities.

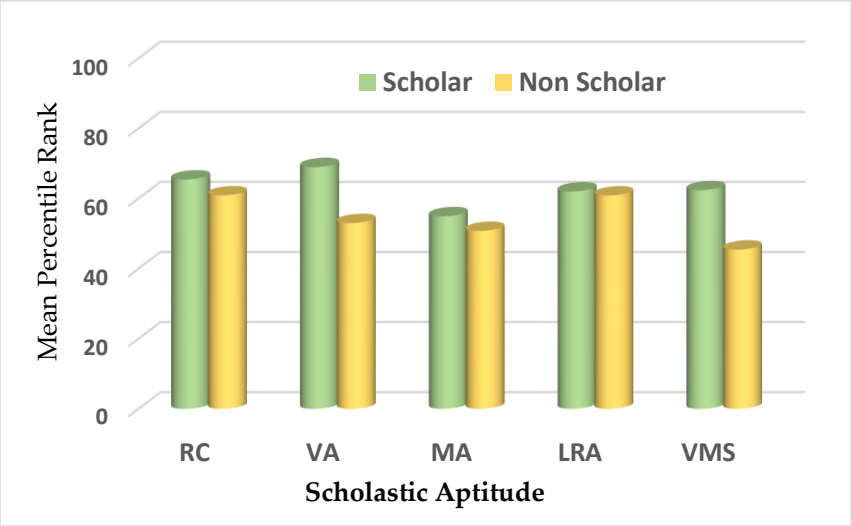

Figure 5: Mean scholastic aptitude of grade 9 learners by scholarship status

With respect to verbal abilities and visual manipulative skills, scholar learners exhibited average percentile ranks of 69 and 62, respectively compared to non-scholar learners with the values 53 and 45, respectively. There is a noticeable difference in their average percentile rank with their verbal abilities and their visual manipulative skills. This reflective finding somehow suggests that scholar learners excel more in terms of their scholastic aptitude and science performance in class. In essence, scholarship favourably contributes to better performance which can be a motivating factor for a learner to work hard just to academically excel.

5. Conclusions and Recommendations

Grounded on the study findings, it is concluded that scholastic aptitude, which is comprised of reading comprehension, verbal ability, mathematical ability, logical reasoning ability, and visual manipulative skills has bearing on science performance among Grade 7 learners. Indeed, scholastic aptitude directly matters in the learning outcome of Grade 7 learners as they go hand in hand, such that high scholastic aptitude will have a corresponding better performance in science. Science performance has direct bearing on the scholastic aptitude of grade 9 learners by sex and scholarship status. The higher the science performance, the higher are the scholastic aptitude in class. Females and scholar learners whose science performance are higher than their than males and non-scholar learners' counterpart creating a gap between learners of different sex and scholarship status.

The authors recommend that parents and teachers collaborate at home and in school to cognitively improve and develop their learners reading comprehension abilities as impetus to higher performance in science. Accordingly, science teachers should take into consideration the gap between male and female learners and between scholars and non-scholars during their learning experiences. Teachers need to be best mentors for their learners in enhancing scientific skills by way of exposing them to various science activities providing opportunities for learners' scientific literacy enhancement.

Conflict of Interest Statement

The authors declare no conflicts of interests.

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