International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

Learners' Science Process Skills for Chemistry 5124 Practical Activities in Selected Secondary Schools of Kitwe District, Zambia

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Abstract: ***This study investigated how learners use science process skills (SPSs) to solve chemistry 5124 practical activities in selected secondary schools of Kitwe district, Zambia. The study was subsequently guided by the research question: how do learners use science process skills to solve chemistry 5124 practical activities, and an hypothesis: there is no significant difference between gender of learners and science process skills used to solve chemistry 5124 practical activities (null hypothesis). The skills which were considered include observing, measuring, classifying, predicting, interpreting, communicating, and inferring. The study used a mixed methods approach and a descriptive survey design to investigate the issues involved. The study sample consisted of 48 grade 12 learners randomly selected from four secondary schools. Data collection instruments included practical instructions called SPSAI and observation schedules. Qualitative data were analyzed through establishment of common themes while quantitative data were analyzed by descriptive (frequencies) and inferential (t-tests) statistics generated by statistical package for social sciences (SPSS). Findings indicated that learners used observing, measuring and classifying at least at satisfactory levels, but failed to use interpreting, inferring, predicting and communicating in Chemistry practical activities at the least required level. It was further established that, there was no significant difference with regard to use of SPS according to gender of learners (t=-0.283, df=335 & p value=0.77>0.05). The study concluded that learners did not use most of the science process skills in chemistry 5124 practical activities at the required level, and gender had no significant impact on how learners used the SPSs. In view of the findings, the study recommend that teachers should emphasize more on acquisition and enhancement of developed science process skills among learners, the cognitive development level of learners should be considered when designing practical activities, and a longitudinal study to be done on Chemistry teachers in order to get in-depth understanding of the nature of chemistry practical activities teachers design and deliver to learners.***

Keywords: Learner, Science process skills, Practical activity

1. Introduction

The importance of science education cannot be over emphasized as it ranges from transmission of knowledge, values, culture, skills and norms among others, to actualizing developmental agendas of given societies and nations at large (Padilla, 2004; Akani, 2015). According to Akani (2015), no nation can progress in terms of development without correct scientific base. Inarguably science is one of the subjects which are able to unleash the potential of learners to turn into desired responsible and productive citizens. Thus, an enviable education system should embrace science as part of core subjects and endeavor to develop and nurture students' potential through a holistic implementation of the set curriculum. This is why nations across the globe endeavor to provide quality science education as the means to facilitate their national development.

According to the United Nations Children's Fund [UNICEF], (2000), quality education is one that focuses on the social, emotional, mental, physical and cognitive development of each learner regardless of gender, race, ethnicity, social economic status, or geographic location. Quality science education should therefore prepare learners holistically for life other than making them pass school tests and examinations. This can be achieved by equipping learners with scientific knowledge, process skills, values and positive learning attitudes.

Developed countries seem to have done well in this regard, nonetheless, developing countries are still striving with regard to provision of quality science education (Willms, 2000). Zambia has not been an exception in striving to provide quality science education. In an effort to do this, in 2013 this country changed the science 5124 curriculum from content to outcome based curriculum. According to the Ministry of Education, Science, Vocational Training and Early Education [MESVTEE], (2013), the curriculum change was not only necessitated by the need to provide an education system that would integrate most modern social, economic, technological and political developments but also equip learners with fundamental scientific knowledge, process skills and values that are essential to contribute to the attainment of vision 2030. Three years later the Examination council of Zambia (ECZ) introduced practicals in science 5124 and this led to the nomenclature of assessment changing from theory papers only to the one incorporating both theory and practical papers. ECZ is a body mandated to oversee the affairs of national examinations such as preparing and marking national examinations at primary, junior and senior secondary school levels in the country.

Since the introduction of science 5124 practical examination, literature has shown that candidates have been displaying weaknesses in questions involving the use of science process skills in chemistry practical activities (ECZ, 2016; 2017). This problem could be attributed to learners' inability to use science process skills in practical tasks (Tobin & Capie, 1982; Valanides, 1996; Omiko, 2013; Nweke, 2015). This raises a great concern as literature has shown that acquisition and use of science process skills (SPS) is crucial both in science learning and the

development of a society (Akani, 2015). However**,** no empirical study has been conducted to investigate how learners use science process skills in chemistry 5124 practical activities particularly in a natural setting other than relying on candidates' examination scripts to make inferences in the Zambian context. Hence, this study which investigated how learners used science process skills to solve chemistry 5124 practical activities in selected secondary schools of Kitwe district.

1.1 Statement of the problem

Previously, ECZ used to administer theoretical examinations in science 5124, but following a curriculum review in 2013, a practical paper was incorporated. ECZ (2016; 2017) annual performance reports have revealed that candidates generally have been facing challenges related to use of science process skills in chemistry 5124 practicals, which lead to poor performance (Tobin & Capie, 1982; Valanides, 1996; Omiko, 2013& Nweke, 2015). However, little is known about how learners use science process skills to solve Chemistry 5124 practical tasks in the natural setting in the Zambian context. This creates a knowledge gap.

1.2 Purpose of the study

The purpose of study was to investigate how learners use science process skills to solve chemistry 5124 practical activities in selected secondary schools in Kitwe district of Zambia.

1.3 Research objectives

The study was guided by the following objectives:

a) To assess how learners use science process skills to solve chemistry 5124 practical activities.
b) To establish whether gender has an effect on the use of science process skills by learners in chemistry 5124 practical activities.

1.4 Research question

The research question was: How do learners use science process skills to solve chemistry 5124 practical activities?

1.5 Research hypothesis

The null hypothesis (H_0) was: There is no significant difference between gender of learners and science process skills used to solve chemistry 5124 practical activities, while the alternative hypothesis (H_1) indicated otherwise.

2. Methodology

Examination annual performance reports from 2016 to 2017 for science 5124 were analyzed to identify the science process skills to be studied. The skills indentified included observing, measuring, classifying, predicting, interpreting, communicating, and inferring. The study took a mixed methods approach and used a descriptive survey design to investigate the issues involved. The study sample consisted of 48 grade twelve learners randomly selected from four secondary schools. Data collection instruments included practical instructions called science process skills assessment instructions, SPSAI and observation schedules (OS). Both instruments were established by the researcher and validated by experts from mathematics and science education department of the University of Zambia. The researcher observed the learners while they carried out practical activities (SPSAI), and used OS to record observations. The level of use of science process skills was based on a 5-point Likert scale of no attempt, unsatisfactory, satisfactory, good and very good. Qualitative data were analyzed thematically while quantitative data were analyzed by descriptive (frequencies) and inferential (t-tests) statistics generated by statistical package for social sciences (SPSS).

3. Presentation of Findings

Findings are presented according to research question and hypothesis.

3.1 How learners use science process skills to solve chemistry practical activities.

The research question was: "How do learners use science process skills to solve chemistry practical activities?", in order to answer this question data was collected by observing learners carrying out SPSAI while the researcher used OS to record observations. Figure 1 shows the findings on performance level indicated by the aforementioned scale.

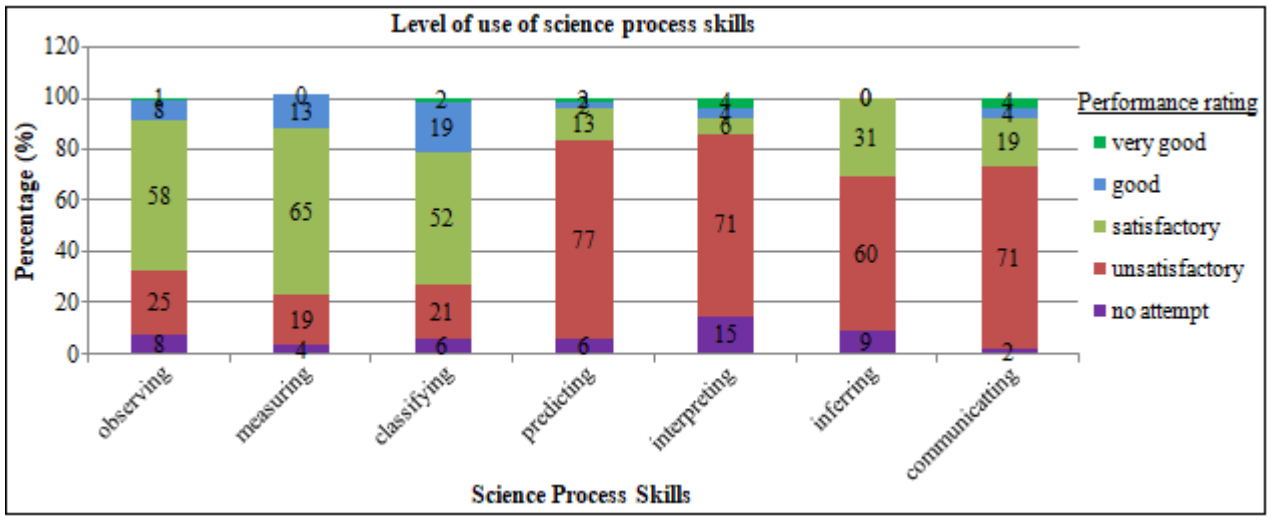

Figure 1: Learner performance level on use of science process skills

The results in figure 9 indicates that learners used observing, measuring and classifying at least at satisfactory level while the level at which they used predicting, interpreting, inferring and communicating was unsatisfactory.

3.2 How learners use science process skills with respect to gender

In order to account for gender disparities against level of use of process skills, a paired sample t-test was conducted and hypothesis tested at 95% confidence interval. The following table 1 indicates results which were generated in SPSS.

Table 1: Paired sample test results for process skills according to gender

Pair		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
	Gender-SPSs	-.01488	.96340	.05256	-.11827	.08850	-.283	335	.777

N=48

Table 1 depicts that there was no significant difference between gender of learners and the SPSs used to solve Chemistry practical activities (t=-0.283, df=335 & p value=0.77>0.05). This means gender had no effect on the use of SPSs by learners to solve chemistry practical activities.

4. Discussion of findings

4.1 How learners use science process skills to solve chemistry practical activities

Findings of the current study indicated that learners used observing, measuring and classifying skills except predicting, interpreting, inferring and communicating at the required level. At first glance percentages for observing, measuring and classifying may seem to depict very good performance but that is not the case when analyzed in detail. A closer look at all the skills, the level of use of science process skills is worrying. This is because such skills are basic and that is where most if not all SPSs depend. Therefore, it was expected of learners to use the said skills at higher levels if they were to succeed in using sophisticated skills such as integrated skills in an effective and efficient manner. According to the scale used in this study, the findings indicated that learners used observing classifying and measuring at satisfactory level, while unsatisfactory levels was observed in predicting, interpreting, inferring and communicating. These findings are on one hand consistent and on the other inconsistent with findings of Akani (2015) who investigated the level of Possession of observing, measuring, communicating, inference and experimenting in college of education final year students in South-Eastern States of Nigeria. His study revealed that there was high level possession of observation, experimentation and measurement skills and low level possession of communication and inference. Despite the difference in terminologies on the scale used in these two studies, findings can be related as they investigated the same phenomenon and same purpose in mind.

For instance, findings of the current study on the level of use on inference and communicating are to a larger extent consistent with findings of Akani (id). The current study established that communicating and inferring skills were at unsatisfactory (low) level while Akani (id) established that it was at low level. Nonetheless, the current study revealed that measuring and observing were at satisfactory (low) level while Akani's (id) study revealed that these skills were at high level of possession. Hence, the findings of the two studies in this regard were not consistent. According to Piagetian theory, the observed discrepancies can be explained by participants' developmental level. Participants in Akani's study were college students while this study considered grade secondary school students. Age differences and particularly education level of participants could have led to the differences noticed. Therefore, it cannot be argued further for literature has shown that possession or use of

science process skills is very much dependent on the cognitive level (age) of an individual (Özgelen, 2012; Brotherton & Preece, 1996). Piaget (1964) contended that there is a positive correlation between children's mental capacity for processing information and their age. There is a close link between cognitive development and science process skills.

However the case, the satisfactory levels of use in science process skills (such as measuring, observing, classifying) by most learners could be considered very low level because good, to very good levels are desired in the science process skills, and so they need to be improved. The unsatisfactory levels in predicting, interpreting, inferring and communicating skills ought to be addressed urgently. There is need to develop and improve the science process skills among learners. Teachers here plays a pivotal role, and so the sought development and improvement in science process skills among learners could be achieved by ensuring that chemistry teachers are well trained in the science process skill as well as in the effective use of science process skills teaching approaches (Mweshi, 2007). Further, the low level and unsatisfactory levels of possession SPS among learners in chemistry 5124 can be traced to none practice of the theory learnt (chemistry knowledge). Therefore, chemistry teachers should be engaging learners in hands-minds on activities regularly. It is only through hands-on-activities that the learners can acquire the science process skills easily (Akani, 2015) and improve them. Furthermore, it becomes vital for teachers who teach chemistry 5124 to pay particular attention to process skills with low and unsatisfactory level such as inferring, interpreting and communicating among other skills in order to develop and enhance them in learners. Performance level of use according to gender is discussed in the succeeding section.

4.2 How learners use science process skills by gender.

The results in this study showed that there was no significant difference with regard to gender of learners and use of science process skills to solve chemistry practical activities. This specifically meant gender had no effect on the use of SPSs by learners in chemistry practical activities. This finding agrees with Aydogdu (2017) who asserted that there was no significant difference between the basic process skills test scores of primary school students and their gender. Some more studies have reported that there is no significant difference between the Science process skills scores of primary school students according to their gender (Hazir & Turkmen, 2008; Senturk, 2012; Rabacal, 2016).

However, Akani (2015) studied college students and discovered that there was significant difference between use of science process skills and gender. Most of similar studies involving secondary school students reveal that there is a significant difference on the use of science process skills favoring female students according to their gender (Aydogdu, 2006; Dokme & Aydinli, 2009; Zeidan & Jayosi, 2015). In some studies it has been found that female primary or elementary school students have higher basic process skills despite these differences being not statistically significant in any of the genders (Ozturk, 2008).

Therefore, it can be seen that gender has an impact on process skills in some studies while it does not in others. According to a recent study, gender does not have an impact on science process skills. There are so many reasons to account for these disparities, one of which is self-regulation. Aydogdu (2017) argued that in some cases female students who have a particular ability in process skills might also have a strong ability in self-regulation hence affecting their ability to use science process skills. This idea can as well be extended to older male students. This is so because the older the person is the more self-regulated they become. This is why significant differences with respect to use of science process skills according to gender are mostly observed in studies involving older participants like secondary school students.

5. Conclusions and Recommendations

The study concluded that learners used observing, measuring and classifying at satisfactory level, but did not use interpreting, inferring, predicting, and communicating at the minimal required level when solving Chemistry 5124 practical activities. The study further concluded that there was no significant difference on the level of use of SPSs according to gender of learners.

In view of the findings, the study recommends that acquisition of science process skills and enhancement of developed process skills among learners should be prioritized and reinforced in chemistry 5124 lessons. A longitudinal study on chemistry 5124 teachers should be done in order to get in-depth understanding of the practical activities they plan and deliver to learners. This would help in understanding the issue from a different dimension thereby enriching our understanding about science process skills in this subject.

6. Acknowledgments

I wish to thank my Supervisor Dr. Kaulu, G and all the lecturers in Mathematics and science education department of the University of Zambia for their unceasing support throughout this work.

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