IOSR Journal of Mathematics (IOSR-JM)
e-ISSN: 2278-5728, p-ISSN: 2319-765X. Volume 13, Issue 4 Ver. I (Jul. – Aug. 2017), PP 06-11
www.iosrjournals.org

Attitude towards Practical Work and Students'Achievement in Biology: A Case of a Private Senior Secondary School in Gaborone, Botswana.

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Abstract: *Despite practical work being accorded a pivotal role in science classrooms, the poor quality of conducting practical work in biology classroom leads students to develop certain undesirable attitude towards practical work. Eventhough there has been lengthy research into students' attitudes to science there is little research specifically into their attitudes to practical work. The purpose of this study was to examine students' attitude toward practical work and the extent to which such attitude influence students' achievement in biology. A sequential explanatory mixed methods design was adopted in this study using the sample of30 Form 5 students in one private senior secondary school. A questionnaire was used to collect quantitative data while qualitative data were collected through non participant observation and interview. Using independent sample t-test and one-way analysis of variance, the study found no significant difference on the three dimensions (importance, interest and difficult) underlying attitudes towards practical work based on students' gender and age group.Furthermore, the multiple regression analysis showed only importance factor accounted for a significant portion of the variability in students' perceived achievement in biology. A follow up thematic analysis revealed most students recognize the importance of practical work but few expressed interest in pursuing career in biology related fields. The study concluded that though practical work is important and enjoyable to students but the experience they gain in the classroom cannot motivate them to want to learn science beyond secondary school.*

Key words*: practical work, perceived achievement, interest factor, importance factor, difficult factor*

Date of Submission: 22-05-2017 Date of acceptance: 17-07-2017

I. Introduction

Over the past decades Western countries have changed their science and mathematics curricula as a way to lay a strong foundation for science and technology. Similarly, some developing countries also changed their science curricula with the thinking that they would improve the quality of science literacy, thus making it relevant. These universal changes prompted Botswana to also change its science and mathematics curricula. These changes were brought about to ensure that Botswana is not left behind in technological developments and that there is no shortage of people with science related careers (Mosothwane, 2013).

In Botswana, practical work is well established in secondary school as part of the curriculum. However, in most secondary schools in Botswana, practical work in science generally involves 'hands on' activities where learners are supposed to follow laid down procedures to arrive at a predetermined outcome. This approach most likely lead to students working on practical activities without much thought of the actions, thus resulting in poor achievement in science at the end of their study. According to Osborne (2003) students' achievement continue to deteriorate in the sciences because of the nature and process of teaching science in secondary schools.In Botswana, practical work has been a cookbook trend in which instructions are conducted as a recipe. According to Kim and Chin (2011) such recipe-based practical work is insufficient to developing students 'habits of mind' principally because students are ask do following stringent guidelines and do not require thinking through doing. Sharp (2012) and Reid (2003) asserted that the manner in which practical work is conducted restricts the science curriculum, often confuse students, restrict students' critical thinking skills, and students mindlessly engaged in practical work just because it is a requirement.

The issue of concern in this study is that the conventional methods of carrying out practical work in most Botswana secondary schools generally focuses on improving students' knowledge in science rather than on developing understanding of scientific investigative procedures. Consequently,during practical activities students do not use scientific ideas to guide their actions and to reflect upon the data collection process (Monica, Nicholas, & David 2015). Hence, this study was conceived to investigate the dynamics of practical work, students' attitude and their achievement in science in the wake of rising poor achievement in science among secondary school students. In this study, attitude towards practical work is defined as the way students' regard

practical work in their biology lessons. Similarly, achievement in biology is defined as students' perceived ability to pursue career in science related areas as the result of their experiences in secondary school.

II. Literature Review

The investigation of students' attitudes towards practical and studying science has been a standing endeavor of the science education research community for the past 30 – 40 years (Osborne, 2003). There are many studies (Hofstein&Lunetta, 2004;Hofstein&Mamlok-Naaman, 2011; Jenkins & Nelson, 2005;&Musasia, Abacha, &Biyoyo, 2012) and Sharpe, 2012) conducted to examine students' attitudes toward practical work in science lessons. These studies among other things found that teachers regard practical-hands onactivities as both an effective and enjoyable way of teaching and learning science in the classroom. Other studies such as Hussain and Akhtar (2013), Kalender and Berberoglu (2009), and Odom, Stoddard and LaNasa (2007) went extra length to investigate the extent to which students' attitudes towards practical work and studying science influence their achievement in science. The literature revealed that there are many approaches to conducting practical science lessons but yet achievement is still low among students. However, there was no vivid demonstration of the influence of students' attitudes and their achievement in science as most of the literature was based on teachers' data. Another area of concern is in regard to research approach and data collection method. The literature showed that most of the research approaches where either qualitative or quantitative methods; the data collection methods were either questionnaire or interview. None of the studies used mixed method and multiple data collection procedures. This study migrated from the point that the extent to which practical work relates to students' attitudes and their achievement in science is not clearly provided in the empirical literature reviewed.

Purpose of the study

The purpose of the study was to examine students' attitude towards practical work and how such attitude affects their perceived achievement in biology. The study sought to achieve the following objectives:

1. To determine the extent to which students differ in their attitudes toward practical work in biology.
2. To examine the extent to which students' attitudes toward practical work influence their perceived achievement in biology.

III. Research Methodology

The study implored the pragmatic paradigm, which sees multiple realities and relies on mixed methods approach. The purpose of mixed methods approach is to elaborate more on results of one methodology and for triangulation of results (Chilisa&Preece, 2005, &Johnson &Turner, 2003).A sequential explanatory mixed methods design**.** The purpose of this two-phase, explanatory mixed methods design was to use a qualitative strand to explain initial quantitative results and also to be able to explain the mechanism or reasons behind the resultant trends (Creswell, Plano, Gutmann, & Hanson, 2003). This design had been used by most quantitative researchers because of its strong quantitative orientation, which enables report presentation to be straightforward thus providing a clear delineation for readers.

The target population was senior secondary school students in Gaborone who had enrolled for academic year 2015. However, the accessible population was form 5 students between the ages of 14 and 18years in private senior secondary school in Gaborone. Gaborone was chosen because it host majority of the private schools in the country. A systematic sampling technique was used to select one school of which the sample of thirty (30) Form 5 students willingly participated in the study.

Instruments

This study used a 30-item Science Attitude Questionnaire (SAQ) adapted from the work of Prokop, Tuncer, and Chudá (2007) to measure students' attitudes toward practical work in science and semi-structure interview along with none participant observation. The questionnaire was administered one day to the completion of the practical lessons by the researcher in order to make sure that no missing data was recorded. Interview was used as a follow up to the questionnaire. The interview was preceded by observation of practical lessons in all the practical sessions. Based on the observation results, seven students were interviewed during the last practical lesson for fifteen minutes each.

In order to ensure reliability and validity, the questionnaire was independently revised by three science teachers and the course lecturer and based on their comments the questionnaire was moderated and subsequently administered. The Cronbach alpha coefficient was .63 for 25 items developed to measure attitude towards practical work in biology.To ensure credibility for the qualitative component of the study, member checking was used. The researcher immediately after each interview asked the respondents to review their responsesso as to make sure that the correct responses were recorded. Interestingly, there was no incident of wrong recording of participants responses reported by the participants.

IV. Results

Objective 1

To determine the extent to which students differ in their attitudes toward practical work in biology.

To achieve this objective, factor analysis was initially performedon the 25 items in order to reduce the items into manageable number of components. Using Varimax with Kaiser Normalization,the rotation solution revealedthree components of students' attitude towards practical work (See Table 1). The cluster loading of items on each of these components indicate a trend of relationship. In view of the pattern in each cluster loadings and in line with previous studies, it was concluded that cluster loading on component 1 describes Importance of practical work; component 2represents Interest in practical work;
andcomponent 3 represents Difficulty of practical work. The result of the factor analysis was followed by the actual analyses of the data based on the research objectives.

Table 1:*Rotated Component Matrixof Factors Underlying Students Attitude towards Practical Work in Biology*

Items	Factors		
	Importance Factor	Interest Factor	Difficulty Factor
Practical work gives me an idea of how the real world functions in terms of discovery	.576		
Practical work shows how it would be like if I were a scientist	.774		
Practical work helps me to see how things work in science	.576		
I learn from practical work in science	.545		
The benefits of practical work in science are greater than the harmful effects	.391		
Practical work helps me develop the spirit of team work	.484		
Practical work increases my concentration than if I am just sitting down listening to teacher	.610		
Doing practical work helps improve my knowledge	.685		
Practical work prepares me adequately for examination	.750		
Practical work in my science lesson is exciting		.669	
I like to be involve in practical work		.580	
Doing practical work is my favorite part of science because		.648	
I always anticipate doing practical work		.647	
I enjoy doing practical work in science lesson		.756	
The way practical work is done makes learning science easier			.558
Practical work is easier than theoretical lesson			.583
Practical work makes complicated concepts easier			.414
It is easy to do well in practical work than in theory			.347

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Hypothesis Testing

The hypothesis stated to provide answers to each research objective was tested at the .05 alpha level.

H_{o1}

There is no significant mean difference between male and female students in their attitudes toward practical work in biology.

The independent t-test carried out in Table 2to test this hypothesis shows no significant mean difference between the gender of participants on the three factors (Importance, Interest, and Difficulty) underlying attitude towards practical work in biology[*t (28) = -1.352, p = .188; t (28) = .411, p =.684, and t (28) = -.240, p =.812* respectively].

Table 2:*Independent Sample t-Test of Gender on Attitude towards Practical Work(df = 28)*

Variable	Gender	X	SD	Mean Diff	Std. Error Diff	t	Sig. (2-tailed)
Importance factor	Male	33.23	3.345	-1.710	1.265	-1.352	.188
	Female	34.94	3.544				
Interest factor	Male	18.62	2.785	.439	1.069	.411	.684
	Female	18.18	2.984				
Difficulty factor	Male	16.62	1.805	-.149	.623	-.240	.812
	Female	16.76	1.602				

H_{o2}

There is no significant mean difference between students' age group in their attitudes toward practical work in biology.

One-way analysis of variance (ANOVA) was carried out to test this hypothesis. The results in Table 3 indicates no significant mean difference between students of different age group on the three factors (Importance, Interest, and Difficulty) underlying attitude towards practical work in biology [*F (2, 27) = .482, p =.62; F (2, 27) = .622, p =.55, and F (2, 27) = .231, p = .795*respectively].

Table 3:*One-way Analysis of Variance of Attitude towards Practical Work as Influenced by Age.*

Variable	Age	n	$\bar{x}$	SD	SE	Source of variance	SS	df	MS	F	Sig.
Importance factor	≥15	4	35.25	3.304	1.652	Between Groups	12.300	2	6.150	0.482	.623
	16 - 17	20	33.75	3.654	.817		344.500	27	12.759		
	18≤	6	35.00	3.406	1.390	Within Groups					
	Total	30	34.20	3.508	.640	Total	356.800	29			
Interest factor	≥15	4	19.25	2.500	1.250	Between Groups	10.433	2	5.217	0.622	.545
	16 - 17	20	17.95	3.170	.709		226.533	27	8.390		
	18≤	6	19.17	1.835	.749	Within Groups					
	Total	30	18.37	2.859	.522	Total	236.967	29			
Difficulty factor	≥15	4	17.00	1.826	.913	Between Groups	1.350	2	.675	0.231	.795
	16 - 17	20	16.55	1.669	.373		78.950	27	2.924		
	18≤	6	17.00	1.789	.730	Within Groups					
	Total	30	16.70	1.664	.304	Total	80.300	29			

Objective 2

To examine the extent to which students' attitudes toward practical work influence their perceived achievement in biology.

To attain this objective, one hypothesis was posited and tested:

H_{o3}

Students' attitude toward practical work does not significant predict their perceived achievement in biology.

Multiple regression analysis was performed with perceived achievement in biology as dependent variable and the three factors (importance, interest, and difficult) underlying attitudes towards practical work as independent variables. Table 4 shows a significant fit of the model, F (3, 26) = 3.521, p = .029, with an R^2 of .289. The result also show only importance factor made a significant contribution to the variability in students perceived achievement in biology, t (29) = 3.221, r = .57, p = .003; but interest and difficult factors did not make significant contribution, t (29) = -1.084, r = -.238, p = .288 and t (29) = -.342, r = -.118, p = .735 respectively. This means that only importance factor (IM) can significantly predict students' achievement in biology, which accounts for 58.3% of the variability. However, interest factor (IN) accounts for 19.8% follow by difficult factor (DI) which accounts for 5.7% of the total variability in students' perceived achievement in biology (PAB). Hence, the regression model can be defined by the equation:

$PAB_i = 12.28 + .57\ IM_i - .24IN_i - .12DI_i$ (1)

Table 4:*Multiple Regression analysis of the Influence of Attitude towards Practical Work on Their Perceived Achievement in Biology*

R	R Square	Adjusted R Square	Std. Error of the Estimate
.538[a]	.289	.207	3.055

Source of Variation	Sum of Squares	df	Mean Square	F	Sig.
Regression	98.630	3	32.877	3.521	.029[b]
Residual	242.737	26	9.336		
Total	341.367	29			

Independent Variables	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	12.283	7.817		1.571	.128
Importance factor	.570	.177	.583	3.221	.003
Interest factor	-.238	.220	-.198	-1.084	.288
Difficulty factor	-.118	.345	-.057	-.342	.735

Note: Dependent Variable: Perceived Achievement in biology

Predictors: (Constant), Importance factor, Interest factor , Difficulty factor,

V. Observation

During the practical lessons, the researcher served as non-participant observer. There were four practical lessons conducted over the period of one month. Each of these practical lessons followed the same format: pre laboratory (demonstration), group work (laboratory), and post laboratory (post discussion). During the pre-laboratory phase, the teacher along with the laboratory technician set up the laboratory with all materials and chemical measured according to group prior to students' arrival in the laboratory. The teacher introduced the topic and the title of the experiments and then invited the students to the front to watch the demonstration. The teacher explained the procedures,gave reasons and provided precautionary tips to students. Upon completion of the demonstration, a brief discussion involving questions and answers was carried out. It was observed that only very few students asked and answered questions during this phase of the practical lesson. Students were then divided into ten groups of three students and each group was assigned to a workstation and handedthe guideline and work sheets for the practical lesson. The second phase of the practical lesson was to allow students work in their respective groups for 45-minutes. Having given students the practical procedure, the teacher went around the laboratory to monitor students work and giving assistance where necessary. It was observed that while other students were actually involved in the practical others were just watching and distracting their friends. However, at the end of their experiment, each group completed the work sheets and exchanged them with the opposite group. The final phase of the practical lesson was the post laboratory discussion. During the discussion, the teacher led the class to mark each group work. Most of the time, the teacher asked the class a question on the work sheet and allow the class to respond. Group whose answer to the work sheet correspond to the correct answer were given mark according to the allocation. This was carried out until all the questions on the worksheets were completed and given to the teacher for recording purpose. This session marked the end of every practical lesson in the study. However, as a routine student were asked to clean and clear their workstation before leaving the laboratory.

VI. Interview

On another note, the interview conducted on the first objective showed that all of the students (100%) recognized practical work as an important component in their learning of science. Majority (86%) of them believe that practical work in science increase their understanding and develop the spirit of team work but only one person indicated that practical work experience helped them to avoid harm at home. This means students see practical work as an important aspect of their learning of science. More than half of the respondents (86%) have interest in doing practical work; this means that they enjoy it and know that practical work reinforces their understanding of science lessons and give them a concise mind of how things actually work in the world. Similarly, a follow up interview on the second objective reveal that three males (43%) said they would choose a career in biology while all the females and one male (67%) did not express their interest in choosing a career in Biology.This means that most students do not develop a long term attitude that could lead to pursuing science related careers beyond secondary school.

VII. Discussions

The first objective was achieved as the study found no significant difference on the three dimensions (importance, interest and difficult) underlying attitudes towards practical work based on students' gender and age group. This was in line with the qualitative result which showed no difference in students' responses between male and female and their age group. In regard to the second objective, the quantitative result showed that only importance factor accounted for a significant portion of the variability in students' perceived achievement in biology. This was confirmed by the qualitative result, which found that though students recognize the importance of practical work very few expressed interest in pursuing career in biology related fields. These concord with those of Kalender and Berberoglu (2009), Hofstein and Mamlok-Naaman (2011), Musasia et al. (2012), and Sharpe (2012) that students' attitudes toward practical work is positive but the experience cannot influence their achievement in biology. However, the finding is contrary to those of Hussian and Akhtar (2013) and Odom et al. (2007) who found that using practical hands on activities can improve student's achievement in science and the daily use of practical activities yield the greatest positive impact on students' achievement in science. One explanation for this may be due to the fact that the manner in which these practical works were carried on in this study did not involve pure hands on activities. Secondly, the study was conducted in one school with a very small sample which could not allow the researcher to observe more practical lessons and involve more students. The findings of this study should be interpreted with caution.

VIII. Conclusion

Giving the objectives of the study, the specific conclusions are:

1. Practical work is considered an essential part of science education in secondary school, but this study has demonstrated its relevance is under a serious threat. The study found that students display similar attitude towards practical work as they consider practical work as important part of learning biology, as an interesting activity during biology lesson, and an easy part of learning biology. Hence, it can be concluded that students' attitude towards practical do not differ in any way according to gender and age of students.
2. The study found that students' attitude about the importance of practical work significantly influence their achievement in biology while their attitude concerning interest and difficulty of practical work do not significantly influence their achievement in biology. It can be concluded that even though students demonstrate some level of positive attitude towards practical work in biology in terms of its importance, the experience students gain from doing practical work in the biology lessons do not motivate them to want to pursue career in biology beyond secondary school. A possible explanation could be the manner in which practical work is carried out in secondary school negatively influences their achievement in the subject. In other words, students' general attitude towards practical work is positive but cannot influence their achievement in biology.

Educational implications and recommendations

The following educational implications and recommendations are made:

1. School Administrators: Schools should take the lead to emphasize the essential role of practical work in learning biology. This will require schools to procure and provide laboratory resources to enhance teaching and learning in biology lessons.
2. Teachers: Teachers should providestudents the opportunity to engage in frequent practical worksrelevant to the condition and topics. This will make students to develop positive attitudes toward practical work and enhance their achievement in biology and in science general even beyond secondary school.
3. Students: Students who wish to pursue career in science should develop positive realistic attitude in order to improve their long term achievement. In this case, students need to take their practical lessons serious and carry out extra practical work in biology.

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Hinneh, J. T. "Attitude towards Practical Work and Students' Achievement in Biology: A Case of a Private Senior Secondary School in Gaborone, Botswana." IOSR Journal of Mathematics (IOSR-JM) 13.4 (2017): 06-11.