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The Role of Practical Approach on Students' Engagement in Biology: A Case of Lower Secondary Schools in Rulindo District, Rwanda

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Abstract*:* This study explored the tole of practical biology activities on student engagement in lower secondary school in Rulindo District. A sample of 84 students from 3 schools and 3 biology teachers was purposively selected from three lower secondary schools. Data was analyzed through descriptive statistics. The study established that biology practical lessons enhanced active interaction and immense support from teachers. Student engagement was higher and their performance was much better in practical than in non-practical options. Therefore, practical classes yielded better learning outcomes than the non-practical classes. Based on the findings, the study recommended that in order to stimulate students' interests and better learning outcomes, teachers should use practical activities while teaching biology lessons. Students should be encouraged to develop interest in and to be familiar with practical activities. Much attention should be given to practical work in biology and all required resources for the implementation of practical activities should be made available. Finally, practical activities should be effectively planned and clearly structured for better learning outcomes to be realized.

Keywords: Practical work; student engagement; multidimensional construct; behavioral engagement

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Introduction

Scientific progress is imperatively needed by every country to ensure its social, economic and technological development in the competitive world today. The development of science over the years exerted influences and dominated every aspect of human endeavor in such a way that individuals devoid of science literacy find it very difficult to survive in the contemporary society (Chinyere, Bebia, David, Amba and Hope 2014). Biology as one of the subjects in science education is a prerequisite subject for several fields of learning. It contributes tremendously to the technological growth of nations. These fields include medicine, agriculture, bio-informatics, biotechnology and nursing. The study of Biology also contributes to the search of scientific solutions of several challenges the world is facing today including diseases, drug resistance, pollution, climate change, global warming etc.

The concepts, topics and processes in Biology are considered to be difficult for secondary school students and this affects their engagement in learning and academic achievement (Çimer, 2012). The author further revealed that one of the reasons behind the difficulties faced by students in Biology is the lack of inclusion of practical activities and experiments in biology lessons. Researchers including Millar and Abrahams (2009), Ude and Ebuoh (2019) argued that when students are taught science (Biology) using practical activities and experiments, their level of understanding is improved. Although a handful studies about the role of practical activities in biology teaching on student performance and achievement were conducted worldwide, the topic about practical activities in Biology on student engagement is still an open question. Thus, there is a need to explore about the student engagement because it is a very important construct in the teaching and learning process. It is asserted that students who are engaged, exert more effort in implementation of learning tasks (Chapman and Elaine, 2003) and it is very difficult for an education system which doesn't value student engagement to reach positive outcomes (Gunuc & Kuzu, 2016). The authors insisted that student engagement is necessary for learning, performance and academic achievement.

The relationship between student engagement and students performance was studied by various scholars such as GUNUC (2014) who revealed a positive relationship between student engagement and student performance. Lee, Song and Hong(2019) demonstrated that student engagement is an antecedent of students performance. According to Nizeyimana and Osman (2014), literature closely associates the students engagement with students' performance. The author argued that the more students are engaged in learning, the better they perform.

Few attempts on student engagement recorded in Rwanda put more focus on student engagement in subjects taught in institutions of higher learning. For example, while Nizeyimana and Osman(2014) examined the student engagement in teacher education, Bahati, Fors and Tedre (2017) investigated on student engagement as a predictor of students' performance in online assessment in the institution of higher learning, University of Rwanda College of Education. None of these studies focused on the influence of practical work on secondary school students' engagement more specifically in biology lessons. Therefore, there is scarce information about student engagement in secondary school especially in Biology subject.

One common thing observed in various biology classes was that whenever teachers used practical activities in biology lessons, students became more engaged and more motivated and this yielded good results. After that realization, it was necessary to investigate on the effect of Biology practical activities on student engagement. This study was guided by the following research questions:

1. What is the rate of students' engagement in learning in biology practical and non-practical lessons as reflected by teachers' and students' activities?
2. What is the rate of student engagement in Biology non-practical and practical lessons from COPUS aspect?
3. What is the rate of student engagement in Biology non-practical and practical lessons in terms of self-reporting?
4. What is the rate of student engagement in Biology non-practical and practical lessons in terms of teachers' checklist?

Literature Review

Concept and measurement of student engagement

The concept of student engagement is very crucial in education context especially in the teaching and learning process. Over years, student engagement has attracted an increasing amount of attention of various authors. Barkley (2010) asserts that engaged students care about what they are learning and have a passion and excitement. Nizeyimana and Osman (2014) indicated that student engagement in teacher education refers to students' psychological investment and participation in learning. Dunne (2013) as cited in Bahati, Fors and Tedre (2017, p.73) pointed out that engaged student is synonymous with successful student. Although, it is noticed that to achieve better results, students need to be more engaged as put forth by different authors, authors failed to explain clearly how various factors related to teaching and learning process affect student engagement. Thus, this

study explored how Biology practical work affects students' engagement.

Newmann (1992) defined student engagement as behavioral engagement (level of efforts that is dedicated to learning) and as emotional engagement (interests); his argument considered student engagement as a dimensional construct. For him, engaged student is known by observing how he/she is emotionally and behaviorally involved in learning. Klem and Connel (2004) as cited in Christenson, Wylie and Reschly (2012) argued that engaged students perform academically, put forth efforts, persist and self-regulate their behavior toward the goals. In their research, Christenson, Wylie and Reschly further (2012) showed that participation, homework completion, time on tasks and class grades are the predictors of student engagement. According to Lee et al. (2019), student engagement was identified as an antecedent of academic achievement. In the same vein, student engagement appeared to be one of the good predictors of learning and personal development (Carini, Kuh & Klein, 2006).

Surveys in the USA and in various countries including China, South Africa, New Zealand, Australia and Canada revealed that student engagement improves learning outcomes (Trowler, 2010). Furthermore, there is a correlation between students' time investment, efforts and interests in a range of various learning activities and the increased academic performance.

Researchers and educators are putting more efforts on student engagement in order to address the problems of low academic achievement, boredom and dropout rates. Fredricks and Mccolskey (2018),Kim and Diong (2012) affirmed that assessing student engagement is crucial since the extent and quality of student engagement serve as a strong predictor of students' learning, achievement and academic progress (Veiga, 2014). Many researchers including Fredricks and Mccolskey (2018), Chapman and Elaine (2003) explained the methods of student engagement which include:

Self-reports: Students are provided items reflecting various aspects of engagement and they choose the response that best describes them.

Teachers 'checklists: Teachers assign scores to students basing on how students are involved in learning.

Interviews: Preset questions are used and students are asked to tell their stories regarding how they are learning.

Observations: The observation involves the direct observation of behaviors of students.

Concepts of Biology and Practical Teaching

Biology is a science subject whose teaching practice and approach are more targeted in this study with an intention to establish whether the use of practical work can engage students in learning activities in a way that the performance of students is improves. The study of Biology provides insights on the structure and constructions of organisms and helps learners to fully understand the variety of living organisms (Dan-Ologe and Shittu, 2012). Biology improves our understanding on diseases and their causes, prevention and treatment of diseases. In several education systems, Biology allows the acquisition of a body of facts, concepts and procedural conceptual knowledge and skills that help students to understand contemporary issues (Ezra and Agah, 2019).

Besides, Biology is incorporated in various curricula of different education system and it equips students with scientific skills which prepare them to deal with scientific trends, technological advancement and today's biological imperatives through various biology career pathways. Like in other education system, in Rwanda Education system, Biology is a science that is compulsory in lower secondary schools and is taught four hours per week (REB, 2015). In upper secondary schools, biology is a core subject in the following combinations: biology-chemistry-geography (BCG), physics-chemistry biology (PCB) and mathematics-chemistry-biology (MCB). These are taught seven hours per week.

There are many methods used in the teaching and learning process. Some of these methods, like the learner centered approach put learners at the center of the learning process. Learner-centered methods include laboratory-based teaching methods, commonly recognized as practical (Ngala, 2019). The author further noted that the use of laboratory-based method implies conducting students' experimentation, fieldwork

and activity project. The method is applicable in Biology as it uses the theoretical and practical aspects to enhance learning.

Based on above studies, one can say that while a lot of methods are used in teaching practical biology, those which engage the students in learning are more preferable. Furthermore, there is also a need of triangulating methods with a focus on those which are practical-based, due to their complex role to demonstrate the biological concepts and processes. The competence based approach adopted by Rwanda education system in teaching biology involves the learner centered methods whereby the students are fully engaged in their learning. The methods used encompass seminars, tutorials, workshops, case analysis, problem based learning, practical work and many others (REB, 2015).

The Role of Practical Activities in Biology

The teaching and learning of Biology among other science subjects enables students to understand biology concept, facts and processes in a better way; therefore the use of practical activities in biology lessons seems to be one of the appropriate strategic ways to reach the goal. The authors such as Ghartey Ampiah , Tufuor and Gadzekpo (2006) contended that practical activities help students to understand clearly theoretical aspects of Biology. Dan Ologe and Shittu (2012), Burke, Auburn, Hunter and Young (2012) concurred that practical activities enable students to gain the hands-on experiences and provides students the opportunity to be engaged in learning process.

The effective learning of science [biology] is practical-oriented which requires teaching using practical activities(Ufonabasi, Rebecca and Nsimeneabasi, 2017). Shana and Abulibdeh (2020) affirmed that Biology is a challenging subject that needs many practical applications and experiments and there is a correlation between practical work and students 'academic achievement. The practical activities in Biology provide incentives for students in the process of learning (Fadzil and Saat, 2020). Daba, Tolessa and Anbesaw (2016) found that teaching science devoid of practical activities affects students 'interests toward science disciplines and this leads to lack of student engagement and less enrollments in science. Holstermann, Grube and Bögeholz (2010), Brickner and Etter (2008) as cited in (McCarthy, 2016). Teresa Sena-Esteves et al.(2018) argued that practical work stimulate students 'interests and participation in biology lesson. Samuel et al. (2019) affirmed that practical activities stimulate motivation. The substantial role of practical activities was also noted by Motlhabane and Dichaba (2013) who showed that practical work in science plays a great role in learning since students learn better by doing.

Challenges Encountered by Teachers

Research conducted by Mwangu and Sibanda (2017)showed that various challenges are encountered while teaching Biology practical lessons including lack of resources and facilities, overcrowded classes and limited time allocated to the practical biological lessons as well as the teachers who are not armed with practical skills. Daba, Tolessa and Anbesaw (2016) indicated that the absence of laboratory equipment and unsuitable laboratory rooms remain the challenges which hamper biology teaching.

A study conducted in Ethiopia by Daba, Tolessa and Anbesaw (2016) indicated that practical activity stimulates students to understand science. Lebata and Mudau(2014) in the study conducted in Lesotho indicated that the great concern in the way Biology is taught is that teachers do not engage the learners in laboratory activities. A research carried out by Ndihokubwayo (2017) on barriers to science laboratory activities in teacher training centers in Rwanda revealed that most of schools do not have laboratories and teachers lack skills to conduct the experiments in the labs. Similarly, Nsengimana (2020), Ndayambaje, Bikorimana and Nsanganwimana (2021) revealed the lack of resources and facilities. Therefore, there is a need to be aware of challenges that are encountered while teaching Biology.

Methodology

Research Design

This study was guided by a descriptive research design through the quantitative methods. The researchers investigated deeply on the role of Biology practical activities on student engagement.

Population and Sampling

The present study involved 3 lower secondary schools in Rulindo District purposively selected from 74 secondary schools. Out of a population of 520 biology students in these 3 schools, 3

Classrooms observed were selected through a purposive sampling procedure targeting the practical content load as per biology syllabus. A classroom of 32 students from the first school, a classroom of 31 students from the second school and a classroom of 21 students from the third school making a total sample of 84 biology students were used for the study. Three biology teachers from these schools were involved in the study during class observation.

Instruments and Procedures

Data collection was conducted basing on classroom observation which involved closely monitoring the way students learned and the way they got engaged in classroom activities. Classroom Observation Protocol for Undergraduate STEM (COPUS) developed by Smith et al in 2013 was used and triangulated with teachers' checklists and students self-report that mainly focus on the student engagement. COPUS tool wad made of 25 codes falling into two categories: What students did and what teachers did. The tool also included the part "student engagement" coded with H (high), M (Medium) and L (low). Its use required an observer to write down the codes related to the activities of teachers and of learners.

For teacher, the instructional activities were noted as follows: presenting, guiding, administration and others whereas for a student, the activities mainly encompassed receiving, talking to class, working and others. The researchers observed three biology non-practical lessons in three weeks in each selected school. These lessons were attended by 84 sampled students in all three schools. There were also three biology practical lessons which were attended by the same 84 sampled students in three weeks after the two days training on the use of practical based method in biology lessons. This made a total of 18 biology lessons observed. For Teacher's checklists, each student was rated by a teacher and for students 'self-reports, each student rated himself on his/her engagement by using a four Likert scale rating (strongly disagree (1), disagree(2),neutral (3) and agree (4) in each statement regarding student engagement.

Statistical Treatment of Data

The data from COPUS were collected and processed using the Microsoft excel and SPSS (Statistical Package for Social Sciences). Data from students' self-reports were analyzed using 25 statements categorized in three dimensions of student engagement: 12 statements of behavioral aspect, 5 for cognitive aspect and 8 for emotional engagement. Data from teachers' checklists were analyzed using 10 statements categorized in two dimensions: 6 for behavioral aspect and 4 for cognitive aspect. The mean scores of each statement were computed.

Validity and Reliability

The observation tools were adopted from the tools developed by Connel and Wellborn (1991) cited in Fredricks and Mccolskey (2011) and in Fredricks and Mccolskey (2018)(students self-reports and teachers' checklists) and were validated by two experts from the University of Rwanda, College of Education. For COPUS, the investigators took the required training and watched related COPUS videos to understand the use of codes that describe the activities of teachers and learners. For the reliability of instruments, the researcher computed Cohen's Kappa coefficient of inter-observer agreement using SPSS which yielded the coefficient of .79 and .90 of Kappa across two observer pairs before collecting data.

Ethical Considerations

The respondents were informed about the purpose, the procedures and all requirements of the Research (e.g., completion of a questionnaire) and they decided on their participation in the research voluntarily. The researchers collected data after having got the permission from the district authorities. In addition, the researchers abode by the rules and guidelines of the University of Rwanda, College of Education regarding ethical considerations and issues.

Findings and Discussion

This section presents the results of the study and was guided by four research questions as follows:

Research Question 1: What is the rate of students' engagement in learning in biology practical and non-practical lessons as reflected by teachers' and students' activities?

Six classroom observations per Biology teacher per school were conducted and COPUS data were analyzed using the percentage of activities (relative abundance).

Table 1 indicates that during the delivery of Biology non-practical lessons, the teacher's activities were dominated by presentation based activities, which were mostly performed at 59, 9/%, followed by guiding activities occurring at 30.7 %. A relative long amount of time was spent by teacher listening to students' responses and observing what activities students were engaged in. These activities constituted 9.4%. During Biology practical lessons, the teachers' activities were highly dominated by facilitation and guiding activities namely moving in class and providing support to students. Teachers asked a variety of questions with an intention to clarify some concepts and experimental processes and answering questions as well. Activities related to guiding were performed at 56.8%. Teachers also performed presentation based activities at 32.6%. The other activities like waiting for students doing the activities scored 9.5% whereas the activities related to administration were relatively less scoring 1.1%. Therefore, biology practical lessons enhance active interaction and immense support of teachers to students through providing guidance, asking questions and providing answers, thus students become more engaged in their learning than in non-practical lessons. Basing on this observation, the practical work in biology teaching was more effective than the non-practical activities to enhance student engagement. The results concurred with the previous findings of Koirala (2019), Ezra and Agah (2019) who revealed that the use of practical activities in science teaching appeared more effective at secondary schools.

Table 1: Teachers' activities during Biology non-practical lessons and Biology practical lessons

Instructional activities	Biology non-practical lessons (%)	Biology practical lessons (%)
Presenting	59.9	32.6
Guiding	30.7	56.8
Administration	0.0	1.1
Others	9.4	9.5

Table 2: Students' activities during Biology non-practical lessons and Biology practical lessons

Instructional activities	Biology non-practical lessons (%)	Biology practical lessons (%)
Receiving	55.9	17.2
Talking to class	30.2	21.5
Working	13.9	57.7
others	0.0	3.8

In Biology non-practical lessons, students' activities were predominantly for receiving (listening), 55.9%. The activities related to talking activities such as answering questions, posing questions and presentation represented 30.2% whereas the instructional activities related to working in class such as working in groups, clicker discussion and individual thinking represented 13.9%. The findings from practical lessons indicate that students were actively working where they were involved in group activities, Individual thinking and were engaged in discussions related to practical activities.

In practical lessons, the activities related to working as depicted in table 2 represents 57.5%. The activities related to talking to class such as answering teachers' questions, asking questions and presentation represented 21.5%. The remaining activities grouped in the others represented 3.8%. It is therefore concluded that the students became more engaged in learning during biology practical lessons than in non-practical lessons. These results are in agreement with that of Umar (2011) who affirmed that the use of practical work enables the acquisition of science process knowledge and skills in Biology and it affects positively students' performance. Similarly, Dagnew and Sitotaw (2019) and Ude and Ebuoh (2019) established that practical work enhances students 'interests in biology learning.

Research Question 2: What is the rate of student engagement in Biology non-practical and practical lessons from COPUS aspect?

The developers of COPUS provided guidance on measuring student engagement. When a small

fraction of students ranging from 0-20% is engaged, the student engagement is very low, between 21 and 79 is medium and higher than 79% means the engagement is high. The student engagement was observed at every 2 minutes and the codes were noted as seen in table 3.

Table 3: Status of student engagement in Biology non-practical lessons and practical lessons

Fraction of students engaged	Biology non-practical lessons (%)	Biology practical lessons (%)
High	49.2	86.4
Medium	49.7	13.6
Low	1.1	0

Table 4: Mean scores for students' self-report in non-practical and practical lessons

S/N	Statement	Non-Practical	Practical
1	I pay attention in biology class	3.7381	3.9643
2	I participate in biology class discussions	3.3810	3.7262
3	I listen attentively in classroom	3.3929	3.7857
4	I ensure to study on a regular basis	3.6190	3.8452
5	I talk to my teacher about my progress in the class	3.2619	3.6071
6	I try to take notes on key points in classroom	3.5595	3.9286
7	I try very hard in classroom	3.5714	3.8095
8	I work hard when we start something new in class	3.4762	3.8571
9	I review my assignments before turning them in	3.2738	3.8929
10	I make a summary of material learnt in class	3.1548	3.8333
11	I discuss course content, ideas and facts with teacher outside of classroom	3.0595	3.5714
12	I asked questions and discussed on course in other ways	3.3810	3.9048
13	I feel good when I am in classroom	3.1429	3.8929
14	I am very interested in learning Biology	3.1190	3.9286
15	I find ways to make this course interesting for myself	3.0595	3.9286
19	When we work on something in classroom, I feel interested	3.5000	3.8690
17	I feel curious about what we are studying , When I am in classroom,	3.1786	3.9405
18	I keep working on a problem even if, it is really hard	3.3929	3.6786
19	When I am doing work, I try to relate what I am learning to what I know	3.3810	3.9048
20	I develop my own examples to help myself understand the concepts	3.2381	3.8690
21	Before I begin to study, I think about what I want to get done	3.2738	3.7619
22	If what I am working on is difficult, I change the way I learn the materials	3.2381	3.6429
23	I often review my class note	3.4286	3.9048
24	I try to connect different topics from course material while studying	3.2857	3.7857
25	I combine ideas from various course content to complete assignments	3.5238	3.9762
	Overall mean score	**3.3452**	**3.8324**

As far as table 3 is concerned, in the non-practical lessons, 49.2 scored high, 49.7 scored medium and 1.1 scored low. On the contrary, in the practical option86.4 scored high, 13.6 scored medium and 0% scored low. The results indicate that in the practical lesson, majority of students (86.4%) scored high as compared to 49.2 in the non-practical option who scored high. About a half (49.7%) of students scored medium while those who scored medium at the practical option was only 13.6%. 1.1% of students scored low at the mon practical while none of the students in the practical scored low. This suggests that the performance of students was much better in the practical than in the non-practical option of learning. The results agree with that of Teresa Sena-Esteves, et al.(2018) who argued that practical work stimulates students 'interests and participation in biology lesson and Samuel et al. (2019) who found that the use of practical work stimulates students motivation in biology practical lessons.

Research Question 3: What is the rate of student engagement in Biology non-practical and practical lessons in terms of self-reporting?

The self-reporting aspect was evaluated as described in table 4 whereby the first column records serial numbers, the second self-reporting statements, the third non-practical scores and the

forth practical scores of students. The table indicates that the overall mean score for non-practical was 3.3452 while that of practical was 3.8324 which means that students generally performed better during the practical session as compared to the non-practical session. Furthermore, the comparison by specific statements in the table indicates that in all cases (behavioral aspect, cognitive aspect and emotional engagement), the mean scores for the practical session were greater than those in the non-practical option. Therefore, it is inferred that the practical session yielded better learning achievement than the non-practical session. This is in harmony with Brickner and Etter (2008) as cited in (McCarthy, 2016) who argued that when students are involved in experimental works, the approach promotes greater interest in learning.

Research Question 4: What is the rate of student engagement in Biology non-practical and practical lessons in terms of teachers' checklist?

Students' engagement through teachers' checklist was evaluated as described in table 5 whereby the first column records serial numbers, the second student engagement items, the third non-practical scores and the forth practical scores of students. The table indicates that the overall mean score for non-practical was 2.7508 while that of practical was 2.8634 which suggest that as far as teachers' checklist is concerned, students generally performed better during the practical session as compared to the non-practical session.

Furthermore, the comparison by specific statements in the table indicates that in all cases, the mean scores for the practical session were greater than those in the non-practical option. Therefore, it is inferred that the practical session yielded better learning achievement than the non-practical session in all aspects of the teachers' checklist This results are supported by previous study finding by Sampson et al. (2018), Ude and Ebuoh (2019) and Shana and Abulibdeh(2020) who established that practical learning approach in Biology teaching yields higher achievement than non-practical approach. These authors argued that practical works stimulate students' interests and students enjoy and appreciate learning by doing which is only possible through the practical approach. Furthermore, practical activities such as manipulation, experimentation and demonstrations of facts and concepts associated with active participation and questions-answers stimulated students' attention and interests.

Table 5: Mean scores of student engagement through teachers 'checklists

S/N	*Statement*	*Non-Practical*	*Practical*
1	In my classroom, student pays attention	3.0873	3.2143
2	This student participates actively in discussions	2.9881	3.1190
3	This student works well with others	2.9762	3.1111
4	This student approaches new assignments with sincere efforts	2.8690	3.0079
5	This student asks questions to get more clarification	2.9087	3.0357
6	In my class, this student comes unprepared	2.3333	2.3690
7	This student attempts to do his/her work and tries to complete it thoroughly	3.0040	3.0992
8	This student tries to finish assignments even if they are difficult	2.8294	2.9444
9	This student is persistent when challenged with difficult problems	2.7381	2.8571
10	In my biology class, this student does more than required	1.7738	1.8770
	Overall mean	2.7508	2.8634

The results also agree with that of Samuel et al. (2019) who found that the use of practical work in Biology lessons stimulated students motivation. Similarly, Holstermann, Grube and Bögeholz (2010) established that students who carried out experiments in some biology lessons (e.g. detection of products of photosynthesis , and osmosis) were more engaged compared to students who did not conduct experiments.

Conclusions and Recommendations

Conclusion

Based on the findings of this study, the study concludes that biology practical lessons enhanced active interaction and immense support from teachers. Student engagement was higher and their performance was much better in practical than in non-practical options. Practical sessions yielded better learning achievement than the non-

practical sessions as far as student self-reporting is concerned. In terms of teacher's checklists, students generally performed better during biology practical sessions compared to the non-practical sessions. Therefore, practical classes yielded better learning outcomes than the non-practical classes.

Recommendations

It is recommended that teachers should use practical activities while teaching biology lessons in order to stimulate students' interests and better learning outcomes. Students should be encouraged to develop interest in and to be familiar with practical activities as such enable them to effectively understand biology concepts much better. Much attention should be given to practical work in biology and all required resources for the implementation of practical activities should be made available to make the practical approach implemented successfully. Finally, practical activities should be effectively planned and clearly structured for better learning outcomes to be realized.

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