

## Investigating the status and barriers of science laboratory activities in Rwandan teacher training colleges towards improvisation practice

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### **Abstract**

*This study aims at investigating the barriers encountered by science teachers in laboratory activities in Rwandan teacher training colleges (TTCs) using questionnaires and interviews. The results confirmed that teachers face barriers like time limitation, material scarcity and lack of improvising skills in their everyday science teaching life. About 95% of teachers who teach in schools with laboratories and only 5% of their peers at schools without laboratory show enough awareness on science laboratory activities. However, in terms of the importance of laboratory experiment and improvisation approach, students had the similar responses in all the investigated schools.*

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**Keywords:** Barriers, TTCs, laboratory activities

### **Introduction**

Most science teachers perceive that laboratory activities are essential in teaching science as it stimulates students' interest as well as developing their scientific skills (Dillon, 2008). Rwandan teachers dominate the activities in the classrooms, and the source of content is mainly from lecturing (Nzeyimana, 2014).

Science should be different subject like history or literature that their contents can be adequately taught by the lecture method. Active learning improves learners' understanding and remembering of information and helps them to develop problem-solving and critical thinking skills (Kigali Institute of Education, 2011). Laboratory activities make students active in science learning and help students to establish the accuracy of their beliefs. In addition, laboratory activities involve students directly in experiment related to a given (Angus & Keith, 1992).

Improvisation, as defined by Nkechi and DomNwachukwu (2006) is the use of alternative materials and resources to facilitate instruction when there is a lack or shortage of some specific immediate teaching aids. This aims at helping teachers to learn designing and constructing materials/resources that would enhance their functions in the absence of the regular materials. However, teachers still undermine these improvised resources. There is evidence for instance from Zimbabwe that teachers felt that science kits promoted a diluted image of science. In Papua New Guinea, moreover primary teachers are taught to improvise at college but they still expect to find the conventional science apparatus (Angus & Keith, 1992).

According to Cossa and Uamusse (2015), laboratory equipment and learning materials are in short supply due to the lack of funds. For instance, science equipment in Rwanda is scarce at a level of 17% (242 out of 1502 secondary schools) schools having science laboratories (MINEDUC, 2014). However hands-on activities are the best strategy for effective science teaching and learning (Sandifer & Haines, 2009).

Based on other deficiency, for many developing countries for example in Mozambique laboratory hands-on failed because of poor practical skills of the science teachers due to lack of time to plan experimental works, to the examination system focusing on theory and less emphasis on science activities (Allsop, 1991). Nevertheless, it is known that due to policy of education for all, the primary school in Rwanda is oversized and this implies disproportional of students and teaching aid ratio. Therefore, this challenge can be tackled by

focusing on primary teacher's pre-service education in terms of trainability and responsibility according to improvised laboratory resources.

science is an experimental discipline, laboratory becomes an essential part in enhancing students' scientific skills (Hofstein & Mamlok-Naaman, 2007; Score, 2008; Oscarsson et al., 2009; Flinn scientific, 2011; Suleiman, 2013). However, in Rwanda, there are few research about status of laboratory activities and the way of overcome the obstacles encountered in this area. Therefore, the present study will reveal out barriers encountered by teachers in laboratory activities from situational analysis to improvised practices as a substitute. Thus, both teachers and students will be encouraged to make and use of local available instructional materials.

## **Methodology**

Teachers and students are often surveyed as to the overall amount or frequency of hands-on work activities they have done in class (Ruby, 2001). In this study, questionnaires and interviews were used to collect data. Observation was indirectly used to support questionnaires and interviews' data collection. Students, teachers, principals and/or deputies of studies from 13 TTCs served as the population of this study. The TTCs were chosen as sample among other schools for simple reason that their graduates will serve as future primary school teachers.

In this research, data were described in qualitative way. Qualitative research methods include describing in details specific situation using research tools like questionnaires, interviews, and observations. It focuses on the gathering of mainly verbal data rather than measurements.

About nineteen science teachers selected randomly among teachers who teach either Physics, Chemistry, Biology or Integrated science participated in filling the first questionnaire asking about science experiments performance, available materials and difficulties in doing conventional experiments as well as creating improvised materials.

The second questionnaire asked 196 students about the hands-on situation in their school life; if they perform experiments or not, availability of materials in their laboratories as well as teachers' practices in a science lesson.

The third questionnaire was finally given to the same teachers after participating in a workshop on making improvised experiment materials aimed at revealing out barriers and difficulty of improvisation as well as motivating better practice of creating/use of science improvised materials in their future teaching.

The interview finally was given to three principals and/or DOS with the purpose of viewing the situational analysis of schools as well as motivational analysis towards teachers in terms of science activities.

TTC Muhanga was chosen to host this workshop since it was in the center of the country and made everyone easy to reach. 8 hours of one day were covered by teachers in groups to create experiment materials guided by author who provided worksheet manuals, waste and cheap materials from around environment like aluminum cans, pet bottles, rubber bands, strings, rubber balloons, alcohol, matches, plastic straws and many more. While working, the author observed the working condition and gave an opportunity for teachers to present their outcomes (the working principle of materials produced and then testing the experiments) in front of other.

Finally, the interview was conducted between the author and three principals and/or DOS for the purpose of viewing the situational analysis of schools as well as motivational analysis towards teachers in terms of science activities.

### **Findings**

Laboratory activities are not fully done because of insufficiency of laboratories, only 5 out of 13 TTCs have science laboratories and teachers encounter many problems including time limitation, scarcity of some materials and lack of skills.

### **Students' Questionnaire**

In this study, students who have laboratory at school reported that experiments are done mostly in laboratory room and sometimes outside classroom, while students who do not have laboratory at school reported that experiments are not done, and even when done, are done in classroom and in science clubs. Based on science subjects, more experiments are performed in chemistry (50%), physics (30%) and biology (20%) respectively.

When students asked the reason why they like or dislike science activities and definition of science improvisation, they tend to have same responses and no difference between schools with lab and without lab at  $t(18)=1.016$ ,  $p < 0.05$  when  $t_{crit}= 2.101$  and  $p=0.323$  (where 18 degrees of freedom cumulate critical value Of 2.101 in t-distribution, and an alpha value of 0.05 implies that the null hypothesis "laboratory has no impact on all schools" is rejected 5% of the time when it is in fact true). In addition, they all are motivated to improvise in their future career since there are no sufficient science equipment in primary schools.

### **Teachers' Questionnaire**

One hundred percent of all respondents mentioned the lack of science laboratories and insufficiency of equipment as major barriers in their teaching activities, however, 27.7% and 11.1% among them also claimed the oldness of materials and lack of laboratory skills respectively. Only five schools have full equipped laboratories; Physics, Chemistry, and Biology, 4 have mobile laboratories in the form of science kits with few old materials whereas other 4 have neither laboratory room nor kit.

In this study, teachers were asked to mention the barriers of the use of lab work on the performance of students and they revealed that: "It is difficult to conduct experiment because: (i) no science laboratory at school), (ii) no enough science equipment and the existing science equipment are too old in form of mobile lab." In the schools that have laboratories, experiments are done and materials are kept in laboratory room while in other schools with no laboratories, experiments are not done and few probable materials are homemade by teachers and nowhere to keep.

About 99.7% of teachers are aware of improvisation and, at least everyone among 19 teachers has improvised once a time in a year. Four out of seven teachers from schools with lab and 9/12 without lab have improvised many times. However, claims are time limitation as one item of science material can be fashioned

between 30 minutes to one day, scarcity of materials (like chemicals, nervous system, radiation, lightning...) as well as the lack of skills.

Several science materials were made in workshop and experiments were tested among were a model elevator, wired motor, electroscope, plastic cup capacitor, rubber balloon that can stick on the wall, a comb that can bend water, canned burner, water rocket and many more (Fig 1). The fact that Materials are scarce and apart from lack of improvisation skills, teachers mentioned some contents that are difficult or impossible to improvise example are chemicals, extracting of metals, nervous system, radiation, sub-elements of atoms, components of air, Lightning, as well as Dynamite.

### MANUAL EXPERIMENT WORKSHEET

**Name of experiment:** Rubber balloon can stick on wall

**Objective:** Demonstration of charging by friction and contact

**Materials:**

-Rubber balloon

-Tissue

-String

**Method and steps**

-Fill the air into balloon

-Tie it with string

-Rub it with tissue or just hair

-Take it to wall with the side rubbed

**Observation and precaution**

Balloon will stick on the wall. Make sure you put the side rubbed on the wall and environment is not humid.

**Interpretation**

Describe the phenomenon in terms of charges.

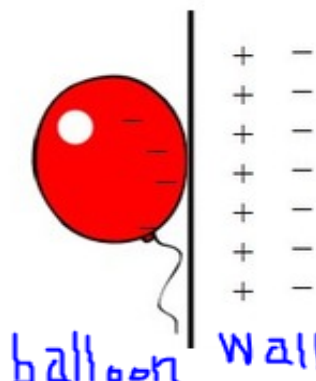


Fig 1. Example of improvised experiment and the procedures

Teachers who are at school with laboratories are the ones who also use improvisation in their teaching. This is shown by using t-test, the statistical significant difference of .005 (p-value) occurred between teachers teaching in schools full of science laboratories and teachers teaching in schools which do not have science laboratories in favor of who teach in schools with laboratories at  $t(2,14)=3.325$ , with a two-tailed hypothesis test and 14 degrees of freedom when t-critical is 2.145.

A better way of improvisation is that the teacher should request students to bring materials available in their environment while teacher brings what students cannot get (teachers compromised). Teachers believe that improvisation can make students be able to participate in the classroom, motivate them to learn science, make science easy to learn, as well as develop the relationship between science and the real world.

### **Principals and DOS Interviews**

Principal and deputies of studies (DOS) interviewed; one DOS said that our college has three laboratories well equipped of Physics, Chemistry and Biology. These laboratories have everything inside, the teachers not only conduct science experiment but also use improvisation at least once a week and they are highly motivated to do so. When asked how they motivate their future students who will go to primary school and encounter with the problem of lack of laboratory, the answer given was: "they will come up with making their own locally materials as the curriculum requirements include the use of several and locally made materials".

"We have nothing!" one Principal in another TTC said. "In order to support science enhancement, even if we do not have conferences, workshop, science clubs; however, we take our students to neighbor science schools for laboratory performance.

Another interviewed DOS said that our TTC does neither have any laboratory nor empty room, however, we only have a small moving box containing some too old materials like 2 small and 4 large optical microscopes, wing scales, tubes, ... too old, from 1998 and no chemicals left. "Experiments are performed in the classroom from materials made by teachers and students," he continued. When asked about motivation not only to teachers but also to students, he declared that even if time is limited, however, they have science club, and therefore, he is sure their students should learn how they will use improvised science materials in their future career conducting experiment for better teaching to the kids.

### **Discussion**

In Rwandan teacher training colleges, laboratory activities are not fully done because of insufficiency of laboratories. In this research, teachers claimed the lack of sufficient laboratory as well as improvising skills. About 8 TTCs do not have complete laboratories, this shows why experiments are not done. Teachers do not know how to conduct experiment because of how they studied or they do not practice it, so with this issue, if they are not motivated by their leaders or by themselves, they will forget everything by being lazy to hands on and the idea of improvisation will never be come up if no stimulation. Tsuma (1998); Hakielimu (2010); Ndibalema (2012); URT (2010); Mabula (2012) and Mkonongwa (2012) also found similar result reporting that there are several reasons for the ineffectiveness of laboratory activities such as the shortage of science teachers; limited laboratory equipment, teachers' low competence in laboratory experiments since they themselves learnt science through alternative to practical during their schooling.

Teachers need to be trained and compensated for the extra time they would need to expend in order to motivate them to create teaching tools (Ndirangu et al., 2003) since improvisation serves to minimize educational costs, as in this study too, Rwandan TTC teachers also claimed training on laboratory skills.

In Rwandan TTC teachers, experiments are not done because of incentives rather, because of lack of materials and skills. Angus and Keith, 1992 mentioned about incentive needed by teachers for doing experiments; teachers being in many cases irregularly paid and overworked, however deputies of studies in Rwandan teacher training colleges said that they highly motivate their teachers to do improvisation and salary was not mentioned by teachers in this study. After attending a training workshop, the teachers improved their

perceptions of the importance of using laboratory work to teach science subjects, they said that laboratory work is a helpful means to teach science content as it familiarizes the students with the practical component. Even if due to the inappropriate conditions diverging from the lack of satisfactory laboratory equipment to awesome classrooms, time to laboratory sessions and pressure to finish the wide syllabus, teachers were not able to use different varieties of laboratory work to teach in their courses (Cossa&Uamusse, 2015). This is in same line with the present study where teachers claimed to be overloaded.

Teachers and students' perceptions influence how teaching and learning take place. In the present study, teaching in schools having conventional laboratories are the one who have positive perceptions of laboratory activities. For instance, in teaching and learning science, Mansour (2009); Sandifer and Haines (2009) and Suleiman (2013) studies revealed that teachers have positive perceptions about laboratory activities since they contend that it leads to students' engagement and active participation in the learning process. This shows the descending potential and out-dates of teachers working in schools without laboratories, and it is a very big problem to their academic career as well as to their students. In the absence of adequate laboratory resources, teachers were found to use strategies like group work and demonstration to teach.

Laboratories are not only performed from laboratory room, rather outside in environment when studying for example Biology, in the classroom as well as in science clubs as extra-curricular activities. Similarly, a study conducted in Nigeria by Olufunke (2012) indicated that practical work both in the classroom and outdoors is an essential element of effective science education. This also a way of managing students and opportunity for teachers' innovation as well as using available resources. The fact that some schools adopted the strategy of sharing laboratories with neighboring schools, this good practice should be shared among other schools.

The shortage of equipment and chemicals challenged improvisation in Rwandan teacher training colleges as well as other schools in a wide range which have nothing or too old materials and refined chemicals. Not only in Rwanda, but also in 2003, Hofstein and Lunetta noted that the availability of laboratory equipment and chemicals is one among the factors that facilitates the process of teaching and learning science not only from developing but also developed nations.

Despite of having too old materials from 1998 and no chemicals but at least science clubs can motivate students to oversee the natural world. This is emphasized by the study of Overton and Chatzichristodoulou (2010) saying that teaching of science through the performing arts involves a combination of pictorial, hearing and kinesthetic learning. Since in science clubs, students play scientific concepts in terms of drama, science will involve both fine and gross motor skills as well as motivate students.

## **Conclusion**

There were only 5 out of 13 TTCs that had science laboratories in Rwanda, therefore, an alternative way of managing this scarcity in science learning is improvisation. However, teachers encounter many problems including time limitation, scarcity of some materials and lack of skills. Studying in schools that have laboratory or not, does not make a significant difference between students' perception of the importance of science experiment and improvisation, however, it does exist among teachers.

As long as learners and teachers are aware of the importance of using locally available hands-on materials, improvisation will solve the problem of rote-learning. I recommend not only teachers from TTCs, lecturers in educational institutions, but also to primary and secondary schools in general, to make students be used to create materials and use fully existing materials. If principals and DOS could motivate their teachers, and teachers could themselves develop self-trainability, these laboratory problems will be gradually reduced and students will get to learn science practically.

Those who involved in teaching personnel generally speaking, should motivate pre- and in-service teachers through workshops and training on the improvement of laboratory teaching skills in order to make them confident, competent and skillful when facing this scarcity of teaching materials.

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