

Inclusion of Real Life Materials in Teaching Physics Concepts: Students' Experiences and Perceptions

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***Abstract:** The purpose of this study was to determine students' perceptions and experiences following the design of Real Life Instructional Materials (RLM) in teaching concepts of elasticity and the law of floatation in physics. The study involved four ordinary level community secondary schools from Rural Moshi district and the urban Moshi. A total of seventy one students from the four schools were involved in the study. Also, four teachers were selected from the sampled schools where by each school provided one physics teacher. The researchers planned and prepared the materials in advance before coaching the teachers on how to implement them. Teachers' ability to execute student centered teaching approaches was assessed before and after coaching. It was found out that the materials could enhance students' involvement in the learning process and also students developed positive attitude towards the use of real life materials in learning the selected concepts. It was recommended that improvisation of instructional materials for teaching the same or different concepts in physics should be encouraged in order to alleviate the problem of material scarcity in the community secondary schools. But selection of such materials should vary according to the nature of the students immediate environments.*

Key Words: Real life, Materials, Physics, Students Experiences

Introduction

Scholars consider knowledge of science and technology as a requirement in all countries and needed by all people globally due to numerous challenges that are facing them (Minishi, Muni, Okumu, Mutai, Mwangasha, Omolo & Munyeke, 2004; Olufunke, 2012). Physics is the heart of science and technology because many of the tools on which the scientific and technological advancement depends are the direct products of Physics. Physics is therefore a core subject in science and technology since it studies the essence of natural phenomena and helps people understand the rapidly technological changing society (Adeyemo, 2011). One may say that it is essential that every child should be given the opportunity to acquire at least basic knowledge and the concept of physics as a science. Unfortunately, Physics is a science subject that student often find very difficult and this is why student always have low achievement in the subject. According to Aina and Akintunde (2013) student usually performed very poorly in physics in all level of education. Many researchers have equally supported the view that students performed poorly in physics (Aiyelabegan, 2003; Akanbi, 2003; Uguanyi, 1994).

Haussler & Hoffmann (2002) cite results from an international survey showing that students' interest in physics declined worldwide during Secondary Level I. This lack of interest in science often manifests itself when students are at an age when they are permitted to make their own curricular choices (Sjøberg, 2002). In Tanzania students' enrolment in physics and chemistry are less compared to biology and mathematics subjects. Students' enrolment in biology and mathematics seem to be more because these subjects are compulsory at O-level while physics and chemistry are optional after the second year of secondary education (Nchungu, 2011).

In any society which wants to develop cognitive skills of their learners in science subjects the laboratory should attain a central part of science learning process (Millar et al., 2002). Considering the significance of the school laboratory, among others Secondary Education Development Program (SEDP)'s goals were to build laboratories and libraries and to provide laboratory equipments, chemicals and other incentives (MoEC, 2004). This was a further emphasis for the Ministry of Education and Culture (1995) in Tanzania that, one of the seven aims of secondary education is to instill a sense and ability for self-study, self-confidence and self-advancement in new frontiers of science and technology, academic and occupational knowledge and skills. However, not much has been achieved as resources for science practical works are very limited (Kira, Komba, Kafanabo, Tilya, 2013; Mafumiko; 2008).

In Tanzanian context scholars have been proposing that shortage of laboratory resource in Community Schools can be some-how replaced by teacher's improvisation approach to enable students participate in hand on activities in learning physics (Kitta and Mafumiko, 2009; Nchungu, 2011). But improvisation in this age of Information and Communication Technology (ICT) need teachers use available local resources to produce instructional and learning materials in schools (Daniel, 2001). However, many teachers do not have access to didactic materials and modern educational technologies (laboratory, printer, video, multimedia, software etc), which could have made training learner – centred (Adeyemo, 2011). Therefore in the mushrooming community secondary schools in Tanzania where most of these schools are found in areas where there is no power supply it is not known if students will be having positive attitude towards improvisation as there is limited possibility of using the modern educational technologies. This is by considering the observation that teachers and students perception of the learning environment are very important on the achievement of students in physics and that the knowing the students' perception will help the teacher in shaping their students' class perception and relatively their achievement in physics (Adeyemo, 2011). Therefore, there is a need of gathering students' perception on improvisation in physics in a context where there is no possibility of accessing modern technology.

Purpose of the Study

Determination of students' perceptions and experiences following inclusion of real life materials when teaching of physics lessons

Literature Review

Physics as a science subject is activity based and the suggested method for teaching it which is Inquiry-Based Teaching (IBT) approach is resource-based (Njoroge, Changeiywo, Ndirangu, 2014; Onasanya & Omosewo, 2011). Research findings indicate that Inquiry-Based Teaching (IBT) may be very effective in enhancing student achievement and motivation to learn science as well as development of scientific process skills (Khan & Iqbal, 2011; Sola & Ojo, 2007). The approach has been considered as being capable of promoting motivation among secondary schools students since it creates interest in the process of acquiring scientific knowledge and skills (Gibson & Chase, 2002). The approach is mainly student-centered rather than teacher-centred teaching approach that offers students opportunities to be actively involved in experimenting, questioning and investigating. According to the cognitive perspective of learning, this approach brings out change in learners' behaviour that can be explained by the change in mental associations arising from experiences (Cahyadi, 2007)

Some of these experiences are a result of visual imagery. Visual imagery helps in constructing knowledge. This is the process of forming mental pictures of objects or ideas (Schwartz, Ellsworth, Graham, & Knight, 1998). The use of visual imagery can be fostered for example by presenting abstract ideas in visual forms such as pictures, charts, maps and models, or by asking learners to create illustrations or diagrams of what they learn. These techniques cement concepts in long term memory. Constructing knowledge in long-term memory is fostered by activities which engage learners actively in either mental or physical states. Physical activities have received increasing emphasis particularly hands on activities (Cahyadi, 2007). The term "hands-on activities" is usually associated with innovative teaching approaches. However, it is important to make sure that learners make connections between new materials and their existing knowledge while they are engaged in working with objects or discussing with their peers (Mayer, 1999).

It implies that for students to learn very well and create interest in science it must be taught with good instructional materials. This aid the teacher from teaching and also students to learn as confirmed by Aina (2012) that instructional materials are very important in teaching and learning science if adequately used. Many of the equipment used in teaching physics can be improvised that is why physics teacher should endeavour to utilize the use of discarded resources around them to improvised teaching aids for physics (Aina, 2012). However, the use of instructional materials or improvisation is only one stage as students will be required to participate in their own learning process; that is become active learners, and focus on transferring information and knowledge to other disciplines and to real life situations (Frenay et al., 1998). To achieve this status learners need to develop an attitude that they are not a passive receivers of knowledge but, rather, active participants. This means the learner has the responsibility to accommodate the learning process to his/her own unique learning style in order to structure his/her own learning. The teacher's role is that of a guide who assists the learner in the difficult process of constructing

his/her individual system of knowledge. For instance, teachers will need to show students how to become responsible for their learning by giving them opportunities to frame questions effectively on their own, to see how problems can be represented, and to determine how to gather information relevant to these problems (Cole,1991).

But research shows that the challenge of moving from a teaching/expert to a student centered approach may be enormous as it involves a minority (20%) influencing the majority (80%) (Moscovici & Personnaz, 2001; Taylor & de la Sablonnière, 2009). These observations base in the fact that students and teachers attitudes may be inclined to teacher-centered approaches than student-centered ones they are less familiar with. Therefore one of the means of determining effective ways of improvising instructional materials targeting student centered approaches is by assessing the extent students can be interested by such materials and make improvements accordingly. This is by considering the observation that attitudes are the best predictor for estimation of students' success (Ibeh et al, 2013). Also, attitudes, once established, help to shape the experiences the individual has with object, subject or person (Ibeh et al, 2013). Although attitude changes gradually, people constantly form new attitudes and modify old ones when they are exposed to new information and new experiences (Adesina & Akinbobola, 2005).

Methodology

In order to gather students' views and experiences, cross-sectional survey design was used to locate community secondary schools to take part in the study. These schools were selected on the basis of limited laboratory resources, having physics teacher(s) as well as students opting physics subject at form three. In order to gather views of students, an action research design was employed. The researcher designed the materials that were familiar to every day students life. The main philosophy of designing such materials was to provide opportunity for students to conduct practical lessons even if schools have limited laboratory resources.

The following activities were carried out in the sampled Community Secondary Schools:

- i. The researcher collected Real Life Materials (RLM) relevant to the topics under consideration around the school premises. The RLM comprises local resources such as plastic bottles, pieces of wood, stones weighing 50 and 100 grams, used syringes, bicycle ball bearings, water and rubber band; teachers and students activities; lessons development stages. During the study the instructional materials were first tried in a school different from the sampled ones, assessed and then refined by the teachers in the sampled schools before conducting the actual practical lessons.
- ii. Teachers were coached on how to use the designed instructional materials in carrying out the practical lessons for the selected topics.
- iii. The researchers assisted execution of the practical lessons using improvised instructional materials on (i) verification of conditions for a substance to float in fluids (ii) relating

- upthrust and weight of a floating body (iii) verification of Hooke's law using a rubber band.
- iv. Questionnaires were administered to students to find out their perceptions and experiences about conducting practical lessons using improvised instructional materials.
 - v. Two Community Secondary Schools with limited laboratory resources were selected from each district. Moshi urban schools were labeled as A and B. While those of Rural Moshi district schools were labeled as C and D from rural area. Tables 1 describe when the school was built, enrollment of students doing physics including also teaching and learning facilities and resources.

Table 1: Characteristics of Selected Community Secondary Schools

School	WSB	Enrollment (form I-IV)						No.STPH (form III-IV)	T/L
		M	F	T	M	F	T		
A	1997	324	300	624	66	24	80	15AMEP sets, 10AHE sets, 12 AEE sets, 04PM, 25 textbook	
B	2005	225	229	554	48	26	74	4AMEP sets, 02PM, 10 textbook	
C	2007	381	216	597	37	16	53	8 textbooks	
D	2004	440	350	790	44	18	62	6AMEP sets, 4 AHE sets, 5 AEE sets	

Source: Field data (2015)

Key: WSB = When school was built; No.STPH = Number of Students Opting Physics; M= Male; F = Female; T/L = Teaching and Learning resources; AMEP = Apparatus for Mechanics Experiments; AHE = Apparatus for Heat Experiments; AEE = Apparatus for Electricity Experiments; PM = Practical Manual; PPR = Physics Performance Rank Region wise; T = Total; GSPR = General School Performance Region wise (NECTA, 2010)

- vi. Table 1 indicates that the students opting physics were few compared to the total number of students in each particular school. In all four sampled schools male students opting physics were many compared to female students. It was also observed that the number of students opting physics is related to the availability of laboratory resources (school A).
- vii. Seventy one (71) students of form three majoring in physics subject as one of their subjects of specialization participated in this study. The researcher selected students opting physics because they have deep feeling on the issue of limited laboratory resources in Community Secondary Schools (CSS). However, factors such as convenience, availability and willingness to work with the researcher, and timetable flexibility were also considered. Sample size specification is as shown in Table 2.

Table 2: Sample Specification

		School name				Total
Sex		A	B	C	D	
	Male	16	7	11	11	44
	Female	9	7	10	0	27
Total		25	14	21	11	71

Source: field data (2015)

Key: A and B schools from urban area; C and D schools from rural areas.

- viii. The researcher expected 100 students to participant in the study but the turn up was only 71 which is 71% of the expected number of students

Results

The researchers were interested in finding out how the prepared instructional materials enhance students' activities during the practical lesson sessions. Based on the data collected through classroom observation checklist and students' questionnaires, 67 (95.7%) students agreed that RLM approach transform the classroom to be attractive place as it facilitated learning by doing (see table 3). One student commented that: *'Through this approach I found myself participating in various learning activities which enabled to perform experiments on my own'*.

Table 3: Students' Responses on Learning Activities by Using RLM

		The RLM transform classroom to be attractive place			Total
Sex		strongly agree	Agree	not sure	
	Male	36(51.4%)	6(8.6%)	1(1.4%)	43(61.4%)
	Female	18(25.7%)	7(10.0%)	2(2.9%)	27(38.6%)
Total		54(77.1%)	13(18.6%)	3(4.3%)	70(100.0%)

Source: field data (2015)

Table 3 has also revealed that, 67(95.7%) students agreed that the RLM approach has transformed classroom into attractive place because the materials were organized into different learning activities that facilitated the conduction of experiments they had not been performed in their usual lessons by their regular teachers. Various learning activities that students get involved were like:

- i. Demonstrating their prior- knowledge by answering questions about the topic to be taught
- ii. Working in groups and each member participate in measuring, observing, recording, discussing and analyzing findings.
- iii. Students exchanging their findings and ideas about the experiment results.

These classroom observations demonstrate the way students were involved in the process of

learning through RLM. Hence conducting the practical work lessons by using RLM maximizes the students' participation in the process of learning.

The analysis indicated that all male 44 (61.4%) and all female 27(38.6%) students accepted that the real life materials enable them to acquire knowledge about flotation law and elasticity. Also the students accepted that teachers could use the same similar approach in teaching other topics. For instance, one student said: *'...I am happy to perform experiments on how to verify the conditions for a substance to float on a fluid and to verify Hooke's law using rubber band'*.

Considering the link between the RLM and the students' environment, students admired the way experiments were linked with real life situation. Specifically 42 (60%) male and 23 (32.8%) female students agreed that practical lessons they had done through RLM were linked with their daily life situations and experiences. However, 3(4.3%) students disagreed and 2 (2.9%) were in undecided position. Some students commented that practical lessons contents were relevant to their education expectations because lessons had questions suggested for exercise and home work that could probably appear in their final examination.

When students were asked to list down at least four aspects they learnt from practical lessons, their responses fall under two categories which are traditional method as well as method supported with RLM. Students listed several aspects they learnt by referring to different activities they carried out during the practical lessons. For instance, 7 (10.0%) students learnt that traditional method was simple, no stages and its organization has no clear instruction that facilitate learning activities while the method supported with RLM has both activities and clear instruction. 17 (24.3%) students learnt that in traditional method the purpose of the lesson was not known while method supported with RLM purpose of experiments were well identified. Other group of 30(42.8%) students learnt that copying instruction and collected data dominated in traditional method while in the RLM prediction, correction, analysis of data, presentation of data as well as discussion of findings were dominated. The rest of students (42.8%) learnt that theory taught separately in traditional method whereas in the method supported with RLM, both theory and practical were taught together.

The researchers asked students aspects they liked and disliked from the practical lessons, the responses from students indicate that the most liked aspects were the method used (the way teacher controlled the classroom and activate the class); structure of practical lessons (local apparatus used and the grouping of students); activities carried out during the experiments (participation of all group members) and relevance of the practical lessons in relation to their life experiences, physics understanding as well as academic performance. In respect to disliked aspects, few students mentioned time limitation during execution of practical lessons.

When the students were asked to suggest if RLM approach can be adopted in all Tanzanian CSSs, 67 (95.7%) students said the approach can be used in Community Secondary Schools because most of those schools lack laboratory resources, adopting RLM approach would be an

alternative way since it uses local available materials that can be found easily within school premises. But they emphasized that, the government has to consider issues of increasing textbooks, building laboratory rooms and importing modern scientific apparatus, increasing skilled physics teachers and improving the school environment to facilitate teaching and learning environment for both teachers and students.

Students were also required to give their views on the role played by the RLM. 8 (11.4%) students viewed RLM approach as way of increasing interest to learn physics while 27(38.6%) students saw RLM approach had increased their physics understanding as well as knowledge. 10(14.3%) students viewed the approach as the means that would increase their academic performance in future final examinations. Other 15(21.2%) students regarded RLM approach as helpful alternative to modern laboratory recourses while 1(1.4%) student considered the approach as a tool to rise and demonstrate talents. Also, 2(2.9%) students and 4(5.7%) students viewed RLM approach as means to build their confidence and creativity respectively. More details according to sex are specified in Table 4.

Table 4: Students’ Suggestions on the Use of RLM in Physics Teaching

		suggest about the use of RLM in physics teaching								Total
		increase interest of physics	increase understanding of physics	increase performance of physics	IM is alternative to modern lab resource	rise talent of physics	Build confidence	build creativity	missing	
Sex	Male	5 7.1%	19 27.1%	6 8.6%	6 8.6%	0 0.0%	2 2.9%	3 4.3%	2 2.9%	43 61.4%
	Female	3 4.3%	8 11.4%	4 5.7%	9 12.9%	1 1.4%	0 0.0%	1 1.4%	1 1.4%	27 38.6%
Total		8 11.4%	27 38.6%	10 14.3%	15 21.4%	1 1.4%	2 2.9%	4 5.7%	3 4.3%	70 100.0%

Source: field data (2015)

Furthermore, students were required to express their feeling on the extent the RLM were supportive to learning physics through practical work by rating from “strongly agree” to “strongly disagree” as shown in Table 5.

Tables 5: How Student Felt about RLM Approach in Supporting Learning of Physics

Statement	Responses				
	SA	A	U	D	SD
i) with RLM theory was taught together with experiment	58 (82%)	9 (12.9%)	2 (2.9%)	1 (1.4%)	0 (0.0%)
ii) with RLM the lesson was understood	56 (80%)	12 (17.1%)	0 (0.0%)	0 (0.0%)	2 (2.9%)
iii) doing practical lessons with RLM is wastage of time	1 (1.4%)	1 (1.4%)	0 (0.0%)	19 (27.1%)	49 (70%)
iv) RLM enable the classroom to be attractive place	54 (77.1%)	13 (18.6%)	3 (4.3%)	0 (0.0%)	0 (0.0%)
v) with RLM more time is needed in practical work session	33 (47.1%)	26 (37.1%)	3 (4.3%)	1 (1.4%)	7 (10.0%)
vi) RLM encourages individual learning	58 (82.9%)	8 (11.4%)	2 (2.9%)	1 (1.4%)	1 (1.4%)
vii) the approach encourages repetitions of experiment to other topics	56 (80%)	14 (20.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
viii) RLM encourage students to link experiment to life situation	49 (70.0%)	16 (22.9%)	2 (2.9%)	2 (2.9%)	1 (1.4%)
ix) RLM facilitate the teacher to provide alternative explanation to students	48 (68.6%)	18 (25.7%)	1 (1.4%)	2 (2.9%)	1 (1.4%)
x)With RLM the teacher becomes a facilitator	53 (75.7%)	15 (21.4%)	1 (1.4%)	1 (1.4%)	0(0.0%)

Source: field data (2015)

Key: **SA** =strongly agree, **A**= Agree, **U**=Undecided, **D**=Disagree, **SD**= strongly disagree

With regard to experience of using RLM to conduct practical lessons, students responded differently to various items. If the rating scales in Table 5 are reduced to only 3; i.e. 'Agree', 'Undecided' and 'Disagree', majority of students agreed that RLM approach:

- i. Enable theory to be taught together with experiment 67 (95.7%)
- ii. Promote lesson to be understood 68 (97.1%)

- iii. Make classroom to be attractive place 67 (95.7)
- iv. Encourage individual learning 59 (84.2%)
- v. Encourage students to link experiment to life situation 65 (92.9%)
- vi. Enable teacher to provide alternative explanation to students 66 (94.3%)
- vii. Enable teacher to become a facilitator in the classroom 68 (97.1%)

Thus, majority of students' responses implies that, RLM seemed as an alternative solution of learning physics by doing in community secondary schools with limited laboratory resources

Discussion

In the analysis of students' responses, majority of students 67 (95.8%) agreed that the approach used in practical lessons enhanced them to link theory and experiment. In this case the researchers found that RLM approach was convenient to students such that it enabled them to associate the idea with observable phenomena. In addition the researchers see that the method facilitated the association of students' mental, thinking and cognitive processes as it could be observed when students were carrying out hands on activities, recording observations, plotting graph and making interpretations. In line with this, Miller et al. (2002) suggested that one of the intentions of practical lessons is to help students to make link between the domain or real objects and observable thing, and domain of ideas.

The analysis also has indicated that majority of students 66(95.3%) agreed that RLM approach assisted them to rise their individual learning habit because every student was supposed to carry out certain activities. Therefore the researchers associated these learning experiences with the observation that practical science support students to work at their own pace and at their own level (SCORE, 2009).

Questionnaire responses further indicate that majority of students 67(95.7%) agreed that conducting practical lessons with RLM approach transform the classroom to be attractive place due to the fact that the approach facilitates learning by doing. In this case the researchers see that, during the practical lessons students were able to test ideas, theories, develop problem solving strategies, build teamwork and taking responsibility. This supports learning by doing by Ausbel (1968) that, practical lessons give students opportunity to engage themselves in the process of investigation and enquiry in such a way that they learn a lot as they observe and do.

Generally, analysis of students' questionnaires revealed that, students agreed that the use of real materials when teaching enabled them to acquire knowledge on selected topics (flotation law and elasticity) and they suggested that teachers could adopt similar approach in teaching other topics. This comment implies that the students were interested with the way experiments were conducted as they could link the activities with real life experiences. However, these findings can only be limited to the concepts of these two topics (low of floatation and elasticity) as each topic or concept in physics is unique in terms of finding out relevant materials from the local

environment for immediate improvisation. Therefore these observations should not lead one to make generalizations across topics in secondary school physics as effectiveness of improvisation may be context bound. For instance, study by Onasanya and Omosewo (2011) revealed that there is no significant difference in the performance of students taught with standard and improvised instructional materials in physics. In addition, it should be considered that teaching approaches that succeed in helping students to learn in one environment may not work with students learning in a different environment (Ramsden, 1992). This implies that, since materials surrounding students' environment are not uniform throughout the country or world, improvisation of instructional materials for teaching the same concepts may be different in other places. Never the less, observations in this study can be used to predict improved students performance in case of appropriate implementation of the improvised instructional materials. This is by considering the observation that students' attitudes are the best predictor for estimation of students' success (Ibeh et al, 2013; Hendrickson, 1997). This does not rule out the necessity of carrying out experimental study to determine if there is any significant difference in students performance by teaching using the improvised instructional materials against traditional approach.

Conclusion

Since it was observed that students developed positive attitude towards the improvised instructional materials it can be said that the materials were appropriately improvised because for students to learn very well and create interest in science it must be taught with good instructional materials. Also, the approach is mainly student-centered rather than teacher-centred teaching approach that offered students opportunities to be actively involved in experimentation, questioning and investigation. Basing on these findings one can predict improved students' performance if compared with teaching using traditional teacher centered approaches. However, in order to be able to explain the extent to which students' performance is improved using these materials experimental design is required. But even by relying on the learners learning experiences during this study the researchers could suggest that adopting RLM approach in teaching practical lessons can be an alternative means to address the issue of limited laboratory resources in Community Secondary Schools in Tanzania or elsewhere in the world.

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