African Journal of Educational Studies in Mathematics and Sciences Vol. 18, No. 1. 2022

Impacts of Improvised Instructional Materials on Grade Nine Learners' Performance in Chemistry

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Abstract

The aim of this study is to investigate the impacts of improvised instructional materials on grade nine learners' performance in chemistry. It is a quasi-experimental study that employed pre- and post- test to investigate the impacts of improvised instructional materials on learners' chemistry performance. A sample of 450 learners randomly selected was used in this study. Thus, a researcher formed two groups, control group made of 255 learners taught with traditional lecture teaching method and an experimental group made of 255 learners that was taught using improvised instructional materials. Learners in both groups were given a survey questionnaire to fill about their views in relation to the use improvised materials. In addition, the researcher gave a pre-test and a post-test to learners in both groups before and after intervention. The results from survey questionnaire showed that learners learned actively and performed better when they learned through improvised instructional materials. The pre-test results [t (248) = .0992; P>0.5] showed that there was no difference in learners' performance. However, post-test results [t (248) = .000; P<0.5], showed a significant difference in learners' performance in favor of those taught with improvised instructional materials. It is, therefore, recommended that chemistry teachers develop and use regularly improvised instructional materials to broaden learners' knowledge and to improve chemistry learners' performance through hands-on activities.

Keywords grade nine chemistry; improvised materials; learners' performance in chemistry; traditional teaching methods

Introduction

Currently, science education is considered as a key factor for countries' economic development, culture, technology, as well as skilled people. For instance, the Government of Rwanda (GoR) seeks to accomplish economic development by emphasizing on the teaching and learning of science and mathematics (Ministry of Education [MINEDUC], 2014). It is in this context that a shift from knowledge-based-curriculum (KBC) to competence-based-curriculum (CBC) was made by the GoR to move from teacher-centred to learner-centred approach whereby learners are actively engaged in interacting with instructional materials and the content itself (Rwanda Basic Education Board [REB], 2015). To this end, teachers should play a key role in using instructional materials to achieve successfully learning objectives (Marita & Banett, 2010).

The learning process is more efficient when the learners have fully interacted with the didactic materials. Teaching and learning by using instructional materials can positively affect learners' performance (Okori & Jerry, 2017). Failure to use instructional materials

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 DOI: https://dx.doi.org/10.4314/ajesms.v18i1.10

may cause less interaction and comprehension throughout the learning process leading to the poor performance of learners (Ndihokubwayo, Uwamahoro, & Ndayambaje, 2018). In this regards, the complexity of sciences like chemistry needs more hands on activities and experiments during learning and teaching process to clarify the concepts (De Jong, Van Driel, & Verloop, 2005). However, these experiments are more expensive due to the fact that they require tools, equipment, and standard materials. This becomes more challenging especially for those schools located in rural areas to provide all the needed materials for carrying out experiments. One of the solutions to face those challenges is to use adapted and improvised instructional materials in place of the standard ones, to minimize the cost and to support some schools for integrating practical works in their teaching and learning activities (Gabel, 1999).

Insufficient and inadequate resources in some schools are becoming issues for the learners to deepen their knowledge and understanding (Okongo, Ngao, Rop, & Nyongesa, 2015). For instance in Rwanda, due to the lack of sufficient equipment and inadequate laboratories, some of the laboratory activities are not fully conducted (Ndihokubwayo et al., 2018). That is why teachers should face this challenge by using adapted and improvised materials. Improvised materials are cost effective and available within the school environment. Improvisation is the utilization of locally made materials in the absence of standardized materials that may assist teaching and learning processes to help learners attain their learning outcomes (Otor, Ogbeba, & Ityo, 2015). The use of improvised instructional materials during the teaching and learning process may enhance learners' motivation, creativity, critical thinking, and innovation (Mboto, Ndem, & Stephen, 2011). Therefore, the improvised instructional materials could be used in case of shortage or the absence of standardized instructional resources.

Some schools in Rwanda lack the standardised instructional materials due to the schools' location and the class size. In 2014, statistics in education showed that science apparatus and chemicals were rated at 17%, or, 242 out of 1502 surveyed secondary schools (MINEDUC, 2014). This percentage is at a very low rate. Thus, there is a need to think on other alternative solution such as the development and use of improvised materials to help learners learn effectively in chemistry subject. Researchers showed that learners from schools with sufficient and adequate instructional materials tend to perform well in examinations, while those without instructional materials are likely to lose motivation and perform poorly (Bukoye, 2019; Ndihokubwayo, 2017). To the best of my knowledge, no studies were conducted in Rwanda to investigate the impacts of improvised instructional materials on learners' performance in chemistry within secondary schools. Thus, this study was proposed to evaluate and find out whether there is an impact of improvised instructional materials on Grade Nine learners' performance in selected secondary schools of Nyanza district, Rwanda.

Research objectives

The main objective of this study was to investigate the impacts of improvised instructional materials on the academic performance in chemistry of Grade Nine learners, in the selected secondary schools in the Nyanza district. Specifically, this study intended:

i. To explore learners' perceptions about learning of chemistry with the

use of improvised instructional materials.

ii. To investigate whether there is a statistically significant test score difference in learners taught with traditional lecture teaching methods and those taught with the use of improvised instructional materials.

Research questions

i. What are learners' perceptions about learning chemistry with the use of improvised instructional materials?

ii. Is there a statistically significant test score difference in learners taught with traditional lecture teaching methods and those taught with the use of improvised instructional materials?

Hypothesis

H_0: There is no statistically significant test score difference in learners taught chemistry with traditional lecture teaching methods and those taught with the use of improvised instructional materials.

Methodology

Research design

This is a quasi-experimental research design that used pre- and post-test to collect data from learners. The researcher put learners into two groups; control and the experimental groups. The experimental group was taught using the improvised materials, while the control group was taught through traditional lecture teaching method, and then the comparison of both teaching approaches was made in terms of mean scores. This study was conducted in Nyanza district, Southern province of Rwanda whereby the selected schools are located in the rural areas. Besides, the researcher gave an attitudinal questionnaire to learners to fill to triangulate findings.

Population and sample size

This study targeted all teachers, and all ordinary level learners within Nyanza district. Stratified sampling method was used to get five rural schools found in Nyanza district, Rwanda. The targeted schools were G.S HVP Gatagara, G.S Gasoro, G.S Kigoma, G.S Kaganza, and G.S Nyarutovu. To get the sample, the Slovin's formula was applied to determine the number of learners to be used in this study. Solvin's equation states that the sample size is obtained by:

$$n = \frac{N}{1 + Ne^2}$$

where: n is the sample size,
N is the total population, and
e is the error tolerance.

Hence, with N= 3056 and e = .05, we obtained the sample size n = 450 participants. The participants involved in this study were chosen because they took part in chemistry courses at the ordinary level. The total number of participants was 450 including 225 learners of control and 225 experimental groups.

Data collection and instruments

The data was collected using survey questionnaires and tests. The questionnaire is effective since it saves time and is friendly for many respondents at the same time (Creswell & Creswell, 2018). The pre-test was given to both learners in control and experimental groups before being taught to test the learners' level of understanding of the concepts. After being exposed to two different teaching methods, both learners within two groups were given a post-test. Tests were used to see learners' conceptual understanding of two different groups before and after being exposed to two different teaching methods. The survey questionnaire was used to explore learners' perceptions about learning chemistry with the use improvised materials.

Data analysis

Both data from survey questionnaire and tests was analyzed by using descriptive and inferential statistics. The tool used to analyze data is a Statistical Package for Social Science (SPSS), Version 16. The researcher used four levels of Likert scales (Strongly Agree, Agree, Disagree, and Strongly Disagree) to generate frequencies and percentages of respondents while analyzing data from survey questionnaire. Besides, the inferential statistics t-test was used while analyzing data from tests to accept or reject null hypothesis of the study.

Validity, reliability of the study, and trustworthiness of the study's findings

Both tests and survey questionnaire were self-constructed. Thus, instruments validity and reliability had to be checked before their use (Golfashni, 2011). Reliability is the accuracy of the actual measuring instrument or procedure while validity is the study's success at measuring what the researcher sets out to measure (Adil, 2018). Thus, to deal with questionnaire and tests content validity, different types of questions have been reformulated after being reviewed by the experts and two University lectures. After being approved to be valid, the questionnaires have been administered to the respondents. In addition, the reliability of the instrument was tested through test-retest approach during piloting phase. The Pearson product-moment correlation was used to find the instruments reliability. The correlation was calculated with $r = \frac{N\sum XY-(\sum X)(\sum Y)}{\sqrt{[N\sum X^2-(\sum X)^2][N\sum Y^2-(\sum Y)^2]}}$ where N stands for a number of respondents, X is the first administration of test scores, and Y is the second administration retest scores. The Correlation coefficient was calculated and found to be r= 0.8 and 0.72 for tests and questionnaire respectively. These are good correlation coefficients indicating that instruments are worthy to be used for data collection.

Before data collection, researcher got permission to collect data issued by Research and Ethics Committee from University of Rwanda, College of Education (URCE). At each school, respondents were explained the purpose of the study and participated voluntarily in the study after signing a consent.

Results and Discussion

To respond to the first research question, we gave survey questionnaire to learners to look at their perceptions about learning chemistry by using improvised instructional materials. Table 1 summarizes learners' responses in frequencies and percentages.

Table 1 Distribution of learners' agreement with statements about teachers' use of improvised chemistry instructional materials

SN	Statement	Number of students (%)[1]			
		Strongly Agree	Agree	Disagree	Strongly Disagree
1	My teacher tries to demonstrate theories while explaining chemistry concepts	213(47.5)	75(17)	55(13)	97(21.5)
2	My teacher uses improvised instructional materials	183(40.5)	22(5)	23 (5)	222(49.5)
3	I actively learn by using improvised instructional materials while learning chemistry	225(50)	220(49)	0(0)	5(1)
4	Improvised instructional materials enhance my deeper understanding of chemistry concepts	376(83.5)	74(16.4)	0(0)	0(0)

[1]Percentage in parentheses; [Source: Field data, 2021]

Table 1 shows that 64.5% agreed that their teachers try to demonstrate theories in chemistry while explaining chemistry concepts while 33.5% disagreed with the statement. Forty-five percent (45.5%) learners agreed that that their teachers use improvised instructional materials, while 54.4% learners disagreed that their teachers use improvised instructional materials. Almost all of the learners (99%) agreed that they learn actively once they are taught using instructional materials. All learners agreed that the use of instructional materials enhance their deeper understanding of chemistry concepts.

Learning by doing is a best way to study science subject such as chemistry because this approach enhances learners to master the content easily and to perform well in tests and exams. Chemistry is science subject that requires experiments which could be learned by doing rather than learning theoretically the concepts which results into unforgetting them. The results from our study showed that learners learn perform better when they used instructional materials. We therefore agree with Adalikwu and Iorkpilgh (2013)'s findings who argued that the use of improvised instructional materials generally enhanced learners' understanding of concepts and led to high academic achievements. That is why Ibrahim, Surif, Hui, and Yaakub (2014) stated that lack of classroom instructional materials has a big negative impact to the teaching and learning process which results into low learners' performance. Therefore, teaching and learning chemistry should involve practical experiments where learn by doing rather than giving theories to student which are likely to be easily forgotten (Ibrahim et al., 2014).

Our results from learners' questionnaire did not only reveal that learners perform better while learning with the use of instructional materials, but also the results of this study showed that use of instructional materials enhance their active learning and motivation. Our findings are in line with Ahmed (2008)'s findings who stated that the use of improvised instructional materials boost

teaching and learning more interesting, practical, realistic and attractive. Likewise, the improvised instructional materials enable both the teachers and learners to participate actively and effectively in lesson sessions (Maheux & Lajoie, 2011).

To respond to the second research question, we gave to learners pre- and post-tests to examine whether there is mean score difference between learners in control and those in experimental group in the pre- and post-test. The results from the pre- and post-test are presented in Table 2 and Table 3 respectively.

Table 2 **Paired sample of learners mean score difference of pre-test scores in control and experimental groups**

Groups	N	Mean	Std. Deviation	Std. Error mean	Df	Sig. (2-tailed)
Control	225	7.24	4.446	0.29637	248	.0992
Experimental	225	7.23	4.197	0.27983		

Significant at P<.05

Table 3 **Paired sample of learners mean score difference of the post-test scores in control and experimental groups**

Groups	N	Mean	Std. Deviation	Std. Error mean	Df	Sig. (2-tailed)
Control	225	53.96	11.391	0.75937	248	.000**
Experimental	225	79.02	12.289	0.81928		

**Significant at P<.05

Table 2 shows (M = 7.24, S.D = 4.446), and (M = 7.23, S.D = 4.197) for control and experimental group respectively. The inferential statistics t-test shows the results [t (248) = .0992; P>.05]. Since the t-value is greater than P-value, these results revealed that there is no significant difference in pre-test mean scores. This implies that learners are at the same level of understanding of chemistry concepts.

Table 3 shows (M = 53.96, S.D = 11.391), and (M = 79.02, S.D = 12.289) for control and experimental group respectively. The inferential statistics t-test shows the results [t (248) = .000; P<0.5]. Since the t-value is less than p-value, we therefore reject the null hypothesis that states that there is no statistically significant difference test mean scores between learners taught with traditional lecture teaching method and those taught with the use of improvised instructional materials. The results from the study revealed that there is a statistically significant difference in post-test mean scores in favour of learners in experimental group who outperformed their counterparts in control group.

The results from our study showed that learners perform high when they are taught with the use of improvised instructional materials compared to when they are taught

theoretically whereby traditional lecture teaching method is used. We therefore agree with Nnanna (2021) who argued that learners taught with the improvised materials perform significantly better compared to those taught without improvised instructional materials. Indeed, Okori and Jerry (2017) argued that improvised instructional materials provide a cognitive bond between abstraction and reality to the learners. The use of improvised instructional materials is a better and a faster method of making the teaching and learning process easier for learners. Improvised instructional materials promote deep learning though the active engagement with new ideas, concepts or problems links to the activities or tasks to prior learning and applying the content to real-life applications and evaluating the logic and evidence presented (Spolin, 1999).

There is a need to stick on developing and using improvised materials especially for developing countries like Rwanda. This is because the improvised instructional materials are vital not only cost effective for carrying out experiments but also in waste management such as bottles of water that can be recycled and used as a funnel. In addition, the use of improvised instructional materials provide the learners with the opportunity to revise the performed experiments while being at home to clarify unfamiliar principles and concepts of science (Osei-himah, Parker, Asare, College, & Box, 2018). Improvisation enhances teachers' attitude to implement a learner-centered approach as one of competence-based curriculum pillars, through designing the needed materials which lead to creativity and innovation (Philip, 2015). The improvisation process gives teachers the knowledge of creativity, manipulative and critical thinking. Improvised instructional materials will help in saving the cost while looking for standards instructional materials in science subject which are more costly (Okori and Jerry, 2017; Olabiyi, 2020). In short, the use of improvised instructional materials will increase learners' performance due to the higher interest, motivation, active participation as well as full engagement during the learning process.

Conclusion and recommendations

This study intended to calculate the impacts of improvised instructional materials on Grade Nine learners' performance. This study employed pre- and post-test in addition to the survey questionnaire whereby these instruments were given to learners to answer to the research questions and test hypothesis. The results from survey questionnaire also reported that students learn actively and perform importantly when they are exposed to improvised instructional materials. In addition, the results from survey questionnaire showed that teachers rarely use improvised instructional materials. However, students reported that their teachers try to demonstrate chemistry concepts using chalk and talk while explaining chemistry concepts. Besides, the results from the post-test showed that there is a statistically significant difference between students in control and experimental group in favour of learners in experimental group who outperformed their counterparts in control group. Thus, teachers are recommended to develop and use improvised materials during teaching and learning process to broaden learners' knowledge and to improve chemistry learners' performance through hands-on activities.

Acknowledgement

Authors acknowledge the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS) for funding this study. District authorities, teachers, head teachers, and students are also recognized for their valuable contribution for the completion of this study.

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