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Effect of smart classroom on learners' performance in organic chemistry: A case study of senior five students in Kicukiro district- Rwanda

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Abstract

The present study was conducted to explore the effect of smart classroom on learners' performance in chemistry. This study was carried out on 71 senior five students selected randomly. After collecting data, t-test and linear regression analysis were used to analyze the data. Based on the research findings, it has been discovered that smart classroom motivated learners in teaching and learning organic chemistry. The results showed a significance difference between leaners taught through smart classroom and those not taught through smart classroom. These results also demonstrated that there is a positive effect of smart classroom on learners' performance in chemistry. This indicated that an effort should be put in increasing adequate smart classrooms across the country to improve the teaching and learning process. Furthermore, other researchers should emphasize on the effect of smart classroom on other units in chemistry. In addition, educational stakeholders should emphasis on the use of smart classroom in instructional activities in education.

Keywords: Performance; Technology; Competency; Organic chemistry

1. Introduction

Technology in education has remarkable potential effect to improve the equivalence of access to and use of education material in primary, secondary and high education. This is in line with the UNESCO 2030 Agenda for education linked with the United Nations 4th sustainable development goal on ensuring inclusive and equitable quality education as well as promoting lifelong learning opportunities for all [1]. A competency-based curriculum can be a basis to bring change and new rational about instructional approaches in teaching, learning and assessment processes in schools for improving the quality education. Different active methods could be used for enhancing teaching and learning process particularly teaching chemistry. Some of these methods include Process Oriented Guided Inquiry Learning (POGIL) and Peer-Led Team Learning (PLTL) [2,3] Both POGIL and PLTL focus on changing traditional science classrooms into more student-centered environments. In addition, the use of ICT in education, play a great role in improving the teaching and learning chemistry as well as students' performance [4].

Smart classroom seems to be the basic tool necessitating the instructional chemistry teaching in learner-centered approach as well as inspires research, communication and collaborative learning. Through the observation of chemistry

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teaching and learning in secondary schools, there are some weaknesses in the teaching and learning method. Firstly, teaching and learning method used by the instructor was not appropriate with the learners needs, so the involvement of learner in learning is minimum. In addition, teaching and learning in classrooms were regularly more attentive on low order thinking like knowledge, comprehension and understanding of the notions and facts. In line with this situation, Smart classroom can be the answer of improving the instructional approaches by reorganizing the inside and outside of the classroom. Government of Rwanda humanizing teacher competences in and through ICT to progress high quality skills and knowledge based and leveraging ICT across various socio-economic sectors of the country [5]. Smart classroom helped learners to gain learning ideas and new vocabulary through video by directing them to discover new ideas by behavior discussion activities associated to problem solving in small groups [6]. This research was built on the Stimulus-Response theory and Social Cognitive Theory. The proponents of stimulus-response learning theory are called associationists or behaviorists. Stimulus is a grouping of visual event, a sound, a taste, touch and smell [7]. Behaviorists learning theory is founded on the association between response and its stimulus [8].

Rwanda has been at the front of the continent's shift to ICTs and has placed ICTs at the Centre of its ambition towards achieving middle income standing by 2020. The education sector emphasis on mechanisms of using ICT to accomplish the goals of Vision 2020 through innovation and science [9]. The SMART classroom inventiveness was planned to align Rwanda's elementary education sector to the SMART Rwanda Master Plan. Through this initiative of ICT in education policy, Rwanda provides educational technology tools and resources as well as building teachers capacity [10]. The active involvement of all educational stakeholders, tasks have been well-defined to promise well-organized implementation of ICT in education policy and harmonization of its Master Plan. The Rwandan Education Board (REB) signed the agreement with SMART classrooms initiative to support primary and secondary schools to access technology tools [11].

2. Literature review

Nowadays, it is important to make learning and educational system full equipped with technology that can help students and teachers to develop their innovation and creativity in chemistry subject. Smart schools' model helped learners to be creative and appreciativeness of the arts especially met the high level of performance in core subjects [12]. The 21st century suggest learning environment which are conducive to the students and teachers in order to enhance academic achievement of science. The introduction of technology in science education motivates teachers to be more creative and innovative. In teaching chemistry, technology is used as new innovation that can helped to predict reaction mechanism, final product of a given reagents, targeting to accelerate the yield of organic synthetic reaction [13]. Technology is recognized to facilitate the mechanism of reactions, cycloaddition, synthesis of proteins and named organic compounds by using IUPAC nomenclature as challenging parts in instructional activities of organic [14]. Through this, teachers explain difficult subjects in chemistry by representation slides of complex reaction mechanism with aid of smart boards [15]. The interactive computer visualization improved the students 'performance in organic chemistry but also evaluation demonstrated that student's confidence and motivation in response question increase [14].

The use of smart classroom in teaching and learning chemistry enhance the students' performance by showing the reaction mechanisms which provide learner with skills for innovation and creativity to make something new in the society through the combination of skills, knowledge and attitudes. In daily life, organic chemistry is used in pharmacy, agriculture, veterinary and medicine, however, student learn this subject in theory without practical experiments of how different organic reactions occur and their reactivity. This make them become less creator and innovator in chemistry. Multimodal instruction was found to enhance the performance of leaners in organic chemistry. In this context, a significance difference was observed in students' score between multimodal group and single group [16]. In addition, multimodal instruction was also found to improve the performance of leaners in understanding different concepts through the use of video animations. Rice [17] declared that the use of physical models in teaching organic chemistry can increase the mental development of the students and thinking. Cope & Kalantzis [18] established that development of knowledge-based economy seeing that new pedagogics generates a dependent grouping of creativity and appropriateness to empower a digitally greatest access of educational material. Smart classrooms should permit students and instructors to mark the setting according to the enjoys and needs but also reinforce the subject contents into teachers and students [19]. The implementation of innovative technology improved curriculum into daily activities of teachers which is motivating task [20]. Similarly, smart classroom upgraded academic achievement and positive relation between creativity of the learners and academic achievement [21].

Educational technology enhances learner engagement and motivation in learner centred approach through collaboration and communication easily. Students learn even abstract and tough concepts easily by using visuals and animations, which creates learning enjoyable for students. In addition, smart classroom allows educators to evaluate and judge the learning attained by learners in class with an innovative assessment technology [22]. Chemistry is the

science subject that could be connected with technology in order to be effectively delivered and exchanged [23]. Even though theories differ in respect to the procedures and planned activities, most properties of self-regulated students are mutual shared theoretical approaches. Metacognitive strategies used by self-regulated students comprise setting goals, actions monitor, evaluating progress and planning [24]. In addition, a study of Horowitz [25] suggested that encouraging academic help seeking a type of self-regulated learning and improves student outcomes. A study conducted by Nandagopal [26] found a relationship between the frequency use of self-regulated learning strategies and science achievement; self-regulated learning strategies accounted for almost as much variance in academic performance as prior grade point average. Different other methods could be used to improve the students' performance in organic chemistry such as used of context-based learning and micro activities [27] and integration of ICT in teaching and learning organic chemistry [4]

Rwanda adopted ICT policy in 2000, much earlier than any of the other East African countries (EAC). The policy has been employed in 5-year phases mentioned to as the National Information and Communications Infrastructure (NICI) plans. In 2001, first phase began and was concluded in 2005 while second phase covered in 2006-2010. These plans were based on the relevant vision for Rwanda mission strategies to transform Rwanda into an ICT-literate nation linked to the development needs of Rwanda and improve the human resource development capacity to meet the changing demands of the economy [28]. All plans went in hand of integrating ICT policies in education and infrastructure were considered as essential to support the incorporation of ICT in education.

In terms of implementing the ICT in education policy, there was installation of educational software, interactive whiteboards, local networks, broadband connectivity and electrical power to all schools in Rwanda [29]. Rwanda's projects progressed to ICT sectors holds installing Fiber Optic and 4th Generation Long -Term Evolution (4G LTE) networks and Government of Rwanda contracted an agreement with Positivo BGH to locally make computers, tablets and other electronic devices. All these projects enhance the usage of smart classroom in teaching and learning in terms of improving learner's performance in chemistry. The assistance of all participants in teaching and learning process as well as administration staff can improve professional development duties. The acceleration of using smart devices in classrooms allow learners and teachers to achieve 21st century skills [30]. Students should use technology in order to participate in smart education and more familiar with technology in daily activities [31].

The smart classroom brought technology into classroom daily activities where teachers use it to teach each subject which is better than students observe the equipment only. The advantages of smart classroom in Rwandan education were: quick digital assessments to control the understanding, less use of chalk on black board, providing to all kind of students with audio-visual, presentations and other digital content. The technology with multimedia digital content brings the concepts to life engaging learners for being enjoyable [32]. In this concern, a researcher was motivated to carry out this research in Kicukiro district located in Kigali City-Rwanda to investigate the effect of smart classroom on learners' performance in organic chemistry.

In terms of having the relevant information related to this study, the following hypotheses were set:

- There is no significant mean difference between the control group and the experimental group in the pretest (H01).
- There is no significant difference between the post-test mean score in organic chemistry of learners taught through smart classroom and those taught through conventional method (H02).

3. Research methodology

3.1. Research design and sample

This research adopted positivist paradigm directed to true information based on experience of senses and can be gotten through observation and experiment. This design is suitable for the study because it helps the investigators to control the association between independent and dependent variables that were discovered by causal implications as a consequence of experimental design [33]. Quantitative approach was led by the researcher to determine the effect of smart classroom on learners' performance in chemistry. In addition, deductive approach was used to build data collection tools and premises based on theory. In this study, students have been taught using PowerPoint presentation slides CD-ROM containing chemistry instructions, white board, laptop and video play. A purposive sampling was used to choose schools and teachers to be involved in the study. The target population was learners and teachers in Kicukiro district from schools with chemistry combination and having a smart classroom. The choice of the sampling method was influenced by the objectives of the research, availability of financial capitals, time, and the nature of the problem to be observed [34]. Two schools were selected based on the accessibility of infrastructure (electricity, computers, smart

board and internet) to take part of this study. These schools were KAGARAMA SECONDARY SCHOOL (School 1) and ECOLE SECONDAIRE KANOMBE (School 2). The piloting study was conducted before gathering data to check the performance of students at selected ordinary secondary schools. After piloting study some questions were adjusted to meet the research purpose and then confirmed to be used in data collection. The sample was 71 chemistry secondary learners and two instructors. The students were from two groups in a chemistry course, with 35 students assigned to the control group (taught with conventional method) and 36 students assigned to the experimental group (taught using smart classroom) (See Table 1).

Table 1 Distribution of respondents 'group type

School	Type of group	Number of learners	Total
School 1	Control	18	36
	Experimental	18	
School 2	Control	17	35
	Experimental	18	
Total			71

3.2. Instrument and data collection

Before administrating data collection tools, a pilot study was directed on students by doing chemistry test out of 20 marks, and the marks of piloting study displayed that there is homogeneity of learners' performance. The minimum scores in the two schools were 7 and 9 respectively while maximum scores were 14.5 and 15.75 respectively. After analyzing the results from pilot study and adjusting the data collection tools, the PowerPoint presentation and video simulation through smart classroom equipped with a computer and a projector were used for teaching organic chemistry in senior five on both control and experimental groups. A pre-test and post-test were used to gather the data of learners' attainment in chemistry subject. In this perspective, closed questions were used in both pre- and post-test to collect the data of achievement in both groups. The questions used in both tests were identical but in post-test, altering the number of questions and use of synonyms were highlighted on. Reliability of questionnaire was established based on grades from three surveyor specialists (lecturers in university) who were comfortable with the reliability of closed questions. By this, some questions were reread and established to be used in data collection. The experimental group passed the post-test using the computer whereas those in control group used the conventional method of teaching. Both learners' tests were marked, recorded and then a descriptive statistic and t-test were used to analyze the results to determine the effectiveness of smart classroom in instructional activities.

3.3. Research findings and discussions

3.3.1. Independent sample t- test

The descriptive analysis results for pre-test in control and experimental group for both school 1 and school 2 are presented in Table 2.

Table 2 Significance of the difference between the means of the control and experimental group in pre-test for selected schools

School	Type of group	N	Mean	S.D	Sig. (two tailed)
School 1	Control	18	7.22	2.39	0.977
	Experimental	18	7.25	3.2	
School 2	Control	17	7.7	2.24	0.690
	Experimental	18	7.4	2.8	

N: Sample size, SD: Standard Deviation

From results of table 2 it is displayed that the mean values for pre-test are 7.22 in the control group and 7.25 in the experimental group for school 1 with 36 students while it was 7.7 in the control group and 7.4 in the experiment group for school 2 with 35 students. For defining the significance of difference between the control and experimental group in

the pre-test, the t- test was used. The p-value for the two schools was 0.977 and 0.690 respectively. Since $p \geq \alpha$ at 0.05 significant level (0.977 ≥0 .05 for school 1 and 0.690 ≥ 0.05 for school 2), we did not reject the first null hypothesis (H01). This suggests that there was not significant mean difference between the control and experimental group in the pre-test. These data inspired the researchers to present smart classroom approach to the experimental group and teach the control group through traditional method to estimate how the smart classroom affect the learners' performance. Smart classroom was used in teaching and learning chemistry within 2 months for experimental group while traditional method used for the control group. After the teaching process, the same achievement test was directed to both groups, and the results of these test are presented in table 3.

Table 3 Significance of the difference between the means of the control and experimental group in post-test for selected schools

School	Type of group	N	Mean	S. D	Sig. (two tailed)
School 1	Control	18	14.7	1.65	0.000
	Experimental	18	17.13	2.0	
School 2	Control	17	15.44	1.71	0.000
	Experimental	18	18.1	1.35	

N: Sample size, S.D: Standard Deviation

The table 3 showed that the average marks of post-tests in control group is 14.7 and 17.13 for experimental with the standard deviation of 1.65 and 2 respectively for school 1, while it was 15.4 for the control and 18.1 for experimental with the standard deviation of 1.71 and 1.35 respectively for school 2. In order to control the significance of the difference between the control and experimental group in the post-test, the t- test was used. Here, the p-value of two schools was 0.000. We know that if $p \leq \alpha$ at 0.05 significant level (0.000 ≤ 0.05), reject null hypothesis. Simply, we did not accept the second null hypothesis (H02). This indicates that there is a significant difference between the post-test average score in organic chemistry of learners taught through smart classroom and those taught through conventional method at school 1 and 2. In addition, table 4 comes to confirm the significance difference between control and experimental group by linear regression analysis.

Table 4 Linear regression analysis of post-test between control and experimental group at selected schools

School	Model	Mean square	DF	Standard error	F	Sig.(Two tailed)	p-value
School 1	Regression	53.2	1	0.980	15.37	0.000[a]	0.000
School 2	Regression	70.8	1	0.826	30.17	0.000[a]	0.000

DF: Degree of freedom, F: Mean of the within group variance

The results in table 4 showed that, F=15.37 and 30.17 respectively schools with standard error of 0.980 for school 1 and 0.826 for school 2. The p-value of selected schools was 0.000, means that we reject null hypothesis H02 that was stating that there is no significant difference between the post-test mean score in organic chemistry of learners taught through smart classroom and those taught through conventional method at two schools. The instructors displayed that a comparatively truthful perception of the students' experience of organic chemistry [35].

The above results concur with the findings of the research conducted by Jena [36], Sevindik [37], (Menon[38], (Ganaie & Delhi [39] confirming that students taught through smart classroom performed well in science subject and mathematics. Smart classroom has been announced as new technique of teaching and learning where it is considered as revolutionary classroom technology in teaching and learning structure to change the way teachers teach learners in schools. This process makes active learning and create experience of knowledge as well as transforming their learning into new product by reflecting what able to do after learning chemistry [40]. In experimental group taught through smart classroom, learners were motivated to use computer in instructional activities planned by instructor. Some comments from students showed that smart classroom is additional tools in teaching chemistry especially chemical test as it supports them to see many chemical tests than in normal laboratory. Smart classroom influences students to manage their time in doing many tasks. Learners enjoyed to use internet in smart classroom where it can be used to search information on different browsers and platforms. Smart classroom helps students in collaboration and communication with teacher through e-platform by receiving and sending works. Regardless to the importance of

internet in teaching and learning process, it was found to be not available at anytime, anywhere and sometime Wi-Fi is off which can be a challenge to students and teachers when they want to use it. In this context, the research participants (students and teachers) suggested that internet (Wi-Fi) should be opened anytime at all possible space in school.

Smart Classrooms had more positive effects on education than traditional classroom [41]. Smart classroom has greatly impact on the students' performance in science by providing animations of scientific experiments through e-resources.

4. Conclusion

Based on the findings of this study, it could be confirmed that the use of smart classroom is an operative technique in enlightening learners' performance in organic chemistry in secondary schools. Use of smart classroom improves learners' knowledge and understanding in adequate approach compared to none use of the smart classroom. The research findings showed that learners who learn through smart classroom performed better than those who are not exposed to it. Due to this importance of smart classroom in teaching and learning process, all stakeholders have to invest in all necessary facilities for enhancing the effective use of this modern technology. In addition, the further researches are also needed to assess the impact of smart classroom on teaching and learning other subjects also considering the higher number of respondents than two schools used due to the limitations of pandemic Covid-19.

Compliance with ethical standards

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Disclosure of conflict of interest

During the whole research process, no conflict of interest arises.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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