East African Journal of Education and Social Sciences
EAJESS May-June 2022, Vol. 3, No. 3, pp. 140-146
ISSN: 2714-2132 (Online), 2714-2183 (Print). Published by G-Card
DOI: https://dx.doi.org/10.4314/eajess.v3i3.188

Challenges in Teaching Physics using Inquiry-Based Teaching and Learning Approach: A Case of Lower Secondary School in Gakenke District, Rwanda

Joseph Dusabimana*
ORCID: https://orcid.org/0000-0002-6222-8137
African Centre of Excellence for Innovative Teaching and Learning of Mathematics and Science
University of Rwanda
Email: josephdusabimana15@gmail.com

Mugabo Rugema Leon, PhD
ORCID: https://orcid.org/0000-0003-4962-5653
African Centre of Excellence for Innovative Teaching and Learning of Mathematics and Science,
University of Rwanda

Email: mugabol2000@yahoo.com

***Corresponding Mail**: josephdusabimana15@gmail.com

Abstract*:* This study was conducted for identifying the challenges confronted by Physics teachers during the implementation of competence-based curriculum (CBC) using inquiry-based teaching and learning (IBTL). It was qualitative by nature and it used a case study design. Semi-structured interview was used to collect data. It involved a sample of three teachers selected purposefully from physics teachers of 50 lower secondary schools of Gakenke District located in Northern Province of Rwanda. Data were analyzed using thematic analysis. The findings from the study revealed that the participants of the study met with number of challenges during the implementation of physics competence-based curriculum using IBTL. Those challenges include the lack or insufficiency of teaching-learning materials and infrastructures, shortage of time, poor English language of students, beliefs of students that physics is difficult subject and the lack of teachers' skills and knowledge to prepare inquiry-based lesson. The participants of the study are recommended to improvise local available teaching materials for effective use of IBTL. Policymakers are recommended to organize regular trainings of teachers at schools levels on how to plan inquiry-based lesson for effective implementation of physics CBC.

Keywords: Competence-based curriculum; inquiry-based teaching and learning; learner-centered.

How to cite: Dusabimana, J. and Mugabo, R. L. (2022). Challenges in Teaching Physics using Inquiry-Based Teaching and Learning Approach: A Case of Lower Secondary School in Gakenke District, Rwanda. East African Journal of Education and Social Sciences 3(3), 140-146. Doi: https://dx.doi.org/10.4314/eajess.v3i3.188.

Introduction

Inquiry-based teaching and learning (IBTL) is one of the learner-centered methodologies of teaching which focuses more on posing questions in order to impart skills which include both problem-solving and critical thinking. During IBTL implementation, the teacher involves students in stating accurate problems (Chu,Tang, Chow & Tse, 2007).Hofmann (2004) defines IBTL as a method of teaching which engages learners in active processes of generating knowledge through answering asked questions within conducive learning environments. In addition, Njagi (2016) defines the IBTL as teaching methodology in which the instructor gives students

the opportunity to learn science through conducting their own investigation.

IBTL, like other student- centered approaches of teaching were introduced by John Dewey in 20th century for giving students knowledge and skills that enable them to deal with socio-polical issues (Chiapetta, 2008). In Rwanda , It was introduced for the first time in 2015 when the Government of Rwanda decided to shift from knowledge-based curriculum (KBC) to competence-based curriculum (CBC) with the aim of allowing students to attain full potentials in terms of suitable knowledge, skills, competences, values and attitudes that enable them to participate in society and take advantage of employment opportunities (REB, 2015). The rationale behind the curriculum review was to train citizens and equip them with knowledge, skills and competences that enable them to compete at the labor market and cope with the 21st Century requirements.

The study of Mupira and Ramnarain (2018) reported IBTL as the approach of teaching that can help students to succeed in science (physics is included). Furthermore, Kafyulilo, Rugambuka and Moses (2012) reported that the effective implementation of IBTL can contribute to the success of competence-based curriculum.

Fitzgerald, Danaia and McKinnon (2017) pointed out that the IBTL approach in science teaching is effectively implemented by teachers from developed countries and that it is not well implemented by teachers from less developed countries due to the lack of teaching and learning materials. A study conducted by Nsengimana, Habimana and Mutarutinya (2017) in nine secondary schools of Rwanda asserted that there was a shortage of studies about IBTL. A study by Mugabo (2015) in lower secondary schools of Rwanda reported a poor use of IBTL by science teachers that affect the implementation of competence-based curriculum negatively. Therefore, this study sought to identify challenges that teachers face when teaching using IBTL for effective implementation of Physics competence-based curriculum

Types of I Inquiry-based Teaching and Learning

There are various types of IBTL. The first type is Open or full inquiry which refers to the learner-centered method of teaching in which students formulate problems and propose suitable methodologies for solution. For instance, the teacher of physics can bring a mass bob and balance and asks students to formulate a problem that can be investigated using those apparatus. After formulating the problem, the teacher can ask students to use those apparatus to investigate the problem (Windschitl, 2003).The second type is Guided Inquiry in which the teacher gives students a problem to investigate while suitable methodologies used to get the answer to the problem are generated by students themselves (Tobin, 2002). The third one is Planned Inquiry in which the teacher gives students a problem to investigate and all directions to go through when finding out the solution to the problem (Martin-Hansen, 2002).The fourth one is Confirmation Experience inquiry in which students are given problems, answers and directions to go through when collecting data for testing known a hypothesis (Wenning, 2010).

Inquiry Continuum

Inquiry continuum is a set of levels or stages through which students acquire essential knowledge and skills which enable them to participate in the process of inquiry (Wenning, 2010):

1. Discovery Learning: In this stage, students construct new knowledge based on their prior knowledge.
2. Interactive Demonstration: In this second stage, teachers involve students in explaining and predicting phenomena for identifying their initial knowledge.
3. Inquiry Lesson: In this third stage, students are engaged in discovering scientific concepts and their connections.
4. Inquiry Laboratory: In this stage, students are engaged in conducting an experiment and to making conclusions basing on the results from that experiment.
5. Real-world Applications: In this stage, students are engaged in solving real life problems using the acquired knowledge.
6. Hypothetical inquiry: In this stage, students provide explanations of phenomena under observation.

Planning of Inquiry-based Teaching

Shanmugavelu, Parasuraman, Ariffin, Kannan and Vadivelu (2020) report the following five elements that science teachers must consider when planning the inquiry-based teaching and learning:

1. **Planning learning objectives:** These are the statements which define the expected goal of the lesson or activity in terms of demonstrable knowledge or skills. In the process, scheduling inquiry instructors are supposed to put more emphasis on the abilities of their students. In addition, instructors are supposed to have information related to initial knowledge of students and their ability to perform the inquiry-based activity.
2. **Designing teaching and learning materials:** Teaching and learning materials are defined as collection of materials including animate, inanimate objects, human and non-human resources that the instructor can use in the teaching and learning process. This can help the instructor to achieve preferred learning objectives. During planning of inquiry-based teaching, teachers are supposed to clarify the activity that students have to accomplish and give all teaching and learning materials such as books, apparatus, technological tools and other materials that allow students to collect data.
3. **Designing strategies of asking questions:** During planning inquiry-based teaching and learning, teachers have to ask questions that allow students to accomplish predetermined learning objectives. Those questions must include recalling, questions that require students to give interpretation and higher level of thinking.
4. **Designing strategies for teaching and learning:** Here teachers have to clarify learning objectives to students. They also have to plan activities and clarify the steps that students go through when carrying out those activities. Furthermore, teachers have to give instructions to students and tell them whether those activities should be carried out in groups or individually. Also teachers have to take into account the teaching technique that will be employed in the process of teaching and learning.
5. **Evaluation:** Evaluation is done by judging the performance of learners in activities they are supposed to accomplish using technological tools. In this stage, the instructor must have knowledge on how the process of inquiry can be evaluated.

Purpose of Using the Inquiry-based Teaching and Learning

In 2015, the Government of Rwanda shifted from Knowledge-Based Curriculum (KBC) to Competence-Based Curriculum (CBC) and from Traditional Methods of Teaching to IBTL. The main aim of using IBTL was to give students opportunities to create knowledge themselves and apply acquired knowledge and skills in real life for socio-economic development of the country (Ngendahayo & Askell-williams, 2016).

In addition, Ngendahayo and Askell-williams (2016) reported that apart from creation of knowledge, IBTL is used during the implementation of CBC for providing students the key competencies including communication skills, critical thinking skills, skills of solving problems and self-management skills. It also provides students with the ability to deal with some issues that affect the society in general including issues related gendered violence, HIV/AIDS and other issues. Therefore, IBTL, like other student-centered approaches, are approaches of teaching in which students are actively engaged in the process of learning instead of hearing and copying the talks of teachers as an experts (Vale, Davies, Weaven & Hooley, 2010).

Duties of Teachers during the Implementation

Teachers have to explain both steps and skills for learning the natural world and help learners to put those steps and skills into practice during the acquisition of physics concepts (Mineo, Fazio & Tarantino, 2010). In addition, physics teacher have to plan concepts of physics to be learned and gives students all possible facilities that enable them to attain those planned concepts (McBride, Bhatti, Hannan & Feinberg, 2004). Similarly, Ahmed, Science and Dar (2018) asserted that the guidance from the teacher is a must during the process of teaching physics using IBTL.

According Aulls and Shore (2008) , teachers 'function in physics teaching using IBTL differs from their function played in traditional methods of teaching. They confirmed that the function of teachers in the IBTL is to engage learners through formulating statements and conducting experiments for obtaining data to be used during hypothesis testing while the function of the teachers in traditional methods of teaching is simply to impart physics content to passive students (Nzeyimana & Ndihokubwayo, 2019). Futhermore, they argued that teacher who use IBTL

have to move from teacher role to facilitator role, and learners have to move from passive receivers of knowledge to active creators of knowledge for effective acquisition of the concepts of physics. Therefore, teachers function as facilitators while students play an active role.

This study sought to establish challenges that participants of the study faced during the implementation of physics CBC using IBTL. The study was guided by the following two research questions:

1. How do participants describe the IBTL approach?
2. What are challenges that participants of the study faced during the implementation of physics CBC using the IBTL approach*?*

Methodology

The study used qualitative method and a case study design for getting detailed information related to challenges that teachers face in implementation of the IBTL in Physics subject.

Population and Sampling

Gakenke District in which the study was conducted had 50 public lower secondary schools. Each school had one physics teacher, totaling 50 physics teachers as the population of the study. The study used the purposive sampling to select three out of 50 teachers. The study was conducted during COVID-19 Pandemic. The three teachers were selected based on the fact that they taught in the schools located near residential place of the researchers. Data was gathered using semi-structured interviews and was completed within 3 days. The semi-structured interviews were used for giving participants full opportunity to provide their views. The interview schedule passed through validation check by educationists from the University of Rwanda. A pilot study was also conducted in two schools for ensuring the validity of the tool.

Ethical Considerations

The study got ethical clearance from the research and innovation unit at the University of Rwanda-College of Education. Participants were given freedom to participate or not.

Statistical Treatment of Data

Data was analyzed using the thematic approach whereby the main themes were extracted from interviews. Data was further grouped into categories/themes and was coded based on their similarities.

Findings and Discussion

The main purpose of the study was to establish challenges faced by the participants of the study in using the IBTL approach. Participants were asked to explain the meaning of inquiry-based teaching and learning and tell whether they used the approach in their physics teaching and also to express the challenges they experienced in using the approach.

Research Question 1: How do participants describe the IBTL approach?

One of respondents revealed that "I always use IBTL in my teaching and it is defined as a form of active teaching and learning involving students' active participation in solving problems and it helps them to take the ownership of their learning." The second participant described the IBTL as "a learner-centred approach of teaching which puts emphasis on engaging students in the leaning activities which include asking questions, conducting experiments and reporting outcomes from an experiment. I use it sometimes in teaching." The third participant likewise described the IBTL as a teaching method which gives students the opportunity to learn through research. The respondent further claimed to have been using the approach in physics teaching. These observations match with Hofmann (2004) who stated that IBTL is a method of teaching which engages learners in active process of generating knowledge through answering asked problems within a conducive learning environment. The findings further match with Njagi (2016) who stated that IBTL is a teaching methodology in which the instructor gives students opportunities to learn science through conducting their own investigation and observation. This implies that the participants understood what is meant by inquiry-based teaching and learning and they actually used it during the implementation of physics competence-based curriculum.

Research Question 2: What are challenges that participants of the study faced during the implementation of physics CBC using the IBTL approach*?*

When participants were asked to indicate challenges they faced when implementation CBC using IBTL, they reported various challenges which were classified in the following themes:

Insufficiency of Teaching- Learning Materials and Infrastructures

The respondents reported the lack or insufficiency of teaching- learning materials and infrastructures as a challenge they faced when implementing competence-based curriculum using the IBTL approach in their physics teaching. One participant, for example reported that "lack of appropriate textbooks and infrastructures such as laboratory, classrooms and smart classrooms are challenges which affect my physics teaching using the inquiry-based teaching and learning approach." These findings were in harmony with previous research findings. A study conducted by Rwanda Education Board (REB) in Nyagatare District located in Eastern province of Rwanda, for instance, identified insufficiency of learning and teaching materials for CBC in schools as one of the hindrances to the implementation of IBTL" (REB, 2018, p.6). Similarly, a study conducted by Nsengimana (2021) regarding opportunities and challenges of CBC implementation in Rwanda reported the absence of laboratory apparatus and lack of teaching and learning materials as the main challenge faced by CBC implementation.

Shortage of Time

Shortage of time is one of challenges reported by the participants of the study. Particularly, one of the respondents held that "the use of IBTL is time consuming compared to the time allocated to a given unit." A study conducted by Gutulo and Tekello (2015) for the purpose of assessing the challenges associated to teaching and learning of physics in the schools of Wolaita and Dwuro Zones, including secondary and post-secondary schools, reported limited time for making discussions as one of main challenges faced by physics teachers in their physics teaching. Furthermore, they reported that due to the shortage of time allocated for each unit, some physics teachers prefered to use teacher-centred method of teaching instead of using IBTL.

Poor English Language for Students

All respondents reported poor English language on the side of students as one of challenges they faced when implementing the competence-based curriculum using IBTL in their physics teaching. One respondent, for instance said, "The challenge I face in my physics teaching using inquiry-based teaching and learning approach is the low level of students to express themselves in English language." This is in harmony with what was reported by Kagwesage (2012) in a study conducted for the purpose of investigating the reflections of Rwandan students on the use English as medium of instruction. The author revealed that Rwandan students including masters and doctorate students had a problem of understanding courses taught in English language. Similarly, a study conducted by Lo and Macaro (2012) in Hong Kong secondary schools revealed that poor English did not allow learners to share ideas during the teaching and learning process that caused the lessons to be teacher-centered rather than being student-centered.

Negative Attitude toward Physics

Students' negative attitude toward Physics subject was also cited as a challenge teachers experienced in their implementation of physics competence-based curriculum using inquiry-based teaching and learning. One teacher said, "Students' belief that physics is a very complicated subject reduces students 'motivation for leaning the subject." This challenge was also reported in the study conducted by Ryan and Guido (2013.p. 2087) who stated that" Students perceived physics as a difficult subject during high school days and it becomes more evasive when they reach in the colleges." In addition, they confirmed that the beliefs of students that physics is tough, leads to lack of students' motivation to learn the physics subject.

Lack of Teachers 'Skills and Knowledge

Participants stated that they had not had enough knowledge and skills to prepare the inquiry-oriented lesson due to lack of training. One respondent held that **"**preparation of inquiry-based lesson at work place is a challenge due to lack of skills on how inquiry-based lesson looks like." This challenge was also reported by Nsengimana,Habimana and Mutarutinya (2017) in a study conducted in three districts of Rwanda. They reported that teachers' knowledge and skills in using student-centered approaches including IBTL during implementation of science CBC were limited. Furthermore, they recommended policymakers and institutions in charge of pre-service teachers to organize training related to student-centered approaches for a better implementation of competence -based curriculum (CBC).

Conclusions and Recommendations

Conclusions

It is concluded that the participants of the study understand what inquiry-based teaching and learning means. Also it can be concluded that the challenges faced by the participants of the study

during the implementation of physics CBC using IBTL include lack or insufficiency of teaching-learning materials and infrastructures, shortage of time for teachers' preparation, poor English language of students, beliefs of students that physics is a difficult subject and the lack of teachers' skills and knowledge to prepare inquiry-based lessons.

Recommendation

The study recommends that teachers should improvise locally available teaching and learning materials for effective use of the IBTL in teaching physics. Policymakers should organize regular training sessions for teachers to enhance their skills in teaching using the IBTL approach.

Acknowledgements

Authors thank the African Centre of Excellence for Innovative Teaching and Learning of Mathematics and Science (ACEITLMS**)** for the financial support and other various supports that enabled this study to be conducted and completed.

References

Ahmed, A. M., Science, C., & Dar, B. (2018). Original Research article Open access Effects of Instructional Strategies on High SchoolSstudents in Mathematics : 08, 22069–22074.

Aulls, M. W., & Shore, B. M. (2008). Inquiry in education. The Conceptual Foundations for Research as a Curricular Imperative. New York: Erlbaum.

Chiapetta, E. L. (2008). Historical development of teaching science as inquiry. Science and Inquiry in the Secondary Setting, 21–30. Retrieved fromhttp://Static.Nsta.Org/Files/PB216X-2.Pdf.

Chu, S., Tang, Q., Chow, K., & Tse, S. K. (2007). Study on Inquiry-based Learning in a Primary School through Librarian-Teacher Partnerships. IASL Annual Conference Proceedings.https://doi.org/10.29173/ias584.

Fitzgerald, M., Danaia, L., & McKinnon, D. H. (2017). Barriers inhibiting inquirybased science teaching and potential solutions: Perceptions of positively inclined early adopters. Research in Science Education. https://doi.org/10.1007/S11165- 017-9623-5.

Hofmann, M. (2004). Inquiry learning through librarian-Teacher partnerships. School Library Journal. Media Source.

Kafyulilo, A. C., Rugambuka, B. I., & Moses, I. (2012). The implementation of competence based teaching approaches in Tanzania. Makerere Journal of Higher Education, 4 (2), 311-326.

Kagwesage, A. M. (2012). Higher Education Students' Reflections on Learning in Times of Academic Language Shift. International Journal for the Scholarship of Teaching and Learning, 6(2). https://doi.org/10.20429/ijsotl.2012.060218

Lo, Y. Y., & Macaro, E. (2012). The medium of instruction and classroom interaction: Evidence from Hong Kong secondary schools. International Journal of Bilingual Education and Bilingualism, 15(1), 29-52. Keywords.

Martin-Hansen, L. (2002). Defining Inquiry. The Science Teacher, 69, 34–37.

McBride, J. W., Bhatti, M. I., Hannan, M. A., & Feinberg, M. (2004). Using an inquiry approach to teach science to secondary school science teachers. Physics Education, 39(5), 434–439. https://doi.org/10.1088/0031-9120/39/5/007

Mineo, R. M., Fazio, C., & Tarantino, G. (2010). An Inquiry-Based Approach to Physics Teacher Education: the Case of Sound Properties. Eaching and Learning Physics Today: Challenges.

Mugabo, R. L. (2015). Science teachers understanding of inquiry-based science teaching (IBST): Case of Rwandan lower secondary school science teachers. Rwandan Journal of Education, 3(1), 77–90.

Mupira, P., & Ramnarain, U. (2018). The effect of inquiry-based learning on the achievement goal-orientation of grade 10 physical sciences learners at 298 township schools in South Africa. Journal of Research in Science Teaching. https://doi.org/1 0.1002/T ea. 21440.

Ngendahayo, E., & Askell-williams, H. (2016). Publishing Higher Degree Research. Publishing Higher Degree Research, January. https://doi.org/10.1007/978-94-6300-672-9

Njagi, J. (2016). Determinants of use of inquiry based instruction by early childhood teachers' in teaching science in Meru South Sub-county, Kenya.

Nsengimana, T., Habimana, S., & Mutarutinya, V. (2017). Mathematics and s cience Teachers ' Understanding and Practices of Learner - Centred Education in Nine Secondary Schools from Three Districts in Rwanda. 4(1), 55–68.

Nsengimana, V. (2021). Implementation of Competence-based Curriculum in Rwanda : Opportunities and Challenges. 5(1), 129–138.

Nzeyimana, J. C., & Ndihokubwayo, K. (2019). Teachers' Role and Learners' Responsibility in Teaching and Learning Science and Elementary Technology in Rwanda. African Journal of Educational Studies in Mathematics and Sciences 15(2), 1–16.

REB. (2018). Implementing CBC: successes and challenges. Urunama Rw'abarezi, 006(July). https://rwanda.vvob.be/publications%0Ahttps://rwanda.vvob.org/sites/rwanda/files/peer_learning_magazine006_v0.0_2018ss4web.pdf.

Ryan, P., & Guido, M. D. (2013). Attitude and Motivation towards Learning Physics. 2(11), 2087–2094.

Shanmugavelu, G., Parasuraman, B., Ariffin, K., Kannan, B., & Vadivelu, M. (2020). Inquiry Method in the Teaching and Learning Process. Shanlax International Journal of Education, 8(3), 6–9. https://doi.org /10.34293/education.v8i3.2396.

Tobin, K. (2002). Types of Inquiry. The Science. Teacher, 69(February), 2002. http://www.lewiscenter.org/documents/AAE/Science/Teaching Science/Types of Inquiry.pdf.

Vale, C., Davies, A., Weaven, M., & Hooley, N. (2010). Student centred approaches: Teachers'learning and practice. Mathemat ics Education Research, 1(2), 571–578. http://files.eric.ed.gov/f ullt ext/ED52 0974 .pdf.

Wenning, C. J. (2010). The Levels of Inquiry Model of Science Teaching Wenning (2010) for explications of real-world applications component of the Inquiry Spectrum.) A Levels of Inquiry Redux. J. Phys. Tchr. Educ. Online, 6(2), 9–16.

Windschitl, M. (2003). Inquiry projects in science teacher education: What can investigative experiences reveal about teacher thinking and eventual classroom practice? Science Education, 87(1), 112–143. https://doi.org//10.1002/Sce.10044.