

Computer-Supported Collaborative Learning and Students Electricity Concepts: A Case of Secondary Schools in Arusha, Tanzania

Abraham Daniel Mollel

ORCID: <https://orcid.org/0000-0001-8618-4469>

Africa Centre of Excellence for Innovative Teaching and Learning Mathematics, University of Rwanda

Email: danielibrahim524@gmail.com

Evariste Minani

ORCID: <https://orcid.org/0000-0001-7970-3056>

Department of Mathematics, Science and Physical Education, University of Rwanda

Email: eminani@ur.ac.rw

Vianney Munezero

ORCID: <https://orcid.org/0000-0002-5817-1668>

Africa Centre of Excellence for Innovative Teaching and Learning Mathematics, University of Rwanda

Email: vianmuneze@gmail.com

Janvier Ngayinteranya

ORCID: <https://orcid.org/0000-0003-3741-1914>

Africa Centre of Excellence for Innovative Teaching and Learning Mathematics, University of Rwanda

Email: ngayinteranyajanvier@gmail.com

Corresponding Author: danielibrahim524@gmail.com

Copyright resides with the author(s) in terms of the Creative Commons Attribution CC BY-NC 4.0.
The users may copy, distribute, transmit and adapt the work, but must recognize the author(s) and the
East African Journal of Education and Social Sciences

Abstract: This study sought to establish the effectiveness of Computer-Supported Collaborative Learning in improving student's electricity conceptions among secondary schools in Arusha City through the exploratory research design. The study employed the electricity conceptual achievement tests (pre-test and post-test) within 196 sampled Form Two students. Data was analysed descriptively. The pre-test mean and standard deviation were 38.082 and 16.75719 respectively while the post-test mean scores and standard deviation results were 59.745 and 17.39898, respectively. The study detected deficiency in the understanding of concepts in the non-participatory teaching methods used before the intervention. After the intervention through the CSCL approach, the variations were detected in that students' understanding of concepts in electricity improved. This means that when technology is incorporated, students' conceptual understanding is enhanced. The study recommends teachers to use digital pedagogical approaches such as CSCL to bring about better learning results.

Keywords: ICT; Information and Computer Studies; Computer-Supported Collaborative Learning; STEM.

How to cite: Mollel, A. D., Minami, E., Munezero, V. and Ngayinteranya, J. (2022). Computer-Supported Collaborative Learning and Students Electricity Concepts: A Case of Secondary Schools in Arusha, Tanzania. East African Journal of Education and Social Sciences 3(2), 139-145. Doi: <https://doi.org/10.46606/eajess2022v03i02.0168>.

Introduction

Physics is among the essential subjects in the field of Science, Technology, Engineering and

Mathematics (STEM). It involves various interesting topics which are useful in daily life. Due students' poor attitudes and perceptions toward learning physics, the enrolment in the

subject has been declining in various country including Tanzania, Kenya, Uganda, Burundi and Rwanda (Guido, 2018). Electricity is an area with some abstract ideas which intend learners to include the assumptions for realm as aspects as DC Electric Circuits (Dega, Kriek & Mogese, 2013). While students always achieve on quantitative calculations, the conceptual meaning of various aspects in Physics is still a trauma (Mbonyirivuze, Yadav & Amadalo, 2019).

The introduction of technology in teaching and learning arose to support the innovation in education. Both developed and developing countries have been implementing the use of Information and Communication Technology (ICT) to encourage access to all sectors including education. In Tanzania, the formulation of ICT policy has been secured where its implementation in all levels of education started in 2006 to support teaching and learning activities (URT, 2007). Despite the introduction and execution, the literacy and infrastructures are still limited in Tanzania (Kafyulilo, 2010).

Further, the innovation brought by technology enables the discovery of some pedagogy which enacts computer and internet connections to be used in teaching and learning. Computer-Supported Collaborative Learning (CSCL) approach is among the pedagogy. It encompasses the use of computers and internet under social interaction to bring effective learning (Devedi, 2006; Van Joolingen, De Jong & Dimitrakopoulou, 2007). Electricity includes concepts that are not simple to visualize through the physical eyes. Therefore, to improve the understandings of the concepts of electricity, CSCL has been recommended to be used in classroom context by various scholars (Başer & Durmuş, 2010; Van Joolingen et al., 2007).

In Tanzania, the use of CSCL is unsatisfactory due to inadequate infrastructures in schools. However, some schools especially private ones have attempt to use CSCL in the teaching and learning process (Mfaume, 2019). The notion of computer laboratory to be used by ICS subject has been commended by Olan'g (2015). CSCL involves the incorporation of various technological tools and resources such as PhET simulations, Multisim, Virtual Lab and Solve Elec which would enable learners to increase their conceptual understanding of electricity. Thus, the study intended to provide the incorporated form

of strategy to improve students' conceptual understanding of the concepts of electricity by answering the following research questions:

1. How was the current level of students' understanding of the concepts of electricity in the prospect of other teaching methods used by teachers?
2. To what extent did students' understanding of the concepts of electricity improve in the view of the CSCL approach?

Literature Review

This section deals with the review of related literature and studies. It is organized into subtopics:

CSCL pedagogy

The meaning of CSCL has been provided by several scholars with a similar sense. Devedi (2006), Gikandi (2020), Jensen, Van Leeuwen, Janssen, Jak & Kester (2006) and Mäkitalo-Siegl, Kohnle & Fischer (2011) defined CSCL as a pedagogical approach in which learning occurs through social interaction with the assistance of computers and the internet. In the approach, for learning to occur, interaction aided by computers and internet connections is required. The role of the teacher in the CSCL classroom is to facilitate and motivate learners by designing a series of activities to make them collaborate frequently throughout the lesson (Urhahne et al., 2010).

CSCL has been implemented to some schools in Tanzania, mostly private schools. All schools having ICS subject possess the computer laboratory which might be used by teachers in teaching sciences subjects (Kafyulilo, 2010). According to Olan'g (2015), some teachers believe that computer laboratory should be used by ICS teachers only. This kind of approach decreases students' responsiveness on how technological resources may be used to support teaching and learning activities.

Some learners possess digital tools such as smart phones and computers in their home places but they are not aware of their use academically (Mfaume, 2019). The knowledge about usefulness of technology in education is insufficient. Therefore, trainings about ICT should be done to encourage both teachers and learners on the practicality of technology for effective learning.

Concepts of Electricity

Determining the greatest way in which students learn physics takes a priority in physics education. Gunstone, Mulhall & McKittrick (2009); Mazur and Hilborn,(1997); Mboniyirivuze et al., (2019); McDermott & Shaffer, (1992); Wieman & Perkins, (2005) discovered that students are able to memorize the mathematical formulae and perform calculations but the problem arises in the understanding of concepts and the real interpretation. This could be due to the fact that majority of teachers still use the teacher-centred method which fails to alter the student's conceptual change when facilitating the teaching and learning process (Uworwabayeho, 2009).

The concepts of electricity require that students should be aware of not only mathematical manipulation but also the cognitive qualitative meaning (Mboniyirivuze, et al.2019). As society changes over time, more skills need to be learned in order to prepare students for a better future. The involvement of technology will enable students to improve their understandings for them to be able to cope with problems arise in their society.

ICT Policy in Tanzania

Various countries have formulated the policies to ensure ICT is implemented effectively in all levels of education. The introduction of Education Sector Development Program (ESDP) in 2001 caused the evaluation on the contribution of ICT in education to be conducted. Effort has been done to ensure the literacy of ICT increases to all human by 2025 (URT, 2003, 2007). The influence target to provide the quality and increase the technology literacy rate. The awareness would enable the use of technology in education to be multiplied. Further, the usability is still not enough which means strengthening is inevitable.

In 2003 Tanzania adopted the national policy which tended to increase the literacy in technology. The policy evolved to train both in-service and pre-service teachers on how technology can influence better teaching and learning. Although the trainings have been conducted, its application in classroom activities is unsatisfactorily (Kafyulilo, 2010. In the 21st Century, technology is a core in all sectors to bring development. Teachers should therefore increase the implementations of ICT in teaching and

learning to enable students to interact for effective learning.

Challenges Facing Technology Utilization in Tanzania Schools

The usage of technology in developing countries is on infancy stage. According to Ndibalema (2014) and Olan'g (2015), challenges facing technology utilization in Tanzanian schools include inadequate teachers' awareness, poor internet connections, lack of modern computer laboratories and absence of electricity to some schools. Although the government has been struggling to distribute the power supply to different places even in rural areas, electricity has not been available to all schools. Furthermore, the strength of internet connection is very restricted to rural areas.

Theoretical Framework

The study espoused the Sociocultural Theory of Cognitive Development by Lev Vygotsky (1978). The theory is grounded in the assumption that learning has its basis when people interact with each other. Vygotsky (1978) contended that for active learning to occur, there is a key zone of proximal development where the composite task to be handled by the learner when working with individuals becomes simple enough to be monitored. CSCL approach helps learners to work together and ensures the active learning. Voogt et al. (2015)asserted that collaboration transforms individuals through a reciprocal process during the execution of planned activities. The theory was adopted in the study because CSCL approach is regarded as the pedagogy that allows students to visualize abstracts concepts and improve their conceptual understandings.

Methodology

This section discusses the research design, population and sampling, instruments used, validity and reliability, statistical treatment of data and ethical considerations.

Research Design

The study employed the mixed method through the exploratory research design. The design involved the sequential collections of data. According to Berman (2017), exploratory design involves the collection of data and analysis in a sequence format. The study intended to assess the effectiveness of Computer-Supported Collaborative Learning in improving students' understanding of the concepts of electricity. To

answer the research questions, the following sequences were employed:

Step 1: Teachers training towards CSCL approach.

The workshop was conducted in four sampled secondary schools. Two physics teachers were selected from each school to make a total of eight teachers. Teachers were trained for three days on the use computer laboratory for teaching and were given time to ask questions related to CSCL approach.

Step 2: Pre-testing. The Electricity Achievement Conceptual Pre-test was conducted before the classroom intervention through the CSCL approach commenced. The aim of the test was to identify the current level of students' understanding of the concepts in the prospect of other teaching methods used by teachers before. The participants were 196 Form Two students from the four schools. The content of the test was in the topic of current electricity specifically in the sub-topic of the concept of current electricity.

Step 3: Post-testing. The Electricity Achievement Conceptual Post-test was conducted after the classroom intervention whereby students were taught using the CSCL approach. The lesson taught was in then sub-topic of current electricity. The purpose of the post-test was to determine the extent to which students' conceptual understanding of electricity improved. The test slightly differed from the pre-test to avoid students to memorize the concepts.

Population and Sampling

The population of the study was Form Two students and their physics teachers in Arusha City Secondary Schools. Four schools having computer laboratories were purposely selected. Stratified sampling was used to select 196 Form Two students and 8 teachers from the four schools. The strata considered gender balance.

Instruments

Electricity Achievement Conceptual Test (EACT) was used to collect the information from

respondents. It included pre-test and post-test. The two tests slightly differed because students could remember the questions and guess the answer which may affect the data validity. Each test consisted of 20 items. The table of specification and test administration procedures was followed accurately (Asia & Noel, 2016).

Statistical Treatment of Data

Descriptive statistics was used to analyze the data in order to determine the differences between the pre-test and the post-test results.

Validity and Reliability

Asia and Noel (2016) define validity as the extent to which the test measure what is intended to measure. To ensure validity, the tests were prepared by a team of experts including the teachers and lectures who were given the chance to assess and validate the tools. Reliability designates the consistency of the results. The tests were piloted in two schools to identify the errors and adjustments were made. The Pearson's method of correlation was used to compare the results through the calculated coefficient of correlation which yielded $r = 0.801$.

Ethical Considerations

The ethical issues were considered in the study. The study got the permit for data collection from various authorities and institutions, including The University of Rwanda and the Government Authority in Tanzania. Anonymity and confidentiality were considered in that names of respondents were not revealed.

Results and Discussions

This section presents the results of the study based on research questions that guided the study.

Research Question 1: How was the current level of students' understanding of the concepts of electricity in the prospect of other teaching methods used by teachers?

Table 1: Electricity Conceptual Achievement Test-ECAT (Pre-test)

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test score	196	3.00	92.00	38.082	16.75719
Valid N	196				

Teachers used various method to ensure successful learning outcome occurring. The methods used by the teachers include discussion, question and answers and lecture methods which

were not enough to empower learners to acquire adequate concepts of electricity. The pre-test results in Table 1 were analysed and the mean score of 38.082 and standard deviation of

16.75719 were established. The results are poor to claim that there is a sufficient conceptual understanding that learners achieved in electricity.

Research Question 2: To what extent did students' understanding of the concepts of electricity improve in the view of the CSCL approach?

The classroom intervention of CSCL approach in the sub-topic of current electricity was steered. The approach gave students and teachers

opportunity to interact enthusiastically in the classroom. The interface permitted students to collaborate and learner-centred approach was potentially utilized. Furthermore, students got a chance to use computer-laboratory in the physics lesson. Students appreciated the use of technology in teaching and learning. One student, for instance, was quoted reflecting the consequence brought by the approach: *"I saw how the electron and current move oppositely in PhET. I used to cram and memorize without justification."*

Table 2: Electricity Conceptual Achievement Test-ECAT (Post-test)

	N	Minimum	Maximum	Mean	Std. Deviation
Pre-test score	196	4.00	94.00	59.745	17.39898
Valid N	196				

Lately, the electricity achievement post-test was conducted and the mean score of 59.745 and standard deviation of 17.39898 were found which show the improvement compared to pre-test scores.

The study investigated how computer-supported collaborative learning can improve students' understanding of the concepts of electricity. Through the finding of the study, technology has been noticed to impact the improvement to support the innovation in education. Therefore, computer as a 21st Century tool plays great role to support all fields in STEM. According to the findings, the CSCL approach enabled students to improve their understanding of the concepts in electricity. This has been demonstrated by the results obtained from the post-test score as compared to ones in the pre-test. Therefore, the use of ICT plays a big part toward effective learning. Likewise, Ndiokubwayo, Uwamahoro and Ndayambaje (2019) discovered the impact of electronic tools in the physics classroom. Furthermore, Başer and Durmuş (2010) and Dega et al. (2013); obtained similar result regarding the improvement of students' conceptual understanding of the concepts in electricity.

In a broader sense, the CSCL approach provides a sequence of interesting activities which encourage innovation in the classroom. The learners have to perform and challenge themselves to reach consensus. Yet, Urhahne et al. (2010) describe the nature of the CSCL classroom as resulting in active learning. Active learning introduces maximum cooperation and donates conceptual improvement. The study's

findings revealed that using the CSCL approach to learn electricity concepts has a significant impact on conceptual improvement.

Conclusions and Recommendations

the study detected students' deficiency in the understanding of concepts in electricity in the prospect of the non-participatory teaching methods used before the intervention. After the classroom intervention through the CSCL approach, the variations were detected in that students' understanding of concepts in electricity improved. This means that when technology is incorporated, students' conceptual understanding is enhanced.

The study recommends teachers to use digital pedagogical approaches such as CSCL in the classroom contexts to bring about better learning outcomes. Furthermore, the study recommends that the information and computer studies should be compulsory in all schools to increase the usability by both teacher and students. Finally, the computer skills aspects should be enhanced in teacher education especially for science teachers.

Acknowledgements

The authors would like to thank the African Centre of Excellence for Innovative Teaching and Learning Mathematics and Science (ACEITLMS) for inspiration, encouragement and funding of the study.

References

- Asia, R., & Noel, M. (2016). Measurement and Evaluation In Education: Karljamer Publishers Limited.

- Başer, M., & Durmuş, S. (2010). The effectiveness of computer supported versus real laboratory inquiry learning environments on the understanding of direct current electricity among pre-service elementary school teachers. *Eurasia Journal of Mathematics, Science and Technology Education*, 6(1), 47-61. <https://doi.org/10.12973/ejmste/75227>.
- Berman, E. A. (2017). An exploratory sequential mixed methods approach to understanding researchers' data management practices at UVM: Integrated findings to develop research data services. <https://doi.org/10.7191/jeslib.2017.1104>.
- Dega, B. G., Kriek, J., & Mogese, T. F. (2013). Students' conceptual change in electricity and magnetism using simulations: A comparison of cognitive perturbation and cognitive conflict. *Journal of Research in Science Teaching*, 50(6), 677-698. <https://doi.org/10.1002/tea.21096>.
- Devedi, V. (2006). Computer-supported collaborative learning. In *Encyclopedia of Human Computer Interaction* (pp. 105-111). IGI Global. <https://doi.org/10.4018/978-1-59140-562-7.ch017>.
- Gikandi, J. W. (2020). Computer-Supported Collaborative Learning and Assessment: A Strategy for Developing Online Learning Communities in Continuing Education. In *Learning and Performance Assessment: Concepts, Methodologies, Tools, and Applications* (pp. 389-413). IGI Global. <https://doi.org/10.4018/978-1-7998-0420-8.ch019>.
- Guido, R. M. D. (2018). Attitude and motivation towards learning physics. *arXiv preprint arXiv:1805.02293*.
- Gunstone, R., Mulhall, P., & McKittrick, B. (2009). Physics teachers' perceptions of the difficulty of teaching electricity. *Research in Science education*, 39(4), 515-538. <https://doi.org/10.1007/s11165-008-9092-y>.
- Ismail, A., Festiana, I., Hartini, T. I., Yusal, Y., & Malik, A. (2019). Enhancing students' conceptual understanding of electricity using learning media-based augmented reality. *Journal of Physics: Conference Series*, 1157(3). <https://doi.org/10.1088/1742-6596/1157/3/032049>.
- Jaakkola, T., Nurmi, S., & Veermans, K. (2011). A comparison of students' conceptual understanding of electric circuits in simulation only and simulation-laboratory contexts. *Journal of research in science teaching*, 48(1), 71-93. <https://doi.org/10.1002/tea.20386>.
- Jansen, R. S., Van Leeuwen, A., Janssen, J., Jak, S., & Kester, L. (2019). Self-regulated learning partially mediates the effect of self-regulated learning interventions on achievement in higher education: A meta-analysis. *Educational Research Review*, 28, 100292. <https://doi.org/10.1016/j.edurev.2019.100292>.
- Kafyulilo, A. C. (2010). Practical Use of ICT in Science and Mathematics Teachers' Training at Dar es Salaam University College of Education: An Analysis of Prospective Teachers' Technological Pedagogical Content Knowledge. Online Submission.
- Manunure, K., Delserieys, A., & Castéra, J. (2020). The effects of combining simulations and laboratory experiments on Zimbabwean students' conceptual understanding of electric circuits. *Research in Science & Technological Education*, 38(3), 289-307. <https://doi.org/10.1080/02635143.2019.1629407>.
- Mäkitalo-Siegl, K., Kohnle, C., & Fischer, F. (2011). Computer-supported collaborative inquiry learning and classroom scripts: Effects on help-seeking processes and learning outcomes. *Learning and Instruction*, 21(2), 257-266. <https://doi.org/10.1016/j.learninstruc.2010.07.001>.
- Mazur, E., & Hilborn, R. C. (1997). Peer instruction: A user's manual. *Physics Today*, 50(4), 68. <https://doi.org/10.1063/1.881735>.
- Mbonyiriyuze, A., Yadav, L. L., & Amadalo, M. M. (2019). Students' conceptual understanding of electricity and magnetism and its implications: A review. *African Journal of Educational*

- Studies in Mathematics and Sciences, 15(2), 55-67. <https://doi.org/10.4314/ajesms.v15i2.5>.
- McDermott, L., & Shaffer, P. (1992). Research as a guide for curriculum development: An example from introductory electricity. Part I: Investigation of student understanding. *American Journal of Physics*, 60, 994-1003. Mioković.
- Mfaume, H. (2019). Awareness and Use of a Mobile Phone as a Potential Pedagogical Tool among Secondary School Teachers in Tanzania. *International Journal of Education and Development using Information and Communication Technology*, 15(2), 154-170.
- Ndibalema, P. (2014). Teachers' attitudes towards the use of information communication technology (ICT) as a pedagogical tool in secondary schools in Tanzania: The Case of Kondoa District.
- Ndihokubwayo, K., Uwamahoro, J., & Ndayambaje, I. (2020). Usability of Electronic Instructional Tools in the Physics Classroom. *EURASIA Journal of Mathematics, Science and Technology Education*, 16(11). <https://doi.org/10.29333/ejmste/8549>.
- Olan'g, Z. G. (2015). Effectiveness of teaching computer studies Subject in secondary schools in Arusha Municipality, Tanzania (Doctoral dissertation, Mzumbe University).
- URT. (2003). Ministry of communications and transport: National information and communications technologies policy. Dar es salaam, Tanzania.
- URT. (2007). ICT Policy in Tanzania.
- Uworwabaye, A. (2009). Teachers' innovative change within countrywide reform: a case study in Rwanda. *Journal of Mathematics Teacher Education*, 12(5), 315. <https://doi.org/10.1007/s10857-009-9124-1>.
- Van Joolingen, W. R., De Jong, T., & Dimitrakopoulou, A. (2007). Issues in computer supported inquiry learning in science. *Journal of Computer Assisted Learning*, 23(2), 111-119. <https://doi.org/10.1111/j.1365-2729.2006.00216.x>
- Voogt, J., Laferriere, T., Breuleux, A., Itow, R. C., Hickey, D. T., & McKenney, S. (2015). Collaborative design as a form of professional development. *Instructional science*, 43(2), 259-282. <https://doi.org/10.1007/s11251-014-9340-7>.
- Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.
- Wieman, C., & Perkins, K. (2005). Transforming physics education. *Physics today*, 58(11), 36.