

Shortage of Science and Mathematics Teachers and its Impacts on Secondary Schools in Tanzania

¹Josephine Donald Mremi; ²Muraina Kamilu Olanrewaju;
Unicaf University, Malawi;
E-mail: josengalas@gmail.com

Prince Abubakar Audu University Anyigba, Nigeria;
²E-mail: muraina_kamilu@yahoo.com

ABSTRACT

This article discusses the shortage of science and mathematics teachers and its impacts on secondary schools in Tanzania. The study adopted a mixed-methods research approach. A total of eight (8) secondary schools were selected. The data were collected through questionnaires and interviews. A total of 106 respondents (98 students and 8 Science Teachers) were involved in responding to the questionnaires and interviews respectively. Quantitative data were analysed using frequency count and percentage while qualitative data were analysed using thematic analysis. Poor performance in science subjects was revealed as the major causative of the shortage of science and mathematics teachers. Many students fail in science and mathematics; thus, the number of graduates declines. Considering that some of the science graduates join other careers, a few join teaching career. This trend of cause and effect creates a cyclic relationship between the factors and the impacts of the shortage of science and mathematics teachers. The study recommends that stakeholders should motivate students to like science, mathematics, and teaching career and ensure that they emphasize positive students' attitudes toward science and mathematics subjects.

Keywords: Science, Mathematics, Shortage of science teachers, Impacts, Tanzania.

INTRODUCTION

Science and mathematics are essential subjects in problem-solving in this changing world of science and technology (Ting-Sheng, 2017). The two (Science and Mathematics) are also considered fundamental in other academic subjects in schools. So many countries, worldwide, are growing economically, technologically, and scientifically due to development in science and mathematics (Li & Schoenfeld, 2019). All countries, including Tanzania, need scientists in many sectors, including agriculture, medical, communication, mining, transportation, construction, and education, just to mention a few (Garcia & Weiss, 2019). The shortage of science and mathematics teachers affects many of these sectors (Mremi, 2022). No one could deny that teachers are essential and responsible for educating all people in any country. Therefore, the shortage of science and mathematics teachers is a serious challenge in this changing world of science and technology.

The shortage of science and mathematics teachers in secondary schools in Tanzania, like in other countries, is a problem that needs to be addressed. The literature shows that the problem is worldwide (Projest, 2013; Ndalichako & Komba 2014; Dlamini, 2014; Kamagi, 2017; Garcia & Weiss, 2019; Mremi, 2022). Many studies, including the current one, have identified the factors behind poor performance in mathematics and science subjects and, among others, poor competence of teachers, insufficient and inadequate teaching and learning facilities, and student negative attitudes towards science and mathematics (Kihwele, 2014; Michael, 2015; Cheung, 2018; Mazana et al., 2020). The students' perceptions and methods of teaching science and mathematics have led to many students' dislike teaching careers (Saks et al., 2016). Studies have noted that mathematics is a crucial subject for understanding other science subjects such as engineering, computer science, and technology (Mazana et al., 2020). This suggests that if students are struggling to understand mathematics, then it is obvious that there is a struggle in studying the said subjects. Consequently, many of them fail their final examinations, leading to a low number of science and mathematics graduates in Tanzania (Mremi, 2022). For several decades, many governments, including Tanzania, have made some efforts

to minimize the shortage of science and mathematics teachers, but the problem still exists. The efforts include some policy-related reforms and education-related efforts such as funding the students who study science and mathematics at tertiary level, as well as school-related interventions like building science laboratories in each secondary school. For instance, in South Africa, two programmes, the Funza Lushaka Bursary Programme (FLBP) and the South African Mathematics and Teacher Intern Programme (SAMTIP) support the Science and Mathematics subjects. These two programmes have increased enrollment in Bachelor of Education and Postgraduate Education Courses (PGEC) in Science and Mathematics (Barrett et al., 2019). In Tanzania, some reforms and programmes include the establishment of School Mathematics Project (SMP), the School Science Project (SSP), and the Science Teacher Improvement Project (STIP) which aimed at improving science and mathematics teachers' knowledge and skills. Some of these reforms underwent the trial stage but were never implemented; others were implemented but with poor achievements (Osaki, 2007). Despite the efforts, the shortage of Science and Mathematics teachers is still an area of concern in many African countries; the student's performance in science and mathematics has remained consistently poor (Ndalichako & Komba, 2014).

According to Mnanka and Likwawa (2017), three essential components must be considered to increase the number of science students enrolled in secondary schools in Tanzania. These include appropriate science teaching strategies; professional and competent teachers; and availability of science educational materials, such as textbooks, laboratory equipment, as well as other necessary supplies of other curriculum materials. Studies suggest that there is a strong correlation between the number of science students enrolled in secondary schools and the availability of science teaching resources, such as laboratory equipment, science textbooks, and science teachers (Osaki, 2007). Literature indicates that Science and Mathematics teachers are scarce in Tanzanian secondary schools. This is due to the fact that many students' dislike entering a teaching career. Most students who choose to study science subjects tend to join other science-related careers, and not to teach. A study by Hizza, Komba and Jonathan (2012) reported that the four

selected schools in Moshi had more teachers in the social science subjects than the natural science subjects. This suggests that the government's efforts to raise the number of trained scientists in the country will hardly be achieved because science teachers are not sufficient in the country, particularly in secondary schools. The National Bureau of Statistics provided a study report on the topic, which showed that, for instance, the total number of primary and secondary school teachers in 2017 had decreased by 4.01 and 1.7 percent, respectively, by 2021 (Mremi, 2022). On the other hand, during that five-year period, the number of students attending primary and secondary schools increased dramatically by 19% and 52%, respectively (Anonymous, 2022). Also, the teacher-to-student ratio has increased significantly from the normal of 1/45 to 1/50 in 2017 and 1/62 in 2021; this is continually rising, regardless the countless numbers of unemployed college graduates (who could be teachers) (Anonymous, 2022). Arguably, this has great impact on science subjects. Thus, the current study investigated the shortage of science and mathematics teachers and its impacts in Tanzanian secondary schools.

The main objective of this study was to examine perceived shortage of science and mathematics teachers and its impacts on secondary schools in Tanzania. Specifically, the study examined:

1. Causes for the shortage of Science and Mathematics teachers in the selected schools in Tanzania
2. The impacts of the shortage of Science and Mathematics teachers in Tanzania
3. Relationship between the causes of the shortage of Science and Mathematics teachers and their impacts on Secondary Schools in Tanzania

Methodology

This study employed a mixed-method research approach. Pwani region – Tanzania (Kibaha and Bagamoyo districts) was involved in this study. The region was selected purposively based on the National Examination Council of Tanzania – NECTA performance. For more than five years, the region maintained its performance; it positioned itself among the top ten secondary

schools in the country (Said, 2018). A total of eight (8) secondary schools were selected. The Eight schools were tagged A-H for confidential and ethical reasons. The schools were randomly selected from the list of schools which were teaching science and mathematics subjects up to the Advanced level. The data were collected through questionnaires and interviews. A total of 98 students were involved in responding to the questionnaires while 8 science teachers were involved in interviews. All ethical issues were taken into consideration including confidentiality, obtained consent, research permit, approval of the research tools, and avoidance of plagiarism. Interviews were used to collect qualitative data from selected science teachers, compiled, and analyzed using thematic analysis, which is a step-by-step data analysis method for qualitative data (Maguire & Delahunt, 2017; Clarke & Braun, 2013; Thomas & Harden, 2008; Attride-Stirling, 2001). During thematic data analysis, the factors causing the shortage of science and mathematics teachers were obtained by putting together the main ideas into basic themes. Then, these were summarized into organized themes and later combined to form global themes, which are the main points in the data collected from the participants. The same steps were followed to analyze the data related to the impacts of the shortage of Science and Mathematics teachers in secondary schools. Quantitative data were analysed using frequency count and percentage.

Results

This section discusses the findings of this study. The discussion is divided into three sub-sections (themes) developed from the thematic analysis.

Causes of the Shortage of Science and Mathematics Teachers in the Selected Schools

Students' responses about the causes of the shortage of science and mathematics teachers were more or less similar to the science teachers' interview responses. Most of the students revealed that poor performance in Science and Mathematics is one of the factors leading to the shortage of science and mathematics teachers in secondary schools in Tanzania. Figure 1 summarizes students' responses to the causes of the shortage of science and mathematics teachers in secondary schools in Tanzania.

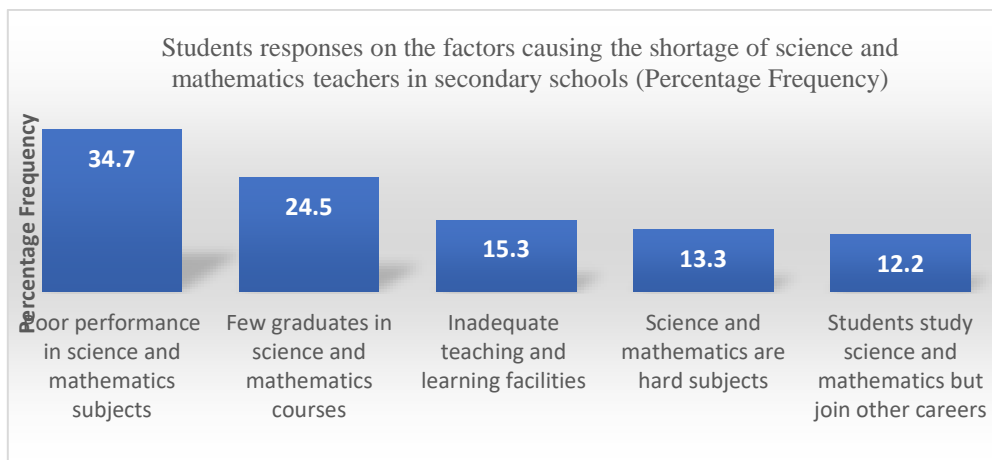


Figure 1: Causes of the Shortage of Science and Mathematics Teachers in Secondary Schools (98 students' responses)

Figure 1 revealed that the causes of the shortage of science and mathematics teachers are due to poor performance in Science and Mathematics subjects, few graduates in Science and Mathematics courses, inadequate teaching and learning facilities, Perceiving Science and Mathematics as hard subjects, and students studying science and mathematics join other careers eventually. All these and many others are responsible for the shortage of Science and Mathematics teachers in secondary schools. The current research discovered that students' dislike the teaching career is one of the causes of the shortage of science and mathematics teachers. When the students explained why they studied science and mathematics, most of them indicated that they wanted to become doctors, engineers, pilots, computer scientists, or nurses; very few wanted to become teachers. For instance, teacher "B" specifically said:

Most students are studying Economics, Geography, and Mathematics subjects because their ambition is to be teachers of economics and geography.

Teacher 'G' responded:

Otherwise, students would like to pursue science disciplines, including biology, chemistry, and physics, which will help pave the way to accomplish their ambition to become medical doctors.

Some of the students said that they did not like to become teachers because of the low salaries. Figure 1 summarizes the percentage frequency responses from the students about the causes for the shortage of science and mathematics teachers in the study area. Teacher ‘E’ commented that:

“Most students are studying science and mathematics because they want to be gas and petroleum engineers and not teachers.” Teacher ‘F’ said: *“students have passion to study science and mathematics because they want to become medical laboratory technician.”*

The Impacts of the Shortage of Science and Mathematics Teachers

When participants were responding to the questions on the impacts of the shortage of science and mathematics teachers in secondary schools, they mentioned low performance in science and mathematics subjects. Also, they mentioned students avoiding entering teaching careers; high teacher-student ratio; students looking for assistance from outside the school; high teaching load; unfinished syllabi; and low students’ interest in studying science and mathematics subjects. Results of the data about the impacts of the shortage of science and mathematics teachers are summarized in figure 2. The major impacts found in the current research included low performances in science and mathematics subjects. With the shortage of science and mathematics teachers, teaching and learning become ineffective leading to low performance in the same subjects. The research revealed that the shortage of science and mathematics teachers had an impact on students who were studying science and mathematics and were interested in science-related careers and mathematics-related careers. These careers include mechanical engineering, electrical engineering, gas and petroleum engineering, pilots, doctors, and others healthy related careers such as dentists, nursing, doctor of medicine, and pharmacy, just to mention a few. Some of them revealed that they were studying science and mathematics because they have a passion for those subjects. They viewed a teaching profession as a low-paying job when compared to other science-related careers such as engineering, medical doctor, and a pilot just to mention a few. Teacher “A” noted that:

Students are studying science subjects because they want to become pilot as prestigious job that can pay them better than other careers. They struggle to pass course combination to ensure they go for the career.

The current study revealed that among the impacts of the shortage of science and mathematics teachers include high teaching load and high teacher-student ratio as indicated in figure 2. The current research study discovers that when science and mathematics teachers are scarce then there is high teachers' workload and syllabi remain unfinished resulting in lower performance. The trend moves on and on until the education stakeholders find a proper intervention. These impacts then cause the shortage of science and mathematics teachers. Students who like to study science and mathematics subjects in the future end up looking for substitute teachers outside the school, especially during the school holidays. These students might end up with unqualified teachers who have no teaching skills and thus affect their learning trend. In the end, the students fail their studies and create more low students' interest in studying and teaching science and mathematics subjects.

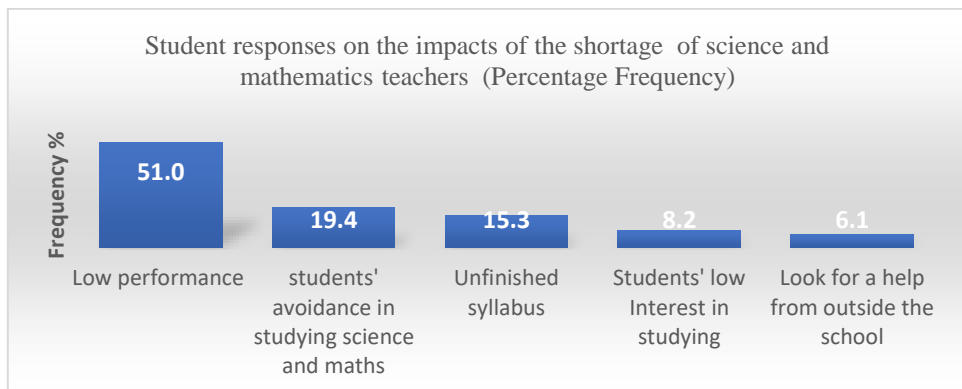


Figure 2: Impacts of the Shortage of Science and Mathematics Teachers in Secondary Schools in Tanzania (98 students frequency percentage)

Therefore, the factors that cause the shortage of science and mathematics subjects are almost the same as the impacts of the shortage. For instance, poor performance is a factor that causes the shortage of science and mathematics teachers and at the same time impacts science and mathematics

teachers. If the students are not performing well, it means we will not have sufficient teachers who will continue teaching science and mathematics subjects in future. Thus, there will be more poor performance in science and mathematics subjects, which is an impact of the shortage of the same.

Relationship between the Factors causing the Shortage of Science and Mathematics Teachers and their Impacts on Secondary Schools in Tanzania

The trend of phobia for science and mathematics continues in the country and it creates a circle whereby the factors causing the shortage of teachers will also appear to create direct impacts on Secondary Schools in Tanzania. The current research revealed that the trend of the factors causing the shortage of science and mathematics teachers and their impacts on secondary schools build the cyclic relationship between them. This relationship between the factors causing the shortage of science and mathematics teachers and their impacts is summarized in figure 3. Whenever there are a few graduates in science and mathematics subjects, many of them enter other science-related or mathematics-related careers, very few join the teaching career. If teachers are few, then they become scarce in secondary schools, and the trend intensifies the problem of the shortage of science and mathematics teachers. Thus, students will perform low if there is no strong intervention.

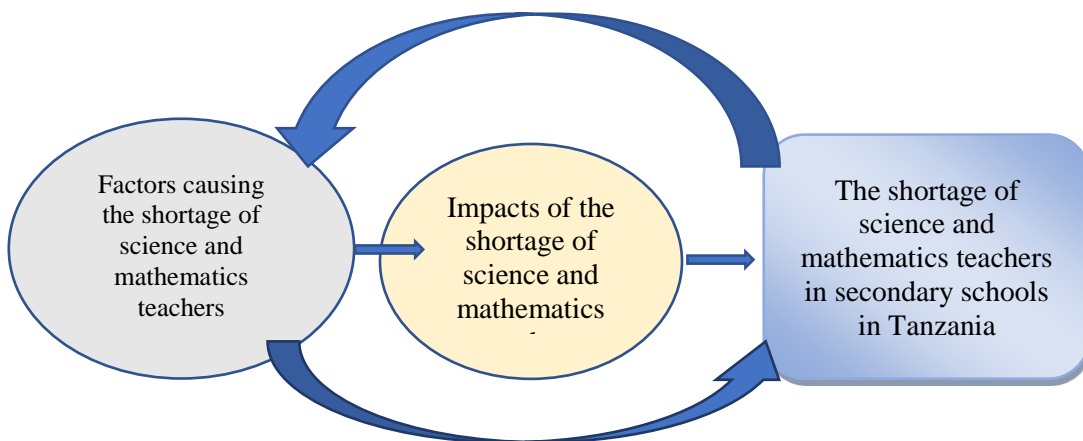


Figure 3: The Cyclic Relationship between the Factors causing the Shortage of Science and Mathematics Teachers and their Impacts on Secondary Schools in Tanzania

Discussion

The findings of the current study imply that, apart from several efforts that were undertaken to address the shortage of science and mathematics teachers in secondary schools in Tanzania, there is still a lot to be done to get away from the problem. This is not a task that can be resolved by a single individual, but by all stakeholders in education including students, parents, teachers, school management, and the government, should work together. The cyclic relationship between the factors causing the shortage of science and mathematics teachers and their impacts on secondary schools in Tanzania should be disconnected. The findings of the current study are in connection with Mazana, Montero, and Casmir’s (2020) study, who suggested that poor performance in science and mathematics subjects in secondary schools causes a few graduates in science and mathematics at higher or tertiary levels of education. It is argued that poor performance in secondary schools increases the shortage of science and mathematics graduates and it is the cause of the decline of graduates. As it is in the current study, Mazana, Montero, and Casmir suggest that among these few science and mathematics graduates, upon completion of their studies, many of them join other science and/or mathematics-related careers; only a few enter teaching career. The findings indicate that some students lose interest and

avoid studying science and mathematics subjects. These factors are related to the issue of poor performance, as suggested by Projest (2013). When there is poor performance, the students tend to lose interest in studying the subjects and avoid the subjects because of the feeling that they will not achieve their goals in the end. There are few graduates in science and mathematics subjects, which affects teaching, especially if these few graduates join other careers. Arguably, this contributes to the shortage of teachers. When students lose interest, they tend to dislike the subjects, and if they continue studying them, they fail at the end (Cheung, 2018). To avoid failing in the end, the current study suggest that such students tend to avoid studying science and mathematics subjects, while some decide to look for assistance from outside the school. It is clear in this study that students' avoidance to teaching career contributes to the shortage of science and mathematics teachers. If students avoid teaching career and, at the same time, very few are graduating in science and mathematics, it is obvious that the shortage of science and mathematics teachers in secondary schools intensifies.

This argument is in connection with Ndalichako and Komba (2014), Projest (2013) and Dlamini (2014). It is argued in the current study that the shortage of science and mathematics teachers in secondary schools and their impacts are maintained by the cyclic relationships between factors and the impacts of the shortage of science and mathematics teachers. This suggests the factors that cause the shortage of science and mathematics teachers create some impacts on students and schools; these impacts, in turn, become the cause of the shortage. This cyclic relationship embraces the problem at every stage in the education system for decades (Mremi, 2022). The factors that are causing the shortage of science and mathematics teachers and the impacts that have shown a cyclic relationship have serious effects on the country's science and mathematics subjects and further affect the economic and technological growth. They result in a low number of scientists in the country, thus Tanzania's growth in science and technology is also affected (Mremi, 2022). The shortage of science and mathematics teachers causes and sustains low performance in those subjects. The low performance causes other factors such as a low number of graduates in science and

mathematics as well as the low number of graduates who are interested in teaching career. Thus, the cyclic relationship between the factors for the shortage of science and mathematics teachers and their impacts remains unsolved and affects secondary school, as well as the tertiary levels.

Conclusion

Based on the findings and discussion, this study concludes that:

1. Poor performance in science and mathematics subjects, students' avoidance of science and mathematics subjects, and the shortage of graduate students in science and mathematics contribute to the shortage of science and mathematics teachers.
2. A high teacher-student ratio, uncompleted syllabi, a high teaching load, low interest in studying science and mathematics, students seeking outside help, and students' pursuit of other science and mathematics-related careers are some of the consequences of a shortage of science and mathematics teachers.
3. There is relationship between the factors causing the shortage of science and mathematics teachers and their impacts on secondary schools in Tanzania. The trend of the factors causing the shortage of science and mathematics teachers and their impacts on secondary schools build the cyclic relationship between them.

Recommendations

Based on the current research findings, the researcher recommends that:

1. The school management, education officers, and the government, through its relevant ministries, should understand the cyclic relationship between the factors causing the shortage of science and mathematics teachers and their impacts so as to address the shortage of science and mathematics teachers.
2. Stakeholders should first motivate students to like science, mathematics, and teaching careers and ensure that they emphasize positive students' attitudes towards science and mathematics subjects.
3. The school management should be responsible for resolving the school-based factors such as inadequate teaching and learning facilities, lack of qualified teachers, insufficient textbooks, libraries, and housing facilities for teachers.

REFERENCES

- Attride-Stirling, J. (2001). Thematic networks: An analytic tool for qualitative research. *Qualitative research*, 1(3), 385-405.
- Barrett, A.M., Gardner, V., Joubet, M.&Tikly, L. (2019). *Approaches to strengthening secondary STEM & ICT education in Sub-Saharan Africa*. MasterCard Foundation.
- Braun, V.,&Clarke, V. (2006).Using thematic analysis in psychology. *Qualitative Research in Psychology*,3, 77-101. [https://doi.org/ 10.1191/1478088706qp063oa](https://doi.org/10.1191/1478088706qp063oa)
- Cheung, D. (2018). The key factors affecting students' interest in school science lessons. *International Journal of Science Education*, 40(1), 1-23. <https://doi.org/10.1080/09500693.2017.1362711>
- Clarke, V. & Braun, V. (2013). Teaching thematic analysis: overcoming challenges and developing strategies for effective learning. *The Psychologist*, 26 (2).120-123.
- Dlamini, Z. T. (2014). *Factors associated with the shortage of physics teachers in senior secondary schools in Swaziland*. (Master's dissertation, the University of South Africa).
- Garcia, E. & Weiss, E. (2019). *The teacher shortage is real, large and growing, and worse than we thought*. The first report in 'The Perfect Storm in the Teacher Labor Market' series.
- Hizza, E. L., Komba, C. K., & Jonathan, T. Y. (2012). *Factors influencing academic performance of Ward secondary schools: A case of selected schools in Moshi Municipality and Moshi District*. MUCCoBS.
- Kamagi, D. (2017). *Tanzania needs over 24,000 science and mathematics teachers: Parliament told*. The Citizen Newspaper article.
- Kihwele, J. (2014). Students' perception of science subjects and their attitude in Tanzanian secondary schools. *World Journal of Educational Research*,1(1), 1-7.
- Kothari, C. R. (2004). *Research methodology: Methods and techniques* New Age International (P) Limited Publishers. 2nd Multi Colour Edition. New Delhi, India.
- Li, Y. & Schoenfeld, A.H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *IJ STEM Ed*,6,44. <https://doi.org/10.1186/s40594-019-0197-9>
- Magano, F. L. (2014). *A review of strategies to address the shortage of science and mathematics educators in grades 10-12*. PhD thesis, the University of Pretoria, Pretoria, South Africa).
- Maguire, M. & Delahunt, B. (2017). Doing a thematic analysis: a practical, step-by-step guide for learning and teaching scholars. *AISHE Journal*,

8(3).

- Mazana, M.Y., Montero, C.S., & Casmir, R.O. (2020). Assessing students' performance in mathematics in Tanzania: the teachers' perspective. *International Electronic Journal of Mathematics Education*, 15(3), 1-28.
- Michael, I. (2015). *Factors leading to poor performance in mathematics subject in Kibahase secondary schools*. (Master's dissertation, the Open University of Tanzania, Dar es Salaam, Tanzania).
- Mnanka, G.M., & Likwawa, S. (2017). *An investigation into causes of fewer science students in Tanzania secondary schools: A case of selected Kinondoni Municipal secondary schools*. Research paper.
- Mremi, J. D. (2022). *Factors causing the shortage of science and mathematics teachers and the impacts on secondary schools in Tanzania* PhD thesis, Unicaf University Malawi).
- Ndalichako, J. L. & Komba, A. A. (2014). Students' Subject Choice in Secondary Schools in Tanzania: A Matter of Students' Ability and Interests or Forced Circumstances? *Open Journal of Social Sciences*, 2, 49-56. <http://doi.org/10.4236/iss.2014.28008>
- Osaki, K. M. (2007). Science and mathematics teacher preparation in Tanzania: Lessons from teacher improvement projects in Tanzania 1965-2006. *NUE Journal of International Education Cooperation*, 2 (1), 51-64.
- Projest, G. (2013). *The effects of shortage of teachers on curriculum implementation in community secondary schools in Tanzania: The case of Bukoba Municipality* (MA. Dissertation, the Open University of Tanzania, Dar es Salaam, Tanzania).
- Said, K. (2018, July 13). *Tanzania: NECTA names top ten schools in 2018 ACSEE form six exams*. The Citizen.
- Saks, K., Soosaar, R. & Ilves, H. (2016, November). The students' perceptions and attitudes to the teaching profession, the Case of Estonia. *The European Proceedings of Social and Behavioural Science (EpSBS)*. A conference Paper.
- Anonymous, (2022, February 22). Editorial: Solve teacher shortage to avoid further Agony. *The Citizen*.
- Thomas, J. & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, 8:45
- Ting-Sheng, W. (2017). The importance of mathematics and science education in the context of digital technology on industrial innovation. *Research Journal of Applied Sciences, Engineering, and Technology*, 14(11), 418-426. <https://doi.org/10.19026/rjaset.14.5142>