

Title: Exploring Mathematics and Science teachers' self-efficacy in adopting online teaching methodology, in public secondary schools in Kenya.

Author: Gladys Aliviza Mwugusi

Abstract

Considerable research has demonstrated that teachers' self-efficacy plays a major role in implementing instructional practices. However little has been written about how teacher professional development and especially in-service training could be reoriented to include self-efficacy as an organizing construct or framework. This paper reports on the findings of a study that used Teacher Self-Efficacy (TSE) construct (Bandura 1977) as a theoretical framework to understand the effect of online teacher professional development on teachers' self-efficacy towards adopting online teaching methodology. A mixed-method design was used to guide the methodology of the study, and data was collected using overall evaluation from 590 Mathematics and Science teachers. Findings showed that online teacher professional development had a positive effect on teacher self-efficacy towards adopting online teaching methodology. Also teachers' favorable perception on ease of use of the online learning platform influenced them to develop online teacher self-efficacy.

Keywords: Teacher professional development, online teaching methodology, Teacher Self-Efficacy

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I. Introduction

The prolonged disruption of teacher-learner face-to-face interaction due to COVID-19 pandemic caused a sudden shift in teaching and learning to online teaching in many countries. However the transition to online teaching was associated with numerous challenges such as; lack of online teaching experience (Johnson et al. 2020), and the difficulty experienced by teachers in their ability to communicate effectively with students, as well as restricting them from transitioning from the physical classroom into the online contexts (Putri et al. 2020). There was need to strengthen teachers' capability in using online platforms for teaching and learning. The Center for Mathematics, Science and Technology Education in Africa (CEMASTEA) conducted an eight-week online teacher professional development (TPD) course for 1163 Secondary school Mathematics and Science teachers in Kenya from June to July, 2020. The aim of the training was to build the teachers' teaching confidence and competency in online teaching techniques. Over a period of eight-weeks teachers were expected to demonstrate the ability to design activities and learning experiences that promoted learners' critical thinking and problem-solving skills in their subjects, undertake a project of creating Google classroom with relevant content and invite their learners, plan lessons and peer teach using online platforms in an engaging and interactive manner. However, lack of exposure for teachers on online education theory and its practical application during the pre-service training, posed challenges to the efforts of developing teacher's feeling of self-efficacy in the online teaching environment. As (Johnson et al. 2020), pointed out that the tendency for teachers to feel less self-efficacious about online teaching is the disparity between physical and online classroom environments. This may be due to the fact that teacher's self-efficacy starts early during pre-service training program where as a trainee they gain academic knowledge on teaching, and practice teaching in a traditional face-to-face classroom to build teaching confidence and competency. According to Northcote, Gosselin, Reynaud, Kilgour, and Anderson (2015), educators who are confident in their abilities in face to face teaching may not bring this confidence with them to online teaching. As such, it becomes necessary to identify underlying sources of efficacy beliefs that could help a teacher to experience success during the online TPD course, and build confidence towards adopting online teaching. According to Bandura's self-efficacy theory (1997), self-efficacy originates from four key sources namely mastery experiences, social persuasion, vicarious experiences and psychological responses (Unal, Yamac, & Uzun, 2017). There is need for TPD programs to develop and implement professional development activities that provide opportunities for teachers to experience the four key sources of efficacy identified by Bandura (1997).

The purpose of this study was to explore the effect of online TPD on teacher self-efficacy towards adopting online teaching methodology. The following four research questions were used to guide the study: 1. what opportunities did CEMASTEA online TPD provide to teachers to gain mastery in subject content and on use of online learning platforms? 2. How did verbal support by CEMASTEA trainers promote the teachers' belief in themselves and their classroom practices? 3. How did interactions with other teachers participating in

the online TPD promote the teachers' belief in themselves and their classroom practices? and 4. What were the perceptions of mathematics and science teachers' on the ease of use of the online platform?

II. Literature Review

Construct of self-efficacy

The social cognitive theory provides an autonomous view of human behaviour in which individuals, through their own self-referent thoughts and feelings, can in part determine the course of actions they take. Of these self-referent thoughts, none is more important than the beliefs individuals hold about their own capabilities, or self-efficacy beliefs (Bandura 1995). Therefore from a social cognitive perspective, the construct of self-efficacy represents human being's perception of their ability to complete foreseeable daily tasks, which shape their decision-making process. In relation to education, teacher's self-efficacy, is the belief that one has the capability of influencing a student's learning and engagement in the learning process (Mehdinezhad, 2012). In line with this view, Bandura's (1997) theory of teacher's self-efficacy, broadly defines self-efficacy, as the extent to which a teacher feels capable of helping students learn. In the context of this study, the focus was on teachers' beliefs in their abilities to successfully use online teaching methodology to influence their student's learning and engagement in the learning process. According to (Glackin & Hohenstein 2018; Van Acker et al. 2013), teacher self-efficacy plays an essential role in the choices of the teacher's personal goals, the extent of being persistent in the face of adversity and the strength of motivation to carry out certain behaviours in teaching such as use of digital teaching learning materials.

Sources of Self-Efficacy

According to self-efficacy theory, influences upon self-belief can be divided into four sources: enactive mastery experience or prior task-based achievement; vicarious experience or observation of peers and other role models; verbal/social persuasion, or encouragement from others; and physiological and affective states, or physical/emotional conditions (Bandura, 1977, Usher & Pajares, 2008).

The most effective way of creating a strong sense of efficacy is through enactive mastery experiences. According to (Bandura, 1997; Schunk & Usher, 2012), the most reliable sources of efficacy information are typically accomplishments that we have experienced ourselves, for which we have "tangible" evidence of success. In relation to this study, it was postulated that enactive mastery experience would be realized by exposing teachers to various activities that involved reflections, and discussions in topics, Project work on creating Google classroom, uploading relevant content and inviting their colleagues in to the classroom as learners. The success teachers would experience as they carried out these activities and navigated the online platform would help convince them that they have what it takes to succeed, and therefore build a strong belief in their personal efficacy.

The second way of creating and strengthening self-beliefs of efficacy is through the vicarious experiences provided by social models. According to, (Bandura, 1997; Schunk, Hanson, & Cox, 1987), observing others perform tasks successfully can provide individuals with a sense of confidence in their ability to perform similar tasks. In this study vicarious experience was to be realized by providing teachers opportunities to collaboratively plan lessons in groups, and peer teach lessons in an online class in an engaging and interactive manner as others observed.

Social persuasion is a third way of strengthening people's beliefs that they have what it takes to succeed through receiving encouragement from others. In this study this was to be realized by giving participants guidance, encouragement and appropriate feedback during their professional development learning experiences.

A physiological state is the fourth way of strengthening self-beliefs. In relation to this study this was to be realized by providing a safe, non-threatening, supportive environment that accorded participants time to interact and establish rapport with each other and with their trainers.

Studies Related to Teacher Self-Efficacy y in Adopting Online Teaching Methods

Numerous research studies on teacher self-efficacy in online education have been undertaken to understand if teachers might adopt online teaching readily. Teachers' Sense of Efficacy Scale (TSES) (Tschannen-Moran & Woolfolk Hoy 2001) has been the most commonly used scale for TSE studies (Ma et al., 2019). The TSES has been used for a face-to-face mode of education delivery and modified for online education. Also Models such as; Technology Acceptance Model (TAM) and the Technological Pedagogical and Content Knowledge framework (TPCK or TPACK) have frequently been used to measure teacher self-efficacy (Davis 1989; Mishra & Koehler 2006). The TAM model has often been used to understand teacher behaviour in online education. For instance the TAM model was used in a study conducted by (Liaw, Huang, & Chen, 2007), which focused on measuring the association between teacher self-efficacy and the intention to use e-learning of 30 teachers. The study revealed that satisfaction with the quality of the technology influenced teacher self-

efficacy, and self-efficacy emerged as a predictor of teacher intent to use e-learning in the classroom. This finding was supported by a study done by (Al-Sayyed & Abdalhaq, 2016; Waheed 2010). Contrary to this, the study conducted by (Yuen & Ma, 2008), that involved 152 in-service teachers contradicted the TAM model, and found that ease of use was a predictor of e-learning adoption, and not usefulness of e-learning. Whereas another study by Awofala et al. (2017) stated that perceived usefulness and perceived control was not a factor for teacher's self-efficacy in ICT integration.

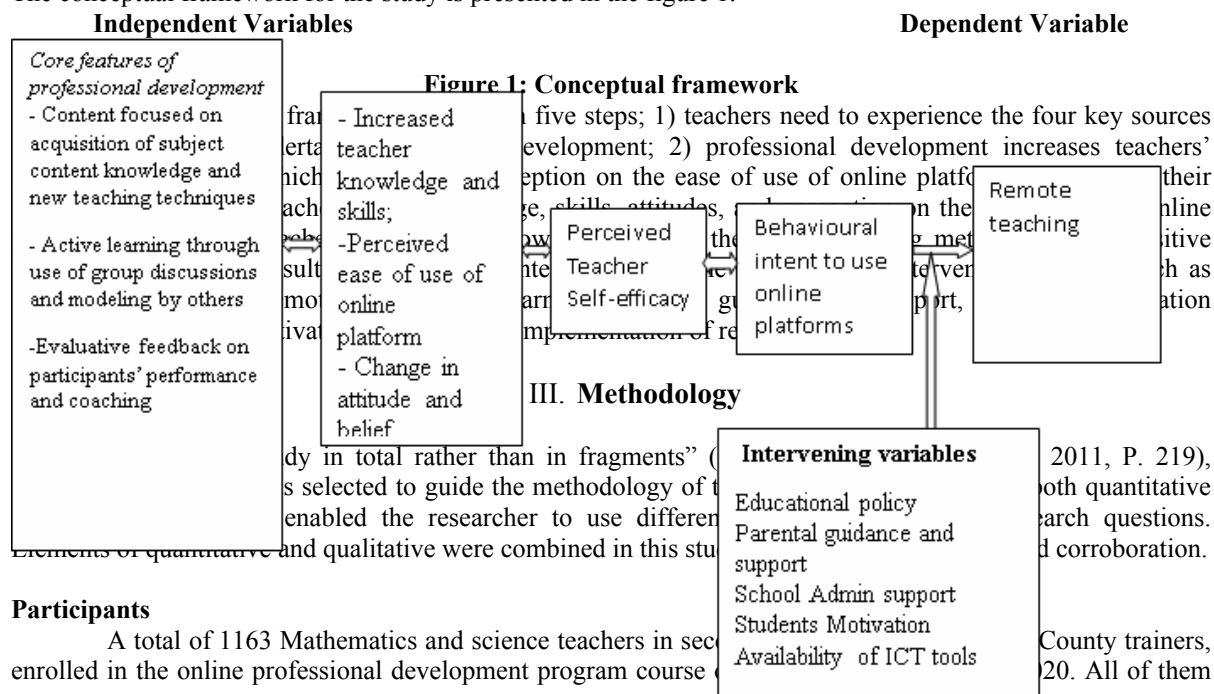
A study conducted by Fordham and Vannatta, (2005), assessed 177 teachers' characteristics to identify the specific indicators that would predict classroom technology usage. The revealed that time commitment to teaching, openness to change, and sufficient training was the best predictors of usage. While a study by Raphael and Mtebe (2017), which examined 386 teachers' self-efficacy towards ICT integration in the classroom at two colleges in Tanzania, established that the sources of ICT self-efficacy are supports, ease of use, performance expectancy, and social influence.

A number of research studies have been conducted to establish factors that influence development of online teaching self-efficacy. For instance a study conducted by (He 2014), established that TSE for online instruction of a cohort of teachers increased by completing an online teacher education course and their TSE for applying technology into online teaching environment was the most worrying. In line with this view, Richter, S., & Idleman, L. (2017), revealed that TSE for online instruction increased with teachers spending more time on it, while that for technology application remains a concern due to lack of technological support.

Though numerous research studies on teacher self-efficacy in online education have been undertaken, most of the teacher self-efficacy measurement instruments used, have been based on scales internally validated for teachers using a face-to-face mode of education delivery and modified for online education. While other studies offer conflicting or incomplete guidelines, for instance the study by (Liaw, Huang, & Chen, 2007) revealed that satisfaction with the quality of the technology influenced teacher self-efficacy, however this was contradicted in another study by (Yuen & Ma, 2008) who found that ease of use was a predictor of e-learning adoption, and not usefulness of e-learning. Raphael and Mtebe (2017) found that the sources of ICT self-efficacy are supports, ease of use, performance expectancy, and social influence, while Awofala et al. (2017), stated that perceived usefulness and perceived control was not a factor for teacher's self-efficacy in ICT integration. Also research studies on measuring changes in teacher self-efficacy before and after teacher professional development and education programmes, have raised the question of whether there is an undefined component, which defines self-efficacy for online teaching (Chai, Koh, & Tsai 2010; Hernandez et al. 2014; Hung et al. 2010; Moore-Adams and Jones, 2015; Woodcock, Sisco, & Eady, 2015). In particular, little attention has been given on how teacher self-efficacy towards adopting online teaching methods evolves as a result of undergoing TPD programs using teachers' own evaluation feedback.

Research conceptualization

The conceptual framework for the study is presented in the figure 1.



Participants

A total of 1163 Mathematics and science teachers in secondary schools enrolled in the online professional development program course

were purposively sampled to participate in the study. However 590 participants comprising of 154 females and 436 males out of 1163, evaluated the training giving a response rate of 50.7%.

Measurement

The following tools were used to collect data; daily session evaluation, and the overall evaluation questionnaire comprising of four main aspects: skills gained, support and guidance by trainers, interactions with other participants, and online platform. A total of 17 items were rated on a 5-point likert scale, where one indicated very poor and five very good. At the end of each day of the training a link was sent to participants to evaluate the sessions covered during the day. Prior to completing the online professional development session, the overall evaluation questionnaire was administered through email, and participants were asked to fill out. These instruments were validated; pilot tested and the reliability coefficients established were 0.90 and 0.86 respectively. Quantitative data was analyzed using frequency counts and mean ratings, and presented in the form of tables and bar graphs. To interpret the findings, the following criteria were applied to mean ratings: $1 \leq x \leq 1.4$, very poor; $1.5 \leq x \leq 2.4$, poor; $2.5 \leq x \leq 3.4$ fair; $3.5 \leq x \leq 4.4$, good; and $4.5 \leq x \leq 5$ very good where x is the mean rating. These criteria are applicable to the rating scale 1- Very Poor, 2- Poor, 3- Fair, 4- Good, 5- Very Good. The qualitative data was analyzed and categorized based on emerging themes and used to support the interpretation of quantitative data.

IV. Results

Research question one was designed to establish opportunities provided by CEMASTEAs online TPD to teachers to gain mastery in subject content and on use of online learning platforms, data was analyzed to get frequency counts and mean ratings as shown in table 1. Also examples of self-analysis comments given by participant to support the ratings are captured

Table 1: Mean scores for various aspects of daily sessions evaluation

Session	Aspects								
	Clarity of expected session outcomes	Variety in activities (i.e., reflections, discussions) in the topic	Appropriateness of activities in the topic	Clarity of instructions given	Ease of carrying out activities in the topic	Level of encouragement of interactions among participants by trainers	Support provided to participants by trainers	Promptness in addressing participants' concerns/questions by trainers	Achievement of session outcomes
Overview of CBC in Kenya	4.1	3.9	4.2	4	3.8	3.9	4	3.9	4
Pedagogies for Critical Thinking and Problem Solving	4.1	4.1	4.3	3.9	3.6	3.9	3.9	3.9	4
Biology	4.2	4.2	4.3	4.2	3.8	4.1	4.2	4.1	4
Chemistry	4.2	4.3	4.4	4	3.7	4	4	3.9	4.1
Physics	4.3	4.2	4.5	4.2	3.8	4.1	4.1	4	4.2
Mathematics	4.3	4.3	4.4	4.2	3.9	4	4	4	4.2
Education for National Cohesion and Integration	4.4	4.1	4.4	4.3	4.2	4.2	4.2	4.1	4.3
Overall mean score	4.2	4.2	4.4	4.1	3.8	4.0	4.1	4.0	4.1

The results in table 1 show various activities in the given session topics that teachers undertook to master subject content and new teaching techniques. All the aspects had an overall mean rating scores of more than 3.5 which is interpreted as good based on the interpretation criterion of $3.5 \leq x \leq 4.4$ where x is the mean rating. These high ratings were supported by self-analysis comments made by participants such as in: Mathematics topic 3D,

P24 "Thanks A LOT! have learnt how to do intersecting planes on 3D And even projections, I observed that objects can be rotated in any direction" while P37 "ICT is an important tool in enhancing the teaching and learning of 3D, Sincerely you facilitators have really assisted me grow in ICT".

Physics topic Radiation, P9 wrote "A very interesting real life analogy to help in the concept half-life, never thought of such a good activity in that 'dry' topic....for the learners to do" while P17 "I used 60 coins of ten shillings and the results are wonderful. This is really a practically applicable simulation. I liked it, interesting activity to apply in teaching and learning process.

Chemistry P4 noted; "The activity presented new ways of accessing digital content that can endear students and teachers towards developing deeper interest and acute skills in chemistry.

Biology; P2: "This has been an awesome experience I have gained more ICT skills even on existence of Padlet"

Pedagogies for Critical Thinking and Problem Solving,

P 67 noted; "The problem doesn't have a known method to be used to find the solution even though the final answer has to be the same. Therefore, it makes one to investigate thoroughly on how to go about it. This

triggers critical thinking as one seeks to find the answer to the problem. Questions that you start asking yourself include; how many handshakes does one person make? Are the number of handshakes per person equal to the number of people in the room i.e are they 22 or 21? How does one get the total number of handshakes? Which concept or operation in mathematics should one employ to get the total number of handshakes? Does this method work for all similar problems? All these help in developing and nurturing critical thinking and problem solving competencies in learners.”

94 wrote; “sharpened my knowledge in critical thinking and problem-solving including analysis of teaching and learning materials.”

Project work on creating and inviting learners in a Google classroom;

P1 wrote; ‘Such a great learning experience. The Google classroom and sharing experiences... we are ready to cascade the same to the colleagues in the counties while P22 noted, “I can manage Google classroom and P178, “the online training is wonderful, can’t wait to have our learners embrace online learning tool”. However P16 had a contrary opinion and wrote “Google class room project needs more time as the majority of county trainers were not ICT compliant and also the concept is new.”

Overview of CBC in Kenya; P109, “This week has proved that most problems in the society can be solved by allowing our learners to think critically and come up with solutions themselves, this with time will lead to innovation. Every problem in the world has solution and the solution is hidden in our brains, so we only have to allow our learners to walk through their brains carefully to get the solution, while P86 “Excellent training happy with the process “Thanks for widening my understanding of CBC” and P57 wrote “activities made me think critically ready for next week.”

Table 2: Mean scores for overall Evaluation

Item No.	Training Organization and implementation Aspect	Mean score
4	The objectives of the training were clear	4.60
5	The topics covered were relevant to the theme of the training	4.69
6	The ICT resources (videos, pictures etc.) were appropriate	4.38
7	A variety of ICT resources were used	4.25
8	The training materials were relevant to the training content	4.46
9	I have gained skills I can employ in my work	4.69
10	Trainers encouraged interactions among participants	4.43
11	I interacted with other participants	4.23
12	I received adequate guidance from the trainers	4.29
13	The timing of the training was appropriate	4.39
14	The duration of the training was sufficient	4.30
15	The training content was easy to follow	4.15
16	The online training platform was user friendly	4.19
17	The training objectives were achieved	4.42
	Overall Mean	4.39

The participants’ overall mean rating of the training organization and implementation aspect was 4.39, which is interpreted as good based on the interpretation criterion of $3.5 \leq x \leq 4.4$ where x is the mean rating. This high rating was supported by comments made by participants such as: P1 noted “I enjoyed the training and it was purpose driven” while P5 noted, “training was very good, with a high level of collaboration”. The aspects rated highest were “the topics covered were relevant to the theme of the training” and “I have gained skills I can employ in my work ” at 4.69 each, which was interpreted as very good, based on the interpretation criterion of $4.5 \leq x \leq 5$ where x is the mean rating. This was supported by self- analysis comments made by participants such as P322, “I wish all teachers had access to this training, we could be able to continue our classes especially now with this Covid- holiday”, while P22 wrote, “I can manage Google classroom and P178, “the online training is wonderful, can’t wait to have our learners embrace online learning tool”. This implies that participants found the topics offered relevant to their expectations, and the activities they were exposed to, added value to them by providing opportunities to master online teaching skills and subject content knowledge. Therefore the teachers were more likely to adopt online teaching methodology as they perceived themselves to be competent. This was in agreement with findings by (Kazempour & Sadler, 2015; Tuchman & Isaacs, 2011), that states, positive effect of professional development on teacher efficacy is not surprising in that strong teacher training programs are known to be positively associated with teacher efficacy. This finding was similar to findings of study by (Brinkerhoff, 2006; Stevens et al., 2013; Swackhamer et al., 2009; Umar & Hassan, 2015; Unal et al., 2017), who found that, professional development offers a positive impact on teacher’s self-efficacy and technology integration.

Research question two was designed to establish how verbal support by CEMASTEAs trainers promoted the teachers’ belief in themselves and their classroom practices. Data was analyzed to get frequency

counts and mean ratings as shown in table 1 & 2. Also examples of self-analysis comments given by participant to support the ratings were captured.

Results in table 1, shows the participants' overall mean rating for the aspects of support provided to participants by trainers at 4.1, and promptness in addressing participants' concerns/questions by trainers at 4.0, and "I received adequate guidance from the trainers" at 4.29 in table 2, which are all interpreted as good based on the interpretation criterion of $3.5 \leq x \leq 4.4$ where x is the mean rating. These high ratings were supported by comments made by participants such as: P61, "*the INSET was excellent; the trainers were in touch all the time and were committed*", while P30, wrote "*Good feedback from facilitators*". This demonstrated that trainers provided support to a large extent, which may have promoted the teachers' belief in themselves and their classroom practices. This was in agreement with the findings by (Sachs, Fisher, & Cannon, 2011), which states that collaboration and mentoring have been reported to be effective in teacher education.

Research question three focused on establishing how interactions with other participants promoted the teachers' belief in themselves and their classroom practices, frequency counts, mean ratings and examples of self-analysis comments made by participant to support the ratings were used.

Results in table 1, shows participants' overall mean rating on the aspect of 'level of encouragement of interactions among participants by trainers' at 4.0, which is interpreted as good. Also the results in table 2, showing participants' overall mean ratings for the aspects of 'trainers encouraged interactions among participants' at 4.43, and 'I interacted with other participants' at 4.23, which were both interpreted as good based on the interpretation criterion of $3.5 \leq x \leq 4.4$ where x is the mean rating. These high ratings were supported by comments made by participants such as; P1 wrote; "*Through engagement with colleagues, there are many ways of identifying unknown salt through various investigative methods*". P15 wrote "*Morning good people I am not sure of my understanding of Activity 5 but I have put the above link to Google docs for anyone to access and add accordingly before uploading it*". While P41 wrote, "*Good morning colleagues, someone with an idea of creating a Google class, please share so we keep practicing, as we prepare to do project. Thanks.*"

This demonstrates that there was a lot of peer learning as participants interacted and performed the assignments.

The study established that use of group discussions and encouraging interactions among participants resulted in peer learning which enhanced individual teacher's efficacy beliefs. According to Fives, & Alexander, (2004), teachers draw reflectively on different kinds of experiences that have impacted their cognitions in different ways. These experiences include those of actually having succeeded or failed in similar tasks themselves, experiences of seeing or learning about others succeeding or failing, and feedback on performance that helps them believe they too can succeed or convinces them they will fail (Bandura, 1986).

Research question four was designed to establish the perceptions of mathematics and science teachers' on the ease of use of the online platform, frequency counts, mean ratings and examples of self-analysis comments made by participant to support the ratings were used.

The study established that participants had a positive perception on ease of use of the platform and accessing training content, as per their overall mean rating for the aspects of the online training platform was user friendly at 4.19 and the training content was easy to follow at 4.15, which were interpreted as good. This shows that teachers had a favourable perception towards using the Google classroom platform, which agrees with the findings of (Richter & Idleman, 2017), that established teachers engaging in online professional development courses shapes their perception of online teaching. Also the finding was similar to (Chai, Koh, & Tsai 2010; Graham, Borup, & Smith, 2012; He 2014; Hernandez et al. 2014; Hung et al. 2010; Moore-Adams and Jones, 2015; Woodcock, Sisco, & Eady, 2015; Wright 2011), which suggested that online teacher education programs and PD delivered online (or focused on technology in particular) are beneficial in developing online teacher self-efficacy.

Qualitative results

After reviewing all data, two themes and one subtheme emerged within suggest areas for improvement. Participants listed many areas for improvement in the open-ended response.

The first theme which emerged under suggest areas for improvement was interactions. This was evident in phrases like, "*more interactive sessions*", "*create more forums for online interaction*" and "*increase meetings*". Many participants positioned this issue of interactions under peer to peer and trainers to participants' interactions. Several participants voiced concerns, such as "*we need more meetings to enhance collaboration, clarification, and sharing new discovery (46 participants)*". "*Create more planned class meetings for participants to learn from each other through discussions (4 participants)*". "*The peer to peer teaching aspect needed more presence for the teachers, to be more effective*" (8 participants), while the "*need to have frequent virtual meeting to address some of the common challenges facing trainees*" (12 participants), and "*make online learning more interactive by creating activities that focus on group discussions to enhance consultations*

and sharing of information” (6 participants). Also a number of teachers in their responses indicated the need to have interaction with their trainers : “trainers need to convene online meetings frequently and at times give presentations online to enable one on one interaction in class” (13 participants), and “make it more interactive by increasing the number of virtual meetings, so that trainers increase their support to participants given that this is a new platform of training, especially when it comes to turning in their work” (21 participants).

The second theme under suggest areas of improvement was accessibility. This was evident in phrases like “data bundles provision”, “provide laptops”, and “internet connectivity.” 155 of the participants positioned this as a critical area in which teachers voiced concerns, such as “increase amount of data bundles since some areas experience network problem” and “increase allocation for bundles to enable us spent more time online and explore all activities. Participants postulated the need to “enable teachers access laptops or desktop computer besides bundles” (12 participants), and “availing modems or strong routers that are compatible to the network depending on our location” (5 participants).

Technical support emerged as a sub-theme within accessibility under suggest areas for improvement. Several teachers in their responses: “for the purpose of our wellbeing we need to have an ICT person on call to help those stuck, as we all adjust and adopt to technology (12 participants) . “Equip teachers with basic computer skills to use them, so that the focus is on information processing during the training”, (6 participants), and “give specifications on appropriate ICT tools required so that we can move” (4 participants).

These findings corroborate the findings of a study undertaken by Richter, S., & Idleman, L. (2017), which revealed that, TSE for online instruction increased with teachers spending more time on it, whereas that for technology application remains a concern due to lack of technological support.

V. Conclusion

Based on the findings of this study, it was concluded that the eight-week online teacher professional development had a positive effect on teacher self-efficacy towards adopting online teaching methodology. Also the timely feedback on participants’ performance or concerns raised, and adequate guidance from trainers during the training changed the teacher’s self-efficacy beliefs for the better.

The study established that use of group discussions and encouraging interactions among participants resulted in peer learning which enhanced individual teacher’s efficacy beliefs. The teachers’ favorable perception on ease of use of the online learning platform influenced them to develop online teacher self-efficacy.

Accordingly, areas of improvement such as interactions, accessibility and technical support were identified as the factors affecting the teachers’ online TSE. Future online TPD programs targeting to enhance teachers' perceived self-efficacy and attitude toward adopting online teaching methodologies need to address these areas.

VI. Recommendations

Based on the findings of this study, some recommendations are made for policy, practice and future research: Recommendations for Policy

1. Policy makers need to include professional development programs on remote learning methodologies for all teachers and school principals to empower them to respond to emerging trends that impact negatively on their practice
2. Ministry of Education and organizations involved in training teachers, to consider development of self-efficacy in the design and development of in-service training plans and teacher development activities.
3. Universities and teacher training colleges to re-shape their pedagogical training for teachers by considering knowledge about online education theory and its practical application.
4. Teacher service commission to consider incorporating online teaching pedagogies into regular mandatory teacher professional development programs, so that teachers are equipped with ongoing skills in online teaching

Recommendations for Future Research

There are many opportunities for future study that would continue to advance the body of knowledge related to the effect of TPD on teacher self-efficacy towards adopting online teaching methodology. Some areas for continued study include:

1. Conduct a qualitative study which would include interviews with mathematics and science teachers to reduce the limitations of the online overall evaluation to get a better sense of the teacher’s feelings about their preparedness to adopt online teaching methodology.

2. Combine quantitative and qualitative procedures for a mixed methods study to determine if mathematics and science teachers self-efficacy correlates to the student's perception of online teaching ability by the teachers.

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