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Teachers as Guides: The role of teachers in the facilitation of technology-mediated learning in an alternative education setting in western Kenya

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Abstract

In this study, we investigate the perception of teachers' changing roles in a class utilizing tablet technology and a mobile learning platform. Deploying educational technology has been shown to shift students' perception of the role played by their teacher. At the same time, the teachers also experience the need for change in their teaching style to integrate this technology. It is important to identify shifts in students' and teachers' understandings in order to achieve the potential of the technology's affordance. Therefore, we seek to understand the change in teachers' perceived roles in a technology-mediated learning environment by asking three key questions: *1.) How have students' perceptions changed of the role of teachers after the integration of technology? 2.) How have teachers' perceptions of their own roles changed as they deploy these learning technologies? 3.) What are the efforts/strategies used by teachers to adapt to the integration of technology in their classroom?*

We deployed a contextualized community-based engineering skills course, "TumainiTech", via tablets and associated software. The course (TumainiTech) is part of an alternative education center in Western Kenya that hosts 21 students and 4 full-time teachers. A dynamic STEM learning platform developed by a leading mechatronics company was integrated into the tablets to build and deliver the interactive learning content. The course and technology deployment began in early 2016, and from then, multiple training sessions have been conducted to familiarize both students and teachers with the technology. We collected data through semi-structured interviews with a purposive sample of the students and all 4 teachers and performed thematic analysis to identify major themes illustrating perceptions of roles and teaching strategies. We identify the benefits and challenges that arise when technology is introduced in a low-resource learning context. By understanding both students' and teachers' respective perceptions of teachers' roles, as well as the strategies teachers use in reaction to integrating technology, we hope to better be able to support ongoing teacher development.

Introduction

Information and Communication technology (ICT) is gaining increased attention as a principal driver of economic and social development worldwide [1]–[3]. Utilizing ICT tools to advance various sectors, including education, healthcare, service, and manufacturing, is increasingly reported as a major development goal by nearly every national government. Justification for higher investments in educational use of ICT is attributed to the need for economic and social development in many growing economies. Kelles-Viitanen [4], referring to growing economies in general, commented that, "ICT is rapidly transforming the way people do business, access

information and services, communicate with each other and even entertain themselves”. UNESCO Institute for Statistics reports that there is a general acceptance by policymakers that access to ICT in education can support the creation of a skilled work force [5]. The national ICT policies of most East African countries emphasize the crucial role of ICT in preparing individuals in school for the workplace [6]. According to infoDev, quoted in Farrell and Isaacs [7] the initial ICT policies in East African countries were comprehensive and included all sub-sectors of the education system. However, the subsequent implementation of the policies has been a long and complicated process. Nduati and Bowman [8] note that in Kenya, the earliest known ICT policies dates back to the 1980s; by 2000, these policies had not been realized. As a result, there has been an unregulated use of ICTs that has prompted the need for governments to offer direction in the use of these technologies [3].

The integration of different technology tools in classrooms has increased the number of studies reporting effective implementation of technology [9], teacher perception of the use of technology [10], and students’ perception of the implementation of technology [11]. However, there is a dearth of literature that focusses on the perception changes on the role of teachers with the introduction of technology. This article reports our descriptive study of changing perceptions of the role of teachers after the integration of technology., according to students and teachers themselves More specifically, it reports the perceptions of five students and three teachers at an alternative school for former ‘street youth’ in western Kenya during the two years of initial implementation of a technology-integrated engineering skills course. The course is designed to equip students with relevant skills by solving a community-based engineering problem and delivers the content developed through a tablet platform.

Literature Review

ICT in education: Kenya

The Kenya National ICT policy was implemented with the aim of improving the livelihoods of citizens by enhancing access to efficient, reliable, and affordable ICT services. The policy had multiple sections delineating the strategies regarding ICT in education, focusing on the use of ICT in schools, colleges, universities, and other educational institutions to improve the quality of teaching and learning [12]. These strategies were interdependent and included steps from creating awareness to capacity building of personnel at facilities. The development of the curriculum and training of teachers at both the in-service and pre-service level are central in achieving these policy objectives, as is noted in the policy documentation. Farrell [13] asserts that while technicians can be employed to fix and maintain computers, teachers and educators must know how to exploit ICT for what it does best – opening learners up to the world of knowledge. In order to provide the teachers with appropriate knowledge, skills and abilities, the policy puts emphasis on the training of teachers and incorporating digital technology practices into pre-service teacher education programs. Teachers who are outside the boundary of government aided and funded ICT training programs rely on external opportunities such as community organized programs, NGO programs, and other professional development programs that are open for teachers within their accessible environments. We engaged with a group of teachers at an alternative school, which is typically non-formal and/or outside direct access to

government-funded training opportunities in ICT usage. As an alternative school, it is also limited in recruiting teachers with adequate digital technology training. The collaboration with the teachers resulted from the deployment of an engineering skills curriculum delivered using tablet technology at the alternative school. Considering the trends and challenges mentioned above specifically to ICT role in education in Kenya, our project deployment was also combined with conducting research on different components of the program that understood the students and teacher's experiences. Dawes [14] discusses that ICT in education has the potential to be influential in bringing about changes in ways of teaching. Such alterations motivated our research understand the changes in teaching and the teacher themselves.

Teacher's roles as they integrate educational technology

Riel [15] notes that "computers by themselves did not lead to the restructuring of education". For technology to transform teaching and learning, there is a need to redefine the teacher's role and change existing teaching practice. According to Becker [16], teachers and school administrators need "to modify their concepts of appropriate and inappropriate teaching behaviors, to reprioritize the value of different types of instructional content, and to change habits and assumptions that guide their classroom and school management strategies".

Teaching with computers requires a shift from the traditional teaching practice. Teachers working in technology-rich classrooms quickly become aware that they cannot carry out the teaching task as usual. Using computers can change the arrangement of classrooms, social organization of student learning, and interactive patterns between teachers and students [17]. Chin and Hortin [18] note that "technology forced a re-evaluation of the authoritative teacher role". Teachers' exemplary technology practices were guided by their pedagogical beliefs about student-centered classrooms. These teachers, who are willing to integrate technology, observe Ertmer, Ross, and Gopalakrishnan [19], "share a common vision of their students as self-regulated learners, capable of setting goals, making choices, monitoring progress, and evaluating learning outcomes". There was a strong agreement among technology-using teachers that their roles changed as the result of the presence of technology [20]. As Norum et al. [17] note, "Roles and teaching and learning strategies are changing because technology fosters the use of more student-centered learning strategies". The teacher's role has been shifted from an information dispenser to a coach [21], from a centralized authority to a decentralized facilitator [18], and from a sage on the stage to a guide at the side [22]. Niederhauser, Salem, and Fields [23] believe that "if teachers are to adopt instructional reforms in ways that truly change their practices, they will need to engage in conceptual change regarding their beliefs about the nature of learning, the role of the student, and their role as teacher". These literatures convey that teachers role in a classroom and their instructional approaches needs to be or will experience change when technology is introduced.

This shift of the teacher's role has been a daunting task on the part of the teacher, one that involves frustration and uneasiness. As Preskill notes [24], "In large part, teachers' uncertainty is based on a lack of knowledge, but more significantly, on the fact that using computers will

require some changes in the ways they've been teaching". Kern [25] notes that a shift from the use of the computer for drill and tutorial purposes to a medium for extending education beyond the classroom and reorganizing instruction has resulted in role changes for both learners and teachers. Learners now view the computer as a medium through which they must negotiate meaning through interaction, interpretation, and collaboration rather than as a finite, authoritative informational base for carrying out a stipulated task [26]. There is a gap in the existing research space of studies that has tried to understand the role changes of the teachers. We believe the study discussed below will address to that need and provide significant academic contributions.

Context

The technology-integrated, contextualized, community-based engineering curriculum is designed for out-of-school youth at a residential alternative school called Tumaini Innovation Center in the city of Eldoret, Kenya. Over the past six years, the center has worked with thousands of out-of-school youth to prepare and support their reintegration into the traditional Kenyan education system [27]. To achieve this objective, participating youth themselves explained that the center needed a more permanent space to deliver a more intensive and formalized education structure. The residential center was established in 2014, housing and educating 11 children and later recruiting 10 more children in 2016 and 2017. The center has since operated as a school that provides the basic content required in the formal primary and secondary education system. Some of the basic subjects covered are English, KiSwahili, Science, Mathematics, Social Science, and Religion. The students range in age from 11-18 years. The center currently has four full-time employed teachers who are accompanied by two volunteer teachers from the community. The engineering curriculum is designed using the authentic learning framework, by allowing the students to select a local community-based problem to be solved. The curriculum benefits from using an Active, Blended, and Collaborative (ABC) model to meet the needs of the students [28].

Technology used

Technology as a tool to aid [29] in access to education is an important aspect of this curriculum. The technological tool being adopted in this curriculum is a tablet with a pre-installed learning platform. The learning platform is designed and developed by a leading mechatronics company Quanser in Canada. The platform requires authoring the content using XML programming language via computer editor software. The tablet performs the role of a modernized and interactive textbook with the intentionally designed content and learning platform. However, the importance of face-to-face interaction and facilitation by the teachers is necessary to ensure construction of meaningful learning experiences [30].

Technology integration

The teachers and students were provided with multiple training sessions that exposed them to the tablet technology and the learning platform. Both the teachers and students had no prior experience of using technology like tablet and the learning platform. An on-going study is

looking at the students perceived technology affordances after utilizing the tablet for six months. Anecdotal evidence suggests that technology is benefitting the learning needs of these community of students. The on-going study also tried to understand the student's perception of teacher's and it can be reported that the students perceive the teacher's role with importance in their classrooms even after technology integration. During the first six months the students perceived the teacher's role as a language translator and facilitator of complex content. Observations suggest that English language ability of the students have far improved over the last year, and this prompts to understand how the students and teachers view the teacher's role in the engineering classroom.

Research Questions (RQ)

In this paper, we attempt to clarify the changing perceptions of the teachers' role after the integration of technology in the last two years. We ask three targeted research questions to unpack and understand the teacher's role:

- 1.) How have students' perceptions changed of the role of teachers after the integration of technology?*
- 2.) How have teachers' perceptions of their own roles changed as they deploy these learning technologies?*
- 3.) What are the efforts/strategies used by teachers to adapt to the integration of technology in their classroom?*

Method

In this qualitative study, we used interviews for data collection and thematic coding for data analysis. Data were collected using semi-structured interviews conducted over Skype by the first author. The participants included three full-time teachers who have by far been the primary facilitators for the engineering course and five purposively sampled students. The students were selected based on their seniority (those who participated in the engineering course from its initiation). Scheduling issues due to the center's academic year limited a larger student sample size. During the time of the interview's schedule, most students were engaged in end-of-term exams, limiting the number of students interviewed.

The interviews took, on average, 15 minutes per student and 25 minutes per teacher. All teacher interviews were conducted in English, whereas two of the five students needed language assistance, and they were supported by a teacher available at the time of the interview for translation. The students were asked to share their experience of learning using the tablets, their perceptions of the teacher's role in the technology-integrated engineering class, and their views on the teacher's change in roles (if any). For most of the questions, students were prompted with further probing questions based on their responses. The teachers were asked to share their

experience of teaching using the tablet, their perceptions of a teacher's role in a technology-integrated classroom, their views on the change in their own role before and after technology integration, and the kinds of efforts and strategies used by individual teachers to familiarize themselves with teaching with technology.

Data Analysis

The interviews were transcribed using a third-party agency, and the first author verified the transcriptions by listening to the recordings. The transcribed interviews were then coded using a qualitative analysis software, NVivo. Coded student interviews comprise the data used to answer research question 1, and the teacher interview data were used for research questions 2 and 3. The open coding done by the first author resulted in 39 nodes with a cumulative 90 references. The first and second author discussed the results of open coding and co-developed the themes in agreement. The third author verified the emergent themes and conducted member checking at the Tumaini Innovation Center with the interviewed teachers and students. The results below will focus on one key theme under each research question and briefly highlight the aspects of other secondary themes.

Emergent Themes

RQ1 – Students' Perceptions of the Change of the Role of Teachers After Integration of Technology: Key dimensions are *Effective teaching for primary and secondary learning outcomes and Classroom management*

The most important dimensions that emerged to respond to our first research question reflected student perceptions of effective teaching of both primary and secondary learning outcomes and classroom management. We briefly describe all of the themes that emerged within these dimensions in this section.

Interestingly, these themes reflect a change from perceptions the students shared in previous interview work. An initial round of student interviews was conducted six months after the engineering course initiation. These interviews were conducted to obtain students' initial reaction and feedback on the tablets, learning platform, and course content. Initial results from interview data analysis showed that students' perception of the teachers' roles during the engineering class was limited to language assistance and acting as translators. From the time of these early interviews to now, almost two years after the program's start, student perceptions have changed, as shown in some of the following themes. It is to be noted that the example quotes contain the terms "module classes" and "tablet classes," which are students' idiomatic names for the TumainiTech.

Effective teaching: Achieving primary learning outcomes

One of the most prevalent themes from the responses by multiple students is that of the teachers' roles of effective teaching becoming clearer, more specific to the primary learning outcomes of the class session, and more visible with the introduction of technology. Students described instances of teachers being able to deliver effective instruction by clarifying difficult concepts or student questions and providing additional information to help in the understanding of content. Quotations from students 4, 5 and 2 illustrate different facets of this theme.

Interpreter for student 4: *“He has said that as the class of load calculation, it was important for a teacher to be there so that they can do that calculation with the teacher so that they can understand more. Even the one on luminosity, the teacher was helpful in measuring, using that ruler and to locate that circle of luminosity, the diameter so that they can explain to them.”*

Student 4 reflects upon his experience of being guided by the teacher when the class required the students to perform certain tasks. Here, the teacher's responsibility of facilitating learning sessions by guiding students through complex tasks is acknowledged and valued by student 4.

Student 2: *“So the teacher explains more about what is the meaning of the ... For example, you'll just read in the Qdex; it has just been written electricity or water pump. So, teacher will tell you more about water pump and the work of water pump, and explain it better so you can understand it.”*

As shown above, Student 2 points out the multiple ways in which the teacher reinforces content covered by the digital textbook. The teacher's actions are closely related to specific topics and learning goals, and the student ascribes multiple role actions to the teacher (e.g., providing more description about the water pump and explaining in more detail than what is provided in the text). According to student 2, the teachers were also inclusive in their pedagogy by differentiating instruction and providing instruction that meets individual student abilities, as shown in the following statement.

Student 2: *“Because the teacher can teach you ways so that you can understand.”*

TumainiTech is designed to include multiple hands-on activities that complement the content and help in unpacking difficult science, engineering, and math content. Teachers at Tumaini are perceived by students as guides in ensuring successful implementation of the planned hands-on sessions.

Student 1: *“The teacher helps you with the activity. To lead you in the activity, and then leading you to do some things and then leading you to know and understand. For example, if you're doing an activity, he'll just guide you and assist you and tell you this is the way you're supposed to do, it's not this way you're doing.”*

Student 1 refers to the teacher providing correct direction, particularly while doing the hands-on activity. A given hands-on activity in the course is already explained in the learning platform. However, the teacher bears the responsibility of ensuring that students follow the procedure. This kind of a role is new to the teacher and to the student, and it is novel for the students to be able to

recognize given the limited experiences with hands-on curricula in this school. It is important to note that it is positive that the student can identify this specific role played by the teacher while doing the activity. It also confirms that the teachers are fulfilling that responsibility.

Achieving secondary learning outcomes

Experiences such as that described by Interpreter for student 3 show that the teacher role as translators and language supporters continue to exist: “*He has said that a place where he can’t understand, he can read but he cannot understand, the teacher can explain for him, so he can understand more*”, and Student 4: “*For example, if I not understand, I can tell him to translate on me. Or tell me more about it.*”

With the integration of technology, teachers by default became the go-to support at Tumaini on using the tablet technology as the students begin to take advantage of its affordances.

Student 2: “I learn from my teacher to how to use tablet like go on chrome, search something.” In these instances, teachers are perceived as giving support towards achieving secondary learning outcomes for the students, in this case, of digital literacy.

Students also viewed their teachers as models for digital literacy, as referred by Student 3: “*My experience, for example, if I see my teacher using a tablet, I use it like that.*”

Classroom Management: Disciplinarian

Teachers as disciplinarian emerged as a new dimension of students’ perceptions from these most recent interviews. Classroom management has grown as a dominant theme, especially more recently than from the responses during the initial interviews and even other multiple observation experiences of both the first and second author. This is reflected in the comments from students 1, 4, and 5.

Student 4: “.... when we are alone, we don't consider it is the class, and we go to some music, and then google. When teacher is there, we, teachers control us to use tablet, and then to go to the qdex and read.”

This response indicates that the teachers have acted as class disciplinarian in controlling the use of tablets inside the classroom. Student 4 perceives that the teacher exerts their power in ensuring that students follow the teacher's directions. However, student 1, in explaining a similar role, contrasts the perception of student 4 by mentioning that the teacher is exercising power to maintain decorum and focus on the learning. *Student 1: “So, for example, you cannot learn in a class without a teacher, because you'll just not be listening. Not all of you will be listening, not all of you will be silent in the classroom. Like the teacher is helping you to maintain that silence in the class and understanding, so each and every person can understand in a class.”*

The comment made by student 5 below recognizes both the perspectives of student 4 and student 5. Though words like “control” are used, he is referring to the class also being distracting mainly due to the use of technology.

Interpreter of student 5: “He has said that the teacher is also important because he can control the class like they will not be too much noisy or some students are not going to maybe other parts like maybe googling other things that is not required in the class, so the teacher can able to control them.”

As the role of disciplinarian is becoming evident, it serves as a valuable feedback for the teachers in developing strategies to using their power more positively to ensure smoother operations inside the classroom.

Attitudes towards Technology

A less predominant but interesting perception shared by two students was their attitude towards the technology and its influence on the perception of the teacher. Teachers using tablets to conduct class sessions were perceived as “modern” by these students.

Interpreter for student 5: “He has said that it will be modern for the teacher to use the tablet because he can get information quickly from the tablet.”

RQ2: How teachers' perceptions of their roles changed as they deployed these learning technologies: Key Dimensions are *Individualized experiences and Comfort while teaching*

Next, we shift to the themes that emerged from analyzing the coded teacher interview data. Unlike students, the three teachers' experiences and perceptions were highly individualized. Though there were a few common perceptions, most of them reflected their own experiences and their characteristics. In this description, we focus on unpacking one key theme more broadly and highlighting a few other important themes. Teacher 3 was involved as the instructor for TumainiTech for the longest, and Teachers 2 and 3 joined as co-instructors a few months after the course initiation.

Perceptions of increased “ease” of teaching

All of the three teachers who have been involved in delivering TumainiTech felt that their teaching was more comfortable compared to their beginning period of course implementation as well as compared to the other traditional classes that are not integrated with tablets.

Teacher 1, who is also the one who has taught the highest number of lessons from the time of her involvement as an instructor for TumainiTech, felt that the features of the tablet to find information more quickly and the possibility to gather additional information by accessing the web have made her teaching more comfortable.

Teacher 1: “My experience, teaching using the tablet, it has been so good, it is effective, and it has given me quite a good response towards, and it has made my teaching feel easy. Now that I can get answers, and I can research from it, it has helped a lot.”

Around the same theme, teacher 2 had a distinct perspective on the tablet technology being a tool that has allowed more easy and effective instruction during the class. She particularly refers to

the benefit of doing a flipped classroom with the access to technology, where the students prepare by watching videos or reading materials before coming to the class.

Teacher 2: "When I'm teaching a class without the tablets ... there's a lot of illustrations, drawing on the board, and also looking for things outside that can bring the point home to them. But with the tablets it's easier, even when you're teaching, because they can always respond. For example, for the module classes there are videos to watch on YouTube. They can easily refer, and my work becomes less when explaining because they have already seen." She also compliments the nature of flipped classrooms, which have become possible with the integration of technology, by saying that *"I think people learn best when they see and know exactly how things work. For me, using the tablets has been very easy."* The extent of the ease and comfort in teaching with the tablets is also reflected by her comment: *"I wish all other subjects were using tablets."*

Teacher 3's comment, *"Yeah rather reading so many information, the tablet is simplifying because it's brief and easy to understand"* adds to the perspectives under this theme by acknowledging that the tablet can provide clear and concise content.

From these individual teacher comments under this theme, it can be seen that the access to the technology along with intentionally designed evidence-based curriculum content available through the learning platform has shifted teachers' perceptions of their burden in the classroom to teaching with "ease."

Teacher Self-Efficacy

Teaching TumainiTech has also brought a sense of personal development for the teachers. Self-reflection on their confidence and capacity building was evident from teacher 3, saying, *"I am able to do things with the capacity that I understand so much."* Teacher 1 had a deeper moment of self-reflection, and it directly appeared as a change in her perspective. As mentioned earlier, all the three teachers had no prior experience teaching using technology or teaching STEM-based course content. Therefore, it was perceived as a challenging task initially due to the complexity of the new STEM experience, as is clear from the comment by teacher 1, *"teaching module classes is not an easy task without something to refer to while am teaching. You know module is not an easy task."* She goes on to say, *"sometimes we tend to think and imagine that some things are very hard, they are not true. But then when you have this perspective that we can understand everything, and we can change everything. It really changed my attitude towards the class and trust me it's a matter of mentality."* The change in perspective that resulted in a shift in the attitude was attributed by the teacher to the overall experience she had with TumainiTech. More importantly, it is the realization of the teacher herself to value and enrich her individuality. She notes that *"Initially, we used to teach what you've already teach, and initially we try to be like the Author 1 (for anonymity), and then after you did the training and we realized we cannot be Author 1, we cannot be Author 2. We decided to be ourselves and it has been really effective."*

Identity development: Teacher as facilitator

Teachers' change in perspective could also be associated with the development of self-identity as a teacher. Teacher 2 points out that it is not merely the content of TumainiTech that must be handled from an instructor standpoint, but also the act of teaching students on using the tablets. This connects back to the students' perception of teachers being models and their support in achieving digital literacy. *"It's that they are not only learning about the subject that you are covering in that module. But they also have to maneuver their way through the tablets, like using apps, downloading, and all those things."* Under these circumstances, teacher 2 reflected on her change in the role of a teacher as a facilitator. *"So, for me, as a teacher, my role there is just to guide them. I can't show them everything they are supposed to do. But be as a guide to lead them on maybe where they are having challenges. It's easier for someone to understand when they actually do it then when someone is explaining to them. So, for me as a teacher in class, even for the module classes, when I'm using the tablets, I'm just easily guiding them on what they're supposed to do, and allowing them to do. So, I come in where they do not understand, and I have to explain to them."*

Vulnerability/Openness

Kelchtermans explains vulnerability as "the feeling that one's identity and integrity are questioned" [32]. Teachers at Tumaini are challenged with the students' notion that teachers have all the answers. Teacher 2 comments on this perceived role, saying *"Yeah, there's a stereotype here in Tumaini where the boys are always looking at us as superwomen, to have the information and the knowledge, so they ask a question, they expect you to answer...."* However, she as a teacher feels that she has to learn along with the students to find the answers. She goes on to say *".... but also when you're in class and you're learning also with them using some of the things, you can relate with them, and for that, I think it has more attention and respect from them because sometimes I tell them I don't know, so we are learning, all of us. I have never taught using tablets before, so I'm also learning how to use them at the same time. I was saying that the fact that you're also learning, and that you admit to the boys that you're also learning brings you at the same level where it's easy for both of you to learn and also to explain and get that respect in class also."* Her shift from being vulnerable in front of the student community to having an openness admitting vulnerability and learning illustrate a change in perspective from a vulnerable to a respected teacher. The openness to learning is also referenced by teacher 1, *"Again module classes have been teaching not only the kids but also I've been learning new things from it. So, I think it's beneficial for both staff and students."*

RQ3: Efforts/strategies used by teachers to adapt to the integration of technology in their classroom: Key Dimensions are *Preparation and Transfer*

Upon understanding both the students' and the teachers' change in perceptions of the role of teachers in a technology integrated classroom, we continued to investigate the actual efforts and strategies used by the teachers to become technology friendly in their classrooms. As a result, the key dimensions responding to this research question resulted in themes of advance preparation for classes and transferring the benefits of technology to other classes taught by the teachers.

Advance class prep

Teacher 1 and 2's responses were detailed and very pointed in stating that their main effort/strategy was to prepare for classes in advance. Teacher 1 discussed her preparation model as *"For me, when I want to, I know tomorrow like Wednesday I have two lessons, then I have one lesson on Thursday and Friday I have double lesson. I start preparing all the tablets two days before, I charge them, check Qdex, check module in my phone, in tablets, to see if they are the same."* Since the tablets are often collected back from the students at the end of each day, the teachers have the responsibility in the moment to ensure downloading and verifying the presence of modules for the week. Preparing the tablets and ensuring they function in advance is reported as one of the important efforts in ensuring integration of technology by the teachers. This can be closely connected back to the teacher's perception of "ease" of teaching with teachers, given the condition that both tablets and the teachers are prepared in advance.

Teacher 2 discussed her primary strategy in the classroom is to get to know the tablets well. She mentions the fact that the different mobile devices have distinct features and functionality, and it is important for the teacher to know the device that is used in the classroom. She notes, *"For me, I had to familiarize myself with the tablets, because I think every device is different with the way you use it. So, I took time to first learn about the tablets, learn how to use even the Q-Dex before even going into the individual modules and for me, that has made me more comfortable in teaching because I am familiar with what I'm doing."* She also refers to the importance of the effort to prepare in advance, similar to teacher 1, *"Yeah, I do a little preparation. Like, you see now, boys are really curious, and they ask a lot of questions, so sometimes for me, I find it really easy to go prepare ... than preparing in class."* The comment on meeting the curiosity of the students by being prepared connects closely with the students' perception of effective teaching and differentiated instruction.

Teacher 3 alluded to the theme of preparing in advance. However, he did not discuss this strategy in more detail. He said, *"I have a list of topics we go through in the module, I read and use the text I find additionally and use in the module."*

Transfer of tablet to other traditional classes helps with comfort

The second predominant theme that emerged around the efforts/strategies to integrate technology was on the transfer the benefits of technology to extra-curricular and other class environments for courses like language, social studies, music, and dance.

Teacher 1, who also conducts classes on music, referred to the benefits from the use of tablets in practice sessions. She conveyed that, *"I've also used tablet in my music class, also the time we download songs using the tablet and practice singing, also the time we record ourselves singing and come up with a band. So, it has not only helped me in module classes, but it has also helped me in my basic education classes and in my music extra activity classes."* Teacher 3 mentioned his role in assisting with the tablets during the dance classes by saying *"normally use the tablets*

during dance ... because it is easy we can download a song and they can operate and use to dance.”

Teacher 2, who is also their social studies teacher, benefitted from utilizing the tablets to provide relevant additional information complementary to textbook content, as well as providing a worldview through comparisons. She said, *“For example. In other subjects apart from engineering, and there's a concept that they want to understand, we just use the google or use the YouTube to watch videos of how some principles are applied. For example, in science. Yeah, there was a time I was teaching social studies, and we were discussing about the Mau Mau war in Kenya that happened. And we were comparing and discussing the World War. Since we didn't have much details in our textbooks we just used the tablets to google some of the things.”*

Owning a smartphone helps with access/preparation as affordance with digital platform

Beyond the key dimensions discussed above, teacher 1 discussed her efforts/strategies of preparing in advance now being a possibility due to the affordance of the digital platform and its capability to integrate into any mobile device. By being able to use their personal devices to refer to TumainiTech content, she has benefitted. It is evident from her comment, *“.....using my phone to review some modules, I also check if it is the same thing with the tablet so that the boys can use it in class. Having my phone with Qdex is like having a tablet because most of the time when I use tablet to google, to check the module and to seek solutions according to engineering classes. So, if I have it on my phone, it's like have a tablet.”*

Peer teacher support

Teacher 1 also referred to her effort/strategy to connect and seek support with peer teachers. Being a smaller community of 21 students and 4 teachers, it has allowed for the teachers to be tightly knit with each other. Though teacher 2 has previously discussed benefitting from peer collaborations with the authors in multiple instances, she did not talk about it during these interviews. However, teacher 1 referred to peer support by saying, *“.... tablets were giving me a hard time, and I had to go to teacher 2, I also went to teacher 3. So, when I realized that I don't get it and I have to teach it, I don't go and ask for the boys of past module. So, what I normally do is, I go to the staff before coming to you.”*

Discussion and Implications

Through this study, we were able to understand shifting views on the multifaceted roles of teachers in TumainiTech, as well as in other classes from both the students' and teachers' perspectives. The results of the study contribute in: (i) further implementation of TumainiTech, by strengthening the benefits of multiple roles perceived by the students, and navigating through complex roles such as *class disciplinarian* with careful analysis; (ii) allowing the teachers to be self-reflective on their perceptions and transitions; (iii) understanding the benefits of different strategies that have worked across the community and for individuals; and (iv) contributing to the knowledge base of the researchers in designing and expanding TumainiTech further with other interventions such as teacher development sessions for technology integration. In a context

such as Tumaini, situated in a low-resource community [28], use of technology is limited by several external factors such as internet access and safety. From the beginning of our program, we faced challenges with internet access and internal school rules such as fixed times for the use of tablets during the day to address safety. In considering such limitations, it has been notable that the students and teachers still perceive benefits and changes in the classroom that they attribute to the technology.

As reported above, students' change of perceptions indicates more distinct, contextualized roles played by the teachers in achieving primary and secondary learning outcomes. This complements the efforts/strategies teachers have made in integrating the technology. Teachers' efforts to transfer the use of tablets to activities in other traditional classes, and their own perception of changes such as improvement in self-efficacy and identity can be aligned with students' perceptions of teachers more holistically. The implication here is that teachers must continue to familiarize themselves with the use of technology and with probable cross-course integration strategies.

Limitations and Future Work

We recognize a few limitations with this study, some of which will continue to be addressed in our future work. First, the experiences of the teacher are not common with the same group of students. Teacher 1 has continued to teach a lower grade of students for the longest time, as compared to teacher 2 and 3 co-instructing more often in teaching senior grades. And, although teacher 1 has been involved in teaching a few modules/lessons for the senior grade, she has not engaged overall as often with the students on TumainiTech (largely due to her commitments as head teacher). Therefore, this limits the student perceptions largely reflecting interactions with teacher 2 and 3, with minimal references to teacher 1. However, teacher 1 is engaged with the senior grade in delivering the traditional classes, and her use of technology in those classes is expected to have contributed in the data. Second, as mentioned earlier, we recognize the limitations on the number of student interviews, which provide a specific set of perspectives from the Tumaini students. This does not reflect the holistic experience of the students at TIC. We intend for this analysis to inform the research team and the Tumaini staff in ways that teacher roles can be better supported and understood. Therefore, in the future, we will work to enhance the technology integration in classroom by providing appropriate teacher support, and we will continue to investigate the students' and teachers' unique experiences.

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