UNIVERSITY LECTURERS' PREPAREDNESS TO USE TECHNOLOGY IN TEACHER TRAINING OF MATHEMATICS DURING COVID-19: THE CASE OF ETHIOPIA

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ABSTRACT

The study aimed to investigate Ethiopian university lecturers' readiness to use technology for teaching mathematics at the tertiary level during the COVID-19 pandemic when they were compelled to adapt to distant education. Using Google Forms, online questionnaires were distributed to 41 lecturers in three Ethiopian universities, of whom eighteen participated. Before the research, the questionnaire was piloted with eight lecturer participants to categorise questions and validate the instrument using the Rasch measurement model. The questionnaire was locally developed based on guidelines from the literature. It purposed to investigate university lecturers' individual preparedness for technological instruction in terms of their knowledge, beliefs and current, and historical exposure to this mode of instruction. As a counterbalance, some circumstantial factors influencing their readiness were investigated too. Lecturers' optimistic beliefs about using educational technologies have been found to contrast with some disabling circumstantial factors. This study revealed that the lecturers were generally able and interested in integrating technology into the teaching process but that barriers, primarily at the institutional level, hindered them from doing so. In addition to the technologies suggested in the questionnaire, participants enriched the research findings by adding more possible technologies that lecturers may use for educational purposes. The data was analysed using WINSTEPS (Student Version of WINSTEPS 4.7.0.0) and SPSS version 20. The results showed the reliability of using the instrument was 0.77 based on Cronbach's alpha. The PT-measure correlation value determined the construct validity (PMC), ranging from 0.23 to 0.71 except item PUT15's infit and outfit MNSQ between 0.1 to 1.86 and ZSTD range -1.05 to 1.61, which was acceptable. The fit statistics showed that the person separation index, 1.97, was considered good and that the item separation index, 0.63 was within an acceptable range. Person and item reliability were at 0.8 and 0.28, respectively.

The result indicated that the new instrument with five items after eliminating unfit items (such as items FAT19, PTT10, KDT1, PTT8 and PTT 12) was reliable and valid to measure the use of technology in the teaching and learning process of the university lecturers.

Keywords: Rasch measurement model, perception, technology, university lecturers, Ethiopia

INTRODUCTION AND BACKGROUND OF THE STUDY

Becoming literate in the 21st century means that "teachers and students need to understand the influence of digital media on our society, develop strategies to analyse it critically, become independent from its influence, and open their minds to embrace new tools of teaching and learning provided by the information age" (Sadaf and Johnson 2017, 129). Although computer literacy and awareness are ever-increasing, teachers' competence and skills are challenged when faced with a new reality where digital teaching becomes the primary, if not the only, mode of instruction. Many schools worldwide are using more educational Technology (Freihofner, Campbell, and Smala 2018); however, countries that lack the educational technology to operate on an online platform may face a problem during COVID-19. As part of the many challenges COVID-19 brought to the world, education is one of the areas that faced the most substantial challenges without being prepared for it. Ethiopia is an example of such.

In response to the changed demands for education during COVID-19, it became imperative to accommodate interactive modes of teaching using technology face-to-face and online. To continue the teaching and learning process within the COVID-19 landscape, "redesigning a drastically new approach for teaching and learning within grades ... may require immediate attention for all constituents' needs, including students, faculty, and parents, to maintain educational continuity in a functional and safe online learning environment" (Avgerinou and Moros 2018, 583). During this trying time in education, some institutions managed to maintain the said educational continuity, an example being the (already) Open Distance e-Learning university, the University of South Africa (UNISA).

The abrupt divorce of instruction from the physical classroom raised questions about whether e-learning will persist after the pandemic, while indications are that a full-scale return to the previous situation seems highly unlikely. Also, what the effect would be on education technology markets. According to the world economic forum, "before COVID-19, there was already high growth and adoption of education technology, with global *edtech* investments reaching US$18.66 billion in 2019 and the overall market for online education projected to reach $350 billion by 2025" (Mutalib2020).

In Ethiopia, online instruction was enforced since the inception of COVID-19 quarantine on 16 March 2020. The production and delivery of e-teaching became a teacher task, while students had to do e-learning from their places of residence. Some teachers were acquainted with the integration of technology into instruction, others were caught off-guard. For the new demands, the Ethiopian Ministry of Education (MoE) at the primary and secondary school level, as well as the Ministry of Science and Higher Education (MoSHE) at the tertiary level, provided advice for both teachers and students, specifically on the use of social media such as Telegram. Ethiopian teachers were not all ready to affect this transition, two of the barriers being their knowledge and beliefs about using technology in distance teaching. Lecturers of pre-service teachers were under double pressure: On the one hand, they had to accept, adapt to, and master the new mode of delivery; on the other hand, they had to rise to a level of expertise by which they could role-model, advocate and demonstrate the technological skills, tools, and teaching practices to their students.

We are aware that the availability of technological amenities and a lack of training and knowledge of technological instruction could be hampering factors; we observed another potentially powerful hurdle in this transition. Leder, Pehkonen and Törner (2002) and Thompson (1992) pointed out that teachers' beliefs powerfully influenced their teaching practice. This notion, paired with our observation that lecturers lacked knowledge and skills, set in motion our double-pronged investigation into the ability and beliefs held by lecturers of pre-service teachers regarding the use of technology for instruction during the COVID-19-time. According to Avgerinou and Moros, "Technological advances are here to stay, and crises such as the current pandemic only come to highlight the digital deficit, not just in terms of supporting technology, or student skills, but also and perhaps most importantly as regards teacher perceptions, attitudes, and actual preparedness" (Avgerinou and Moros 2020, 587).

The purpose of this study was to explore Ethiopian university mathematics lecturers' current status of preparedness in terms of knowledge and skills on the one hand and their behavioural, normative, and control beliefs related to their intentions to integrate technology into teaching and learning. The study identifies relevant intervention areas and provides a springboard for concerned bodies to help overcome the factors hampering technology integration in instruction. Teachers can use the findings to enhance their technology-driven instructional design and practices. The Ministry of Science and Higher Education (MoSHE) may also utilise the findings and recommendations to guide decisions about the amenities that teacher educators may need during and after COVID-19. The research questions that guided the study were:

- What is the current status of mathematics lecturers' knowledge and skills in using technology during the COVID-19 pandemic?

- What are these lecturers' beliefs about using technology as mode of instruction in the virtual classroom during the COVID-19 pandemic?
- What are some factors affecting the use of technologies in the teaching and learning of mathematics at tertiary level?

LITERATURE REVIEW

Computer-based instruction

Teaching and learning are two sides of the same coin; however, the way teaching is presented shapes how learning takes place. Even though each student has the right to choose their own developmental path, the *stereotyped education system* may not afford them the individual attention, initiative and self-education they need to shape their future. Could the 21st century, with its rapidly changing training methods, hold the potential for shaping their individual developmental pathway because of its diverse options and its multitude of extra-classroom enrichment- and research opportunities? Indeed, educational technology has emerged globally as an effective way to support or facilitate learning, performance, individuation and instruction, and its possibilities are rapidly increasing. Television and animations, which dominated the second half of the previous century have been replaced by computers and the Internet in this century (Huang, Spector and Yang 2019), with the result that technology's current driving factors in education are considered computer-based instruction and technology-assisted teaching methods.

Technology includes tools and machines and their impact on society's processes and systems and the way people think, perceive, and define their world. Michael (2015) contends the necessity of integrating technology, pedagogy and content to enhance education quality. Computer-Assisted Instruction was one of the first applications of the new technology in mathematical learning in schools, utilising individualised student-paced modules to promote a more active form of student learning. According to Pappas (2014), who was the invertor of eLearning applications, the advantages of computer-based instruction are the following:

- Simulations – Simplified representations of real situations, processes, etc.
- Tutorials – Enriching background knowledge, ideal for verbal and conceptual learning, as well as for simultaneous attendance.
- Practice – Increasing fluency in a new skill and providing immediate feedback.
- Instructional games – Providing motivation elements, such as competition, cooperation,

etc., substituting exercises, and inspiring goal setting, creativity, and respect for rules.

- Problem solving – Focused, specialised, and designed to promote problem-solving abilities for a variety of situations.

Factors affecting the perception of teachers towards technology.

Sadaf and Johnson (2017, 130) found that "teachers' integration of digital literacy was related to their behavioral beliefs (attitude toward outcomes of a behavior) about the value of digital literacy for developing students' 21st-century skills, increasing student engagement, and preparation for future careers; normative beliefs (social support) about meeting the expectations of administrators, parents, colleagues, and students; and control beliefs (perceived behavioral control) about ease of integrating digital literacy due to access to technology, professional development, and curriculum resources." The research done in the twentieth century points out that the factors that affect classroom technology implementation were two-fold, namely first-order and second-order barriers to changes.

Research on mathematics teachers' use of technology has identified various factors influencing its uptake and implementation (Forgasz and Prince 2001; Norton and Cooper 2001, as cited in Goos 2005, 39). These include:

- "skill and previous experience in using technology;
- time and opportunities to learn (pre-service education, guidance during practicum and beginning teaching, professional development);
- access to hardware (computers and calculators), software, and computer laboratories;
- availability of appropriate teaching materials; technical support;
- support from colleagues and school administration;
- curriculum and assessment requirements and how teachers interpret these for students perceived to have different mathematical abilities;
- knowledge of how to integrate technology into mathematics teaching; and
- beliefs about mathematics and how it is learned."

Kagan defined teacher beliefs as "tacit, often unconsciously held assumptions about students, classrooms, and the academic material to be taught" (Kagan 1992, 65). Albion and Ertmer (2002) emphasised the importance of teachers' beliefs in directing their use of technology in their classrooms. Their beliefs about digital literacy may affect their decisions to integrate digital literacy into their classrooms or limit their endeavours to leverage the technology. Petko's (2012) study found that teachers' views about media education literacy's relevancy were highly correlated with their deployment of information and computer technology.

Teachers' positive beliefs about using technologies have been a significant factor in integrating the technology into their classrooms (Albion and Ertmer 2002; Perry, Wong, and Howard 2006; Yushau 2006). Yushau (2006, 1) states that "teachers' attitudes toward information technology play as a crucial factor in the successful use of computers in teaching and learning".

The scholars Galbraith and Haines (1998) define the term belief, attitudes and emotions of teachers and students. According to them, *belief* is an imitation of a certain set of concepts; *attitude* is an emotional reaction to or behaviour regarding an object, such as technology, and emotion is agitated arousal created by some stimulus. Their study points out that understanding students' attitudes and beliefs in learning is a crucial step in understanding how the learning environment is affected by the introduction of computers and other technology in the classroom, in other words, about the integration of technology into the classroom.

Educational technology options for Ethiopia during the COVID-19 pandemic

The COVID-19 pandemic brought a crisis to the world. Like many other aspects of everyday life, the pandemic severely affected students, instructors, and higher education institutions worldwide (Mailizar and Bruce 2020). The pandemic forced schools, colleges, and universities worldwide to shut down in-person classes so that students could practice COVID-protocols such as social distancing (Toquero 2020). The migration from conventional education models to distance and virtual learning required time and resources to accomplish the desired outcome of rapid migration has various obstacles and challenges at this point (Crawford et al. 2020). However, "because nobody knows when this pandemic will disappear fully, educational institutions across the globe decided to use the already available technical resources to create online learning material for students of all academic fields" (Kaur 2020).

Some Ethiopian universities started training their lecturers on how to employ the e-learning platform for learning and teaching process in response to the challenges associated with COVID-19; hence, the main educational technology platform was online. Accompanying the rise of online learning and teaching all the countries of the world, researchers tried to compare their country with other countries. For instance, Basilaia and Kvavadze (2020) stated that online teaching and learning were effective for digitally advanced countries, but in Pakistan, it was ineffective. According to the scholars' views, something must be done for developing countries. Ethiopia is also one of the developing countries.

Unlike digital learning in normal situations, the current circumstances are unique. They were abruptly enforced due to a global crisis, leaving no choice but to adapt or die, so to speak (Pace, Pettit and Barker 2020). The shift to digital learning brought a stronger need for academic organisations to improve their curriculum and use new, state-of-the-art instructional methods and strategies (Toquero 2020).

Social activities and interactions are concentrated in higher educational institutions. If educational activities are restricted to distance learning and virtual teaching, children and young people will be deprived of social interaction essential for their learning and growth. Students, especially underprivileged children and young adults affected by the institutions' closure, must continue to learn and interact with their peers and teachers, so this is a major challenge to overcome. Following the school closures because of COVID-19, the Ethiopian government developed a Distance Learning Plan, with the support of UNICEF and other education partners, called *Save the Children*, to assist children in learning remotely through TV, regional radio and digital platforms. According to McCarthy, "while short term closure of academic institutions as a consequence of emergencies is not recent, the global scope and pace of present-day educational instability are sadly unparalleled and, if sustained, may inflict psychological distress and misery at various levels" (McCarthy 2020, as cited in Adnan and Anwar 2020, 46).

A review of the literature points out that "Integrating successful procedures of education with online learning, may prove useful and enhance learning outcomes. Cooperative learning and online learning both share the aspect of socialisation in education. Shared learning enables students to become autonomous and creative learners. Network-based cooperative activities ensure students access to peers and teachers and motivates them for better learning" (Aghajani and Adloo 2018, 434). According to Jain (2020) "Platforms like Zoom, Google Classrooms, Microsoft teams, Cisco Webex and Skype are stepping up and making virtual classrooms a reality by providing easy and free access to both the students and the lecturers*"* (Jain 2020, 70).

To investigate these solutions, we explored some of the platforms that can support the above-mentioned applications were discussed in this study.

Telegram is one of the mobile applications developed for communication purposes. The widespread use of mobile devices holds great potential to e-leaning in terms of pervasiveness, ubiquity, personalisation, and flexibility (Aghajani and Adloo 2018). Surprisingly, this mobile app was also used to reduce the spread of COVID-19 during the closure of schools and universities in Ethiopia. Aghajani and Adloo (2018) used *Telegram,* one of the most popular social networking applications with millions of educational users, in their study to compare its efficacy with more conventional methods. They found that participants in *Telegram* cooperative writing groups displayed slightly higher scores than conventional methods.

During the COVID-19 pandemic, the mobile application *Telegram* was also used as a solution for teaching and learning in education in other countries. Iqbal et al. (2020) pointed out that *Telegram* provided an effective mobile learning platform for medical students during the COVID-19 and had fewer potential drawbacks, such as information overload through notifications. More studies revealed that *Telegram* had become one of the most famous online social media networks among university students (Mashhadi and Kaviani 2016). Telegram has channels and bots to access information with the teacher.

Wiranegara and Hairi (2020) used three techniques for implementing Telegram for teaching and learning to reach their research objectives. These were a) Pre-Teaching (prepare Telegram Group Learning), b) Whilst-Teaching, and c) Post-teaching. After implementation, they concluded that the Telegram social media group learning strategy could be developed to involve and encourage students to be active in the process of teaching and learning. In this educational platform, the teaching and learning can be individual and in groups, and the comments can be undertaken in the form of chats. The application helps teachers and students to share their reading material. Teachers used this application in the form of sharing reading material in Ethiopia.

E-learning is an umbrella term for open- or closed sources, mostly free or involving minimum cost (Piotrowski 2010). Some popular e-learning platforms available in 2021 are listed below. Among others, they also feature in our investigation of lecturers' use of technology.

Microsoft Teams was initially described by Microsoft as a "business communication platform" but has since added functionality, leading to broader acceptance and a changed marketing message that now says "Microsoft Teams is for everyone". It is a collaborative platform that supports chats, voice, and calling features, including support for video calls. It is fully integrated with Office 365 for managing documents with live streaming. The cost is $5 per month, which will also give you the additional functionality of the Microsoft 365 business essentials package. (https://support.office.com).

Zoom is a live video conferencing tool that can be used on smartphones and computers. A free version is suitable for most video conferencing requirements, but then meetings are restricted to a maximum of 40 minutes. It is possible to upgrade to a professional option at $14.99 per month that supports features like meeting recordings on the cloud, unlimited duration meetings and more user management features. (https://zoom.us).

Google Classroom is an open-source Web service provided by Google for education and training, supporting online assessment in a paperless way. Although the product is free, organisations must register their accounts, and students need valid email addresses. Google Drive, Google Docs, and Gmail are supported, allowing the sharing of resources. (https://classroom.google.com).

Moodle (Modular Object-Oriented Dynamic Learning Environment) is a learning platform or course management system aimed at online automation of examinations. It allows lecturers to create personal websites. Moodle is free, open-source and has been developed in Australia as a free alternative to commercial learning management systems (Piotrowski 2010).

RESEARCH METHODOLOGY

Research design

In the primary study, both qualitative and quantitative primary data were collected from lecturers to answer the research questions comprehensively.

Research sample

The study's target population was the university mathematics lecturers in Ethiopia who were in service during the academic year of 2021. From the 45 public universities in Ethiopia, the researcher selected three universities to participate in the study. In a pilot study, the questionnaire was distributed online through *Google Forms* to 20 lecturers in a specific university, of whom eight responded to validate the instrument. These lecturers held Master's and Doctoral degrees. For the main study, the questionnaire was distributed to 41 mathematics lecturers, of whom eighteen responded and participated. These lecturers are teaching different mathematics specialisations, such as mathematics education and algebra.

Mode of data collection

Data collection was carried out in three Ethiopian Universities through online questionnaires (Web survey) for mathematics lecturers of different educational levels. The use of Internet- or Intranet-based web surveys is increasing in all social sciences (Phellas, Bloch, and Seale 2011), as the respondents can utilise a link to the web page with the questionnaire and complete it online. A survey in the form of a questionnaire is one of the most frequently used methods of data collection for testing attitudes and opinions. Phellas et al. (2011) mentioned some advantages and disadvantages of web-based (online) surveys. The advantages of web-based surveys include that:

- Speed, they are extremely fast;
- They are cost-effective. There are only the set-up cost to consider;
- They support multi-media displays;
- There are many easy-to-use formatting instructions available to set up web pages, e.g., skip instructions, support for different fonts and colours;

- The anonymity of web-based surveys put respondents at ease to provide more honest responses;
- As people can respond at their convenience, they tend to provide longer, more comprehensive answers.

However, there are some disadvantages as well:

- Many people do not have access to the Internet so internet surveys do not reflect the views of all the demographics;
- People may be interrupted and abandon their responses before completing them;
- There are usually no checks on who replies and if they reply more than once, unless special accommodation is made in the software.

Data collection instrument

The online questionnaires consisted of four sections as follows:

- Section 1 consisted of *demographic* information and included questions about lecturers' background, gender, age, and education level.
- Section 2 elicited lecturers' responses on 25 statements in three categories as follows:
  Category 1: lecturers' *knowledge* of the technology they had to use;
  Category 2: lecturers' *beliefs* about using technology as mode of instruction;
  Category 3: *factors* affecting the use of technology as a mode of instruction beliefs.
  Within these categories, respondents stated to what extent the statement reflected their opinion on a five-point Likert scale (1-*strongly disagree;* 2-*disagree;* 3-*neutra*l; 4-*agree;* 5-*strongly agree*).
- Section 3 featured eight *types of technologies* available for distance learning. Respondents rated their preference of using the specific technological mode, platform or amenity, on a three-point Likert scale (1-*never*, 2-*sometimes*, 3-*always*).
- Section 4 contained open-ended questions where respondents wrote about their *experience with technology* before and during COVID-19 and the challenges they faced in using it. In this section, lecturers were also asked whether they stayed on track with instruction during the COVID-19 pandemic.

Validation of questionnaire items

The pilot study's purpose was to gauge the validity and reliability of the questionnaire through the application of the researcher's use of the Rasch measurement model. Bond and Fox (2015) stated that the Rasch model could measure reliability for right-wrong or dichotomous data, and that it could also be extended to polytomous data like that emanating from the Likert scale (Likert 1932). Data were analysed using WINSTEPS 4.7.0.0 (Student Version). The reliability of the technological mode of data collection was 0.77 based on Cronbach's alpha. Construct validity, determined by the PT-measure correlation value (PMC) ranged from 0.23 to 0.71. Except for item PUT15, the infit and outfit minimum square (MNSQ) value was between 0.1 to 1.86, while the Z-standardised value (ZSTD) ranged from -1.05 to 1.61, which was acceptable within the ideal range of -2 to +2 (Bond and Fox 2001). However, if the outfit and infit MNSQ are acceptable, the ZSTD index can be ignored (Linacre 2002). This was confirmed by the scholars Wright and Linacre (1994), who stated that the rating scale measurement is productive when the infit and outfit mean square range between 0.6 to 1.4 logits.

The reliability and separation of the items and respondents for the entire construct instrument in the pilot study are depicted in Table 1.

Table 1: Reliability and separation of item and respondents for entire construct instrument

INPUT: 8 PERSON 19 ITEM REPORTED: 8 PERSON 19 ITEM 5 CATS MINISTEP 4.7.0.0

SUMMARY OF 8 MEASURED PERSON

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	69.3	19.0	.66	.25	1.02	.05	.98	-.04
SEM	3.4	.0	.21	.01	.15	.42	.13	.36
P.SD	9.0	.0	.55	.04	.40	1.12	.34	.96
S.SD	9.6	.0	.59	.04	.42	1.20	.36	1.03
MAX.	85.0	19.0	1.74	.33	1.74	1.82	1.57	1.43
MIN.	56.0	19.0	-.05	.22	.38	-1.85	.37	-1.81

REAL RMSE .27 TRUE SD .48 SEPARATION 1.78 PERSON RELIABILITY .76
MODEL RMSE .25 TRUE SD .49 SEPARATION 1.97 PERSON RELIABILITY .80
S.E. OF PERSON MEAN = .21

PERSON RAW SCORE-TO-MEASURE CORRELATION = .99
CRONBACH ALPHA (KR-20) PERSON RAW SCORE "TEST" RELIABILITY = .77 SEM = 4.33
STANDARDIZED (50 ITEM) RELIABILITY = .91

SUMMARY OF 19 MEASURED ITEM

	TOTAL SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	29.2	8.0	.00	.37	1.01	.08	.98	.06
SEM	.8	.0	.10	.01	.10	.21	.09	.19
P.SD	3.4	.0	.44	.03	.42	.87	.40	.79
S.SD	3.5	.0	.45	.03	.43	.90	.41	.81
MAX.	34.0	8.0	.77	.44	1.78	1.58	1.86	1.61
MIN.	23.0	8.0	-.71	.34	.46	-1.05	.48	-.99

REAL RMSE .40 TRUE SD .18 SEPARATION .45 ITEM RELIABILITY .17
MODEL RMSE .37 TRUE SD .23 SEPARATION .63 ITEM RELIABILITY .28
S.E. OF ITEM MEAN = .10

ITEM RAW SCORE-TO-MEASURE CORRELATION = -1.00
Global statistics: please see Table 44.
UMEAN=.0000 USCALE=1.0000

We categorised the data obtained from the participant responses to the questionnaires into four sections for analysis and discussion purposes. The questions in Section 2 were divided into three categories as shown in Figure 1.

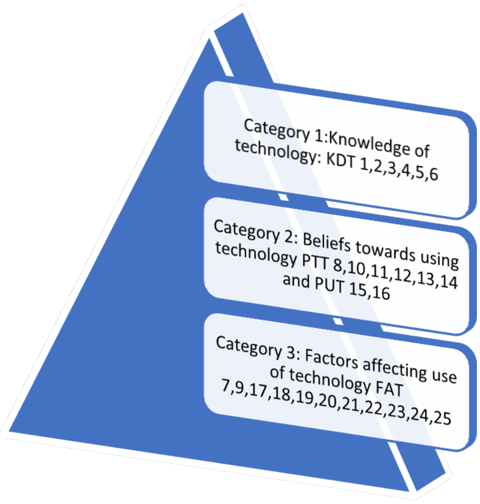

Figure 1: Categories of data in Section 2 of the questionnaire.

The Rasch measurement model is of interest to educational researchers for developing and validating test instruments (Beglar 2010). According to Bond and Fox (2015), if PT-measured correlations (PTMC) that were negative or nearly zero, it would signal problematic items not consistent with the construct or with items constructed for the main study. Such items can be improved or removed to ensure that the questionnaires measure the constructs. We, therefore, removed the responses to problematic items from the main research results. This removal ensured that the results obtained related to the research construct reliably and validly, and appropriately answered the study's research questions. Table 2 reflects the six items which were dropped and the nineteen items which were retained within Section 2 (the main body) of the questionnaire.

Table 2: Summary of item codes dropped and retained in Section 2 of the questionnaire

Categories	Retained	Total retained	Dropped	Total dropped
Category1	KDT (2,4,5,6)	4	KDT (1,3)	2
Category2	PTT (11,13,14), PUT (15*,16)	5	PTT (8,10,12)	3
Category3	FAT (7,9,17,18,20,21,22,23,24,25)	10	FAT19	1
Overall	2,4,5,6,7,9,11,13,14,15,16,17,18,20,21,22,23,24,25	19	1,3,8,10,12,19	6

PUT15* is again problematic as the PT-measure of this item is negative. We were however, attentive to analyse this item carefully and managed to improve it.

Data analysis

All collected survey questionnaires (quantitative part) from Google Forms were coded and inserted into the Statistical Package for the Social Sciences (SPSS) version 20, analysed carefully, and the answers to the open-ended section were analysed narratively.

Lecturers' perceptions towards the use of technology statements were scored with the responses progressing from one through to five for *strongly agree* (SA), *agree* (A), *neutra*l (N), *disagree* (D) and *strongly disagree* (SD), respectively. (ANOVA) statistics were employed to investigate the differences according to the teachers' characteristics – gender, age and educational qualification, the t-test, and analysis of variances.

RESULTS AND DISCUSSIONS

The ages of 18 all-male university lecturer participants from three Ethiopian universities ranged from 32 to 55 years, with the mean being 42.67 years. The education level of the participants varied from a master's degree to a doctorate. Of these lecturers, ten (55.6%) had an M.Sc./M.Ed qualification, seven (38.9%) had doctorate degrees and one (5.6%) was an assistant professor.

We were interested in finding out whether the difference in age (test variable list) affected the teachers' educational background (grouping variable) using the Kruskal-Wallis Test. The result revealed that there was an insignificant difference (Asymp.sgn, n=0.432>0.05) in the effect of the age of teachers on their education background (MSc/M. Ed, n=10 with mean rank=8.35, assistant professor=1 with mean rank=7 and Doctorate=7 with mean rank =11.5).

More importantly than the effect of age on qualification, we were interested in the effect of the age variable on technology use. The question was – could we regard the cohort of lecturers as homogenous, or should we reckon that, for example, younger lecturers were more inclined towards the use of technology than their older counterparts? We, therefore, studied the responses of lecturers, keeping this variable in mind; however, we found an insignificant effect of age on their perception of the use of instructional technology. Following below is a summary of participant responses to Section 2:

Category 1: Lecturers' knowledge of educational technology

On a five-point scale, four statements would assess lecturers' knowledge of using technology in instruction, of which items 1 and 3 were dropped because of item misfit pointed out by the Rasch model. The remaining items all had a bearing on lecturers' knowledge to date and experience of instructional technology exposure.

Analysis revealed that lecturers were all aware of the knowledge required for using technology, with 100 per cent giving an affirmative answer. Item analysis showed that most respondents had the required knowledge, while 16 (88.9%) already used technology in classroom instruction. Five lecturers (27.6%) had not seen when other lecturers were using technology in the classroom, nine lecturers (50%) neglected this mode of instruction, while four (22.2%) were neutral. The overall mean of this statement is 3,3, which is greater than a neutral score, so we can say that the university teachers are knowledgeable about the use of instructional technology. This finding resonates with what Michael (2015) found that many teachers contend and are aware of integrating technology, pedagogy, and content to enhance education quality.

The findings are presented in Table 3.

Table 3: Section 2, Category 1, percentage, mean and standard deviation of lecturers' knowledge regarding instructional technology (KDT)

Items	1: SD	2: DA	3: N	4: A	5: SA	Mean	S. D
KDT2: I have used technology in my learning and teaching process	5.6%	0.0%	5.6%	55.6%	33.3%	4.1111	0.96338
KDT4: I have seen other teachers use technology in the classroom	5.6%	22.2%	22.2%	33.3%	16.7%	**3.3333***	1.18818
KDT5: I have downloaded the software from the internet for my study	5.6%	0.0%	5.6%	61.1%	27.8%	4.0556	0.93760
KDT6: I know about some exemplary materials of using technology	5.6%	5.6%	0.0%	61.1%	22.2%	3.8889	1.02262
Overall	3 (2.24)	5 (2.78)	6 (3.34)	38 (21.11)	18 (9.92)	15.4	4.112

*Mean score near to the neutral level of 3.0

The item and item analysis in Table 3 show a consistent pattern in the answers of the lecturers to Category 1 items under Section 2 of the questionnaire.

Category 2: Lecturers' beliefs regarding the use of instructional technology

In Category 2 of Section 2, five statements were used to assess lecturers' beliefs towards using instructional technology, again on a five-point Likert-type scale from 1 - *strongly disagree* to 5 - *strongly agree*. In this category, we dropped items 8, 10 and 12 while running the pilot study using the Rasch model measurement as the items were a misfit for the desired data. The remaining questions all had a bearing on beliefs regarding the advantageous effect of using instructional technology to sharpen and deepen lecturers' pedagogies. This finding, as will be reflected in the discussion, translates to a valuation or value judgement of the perceived benefits (or not) of instructional technology. The results are reflected in Table 4.

Table 4: Section 2, Category 2, percentage, mean and standard deviation of lecturers' beliefs about using instructional technology (PPT and PUT)

Items	1: SD	2: DA	3: N	4: A	5: SA	Mean	S. D
PDT11: Technological software helps me relearn some mathematical ideas	5.6%	5.6%	16.7%	55.6%	16.7%	3.7222	1.01782
PDT13: I have learned a lot after I used technology that would otherwise be difficult to learn	5.6%	5.6%	22.2%	44.4%	22.2%	3.7222	1.07406
PDT14: Technological software helps me see my lesson as a consistent system of ideas	5.6%	5.6%	22.2%	55.6%	11.1%	3.6111	0.97853

Items	1: SD	2: DA	3: N	4: A	5: SA	Mean	S. D
PUT15: I would like to learn more about my lesson before using Technological software	11.1%	16.7%	16.7%	38.9%	16.7%	3.6867	1.28338
PUT16: I feel that a new kind of my lesson is being taught by Technology	5.6%	16.7%	38.9%	27.8%	11.1%	2.59333	1.06027
Overall	6 (3.35)	9 (5.02)	18 (11.67)	40 (22.23)	14 (7.78)	17.6	5.4

Of all participants, 38.9 per cent believed that their lessons would be rejuvenated by technology, while 22.3 per cent did not believe that this would be the case, and 38.9 per cent were neutral. These responses were inconsistent with the general belief amongst lecturers that they were more efficient when they used technology for lessons containing difficult concepts; that the technological instructional mode brought about greater consistency of ideas, and that technology stimulated the learning of new mathematical ideas. This inconsistency is evidenced by the response of 36.6 per cent of lecturers saying that they had learned much through the use of technological instruction that would otherwise have been difficult to learn. Also, most lecturers evaluated the use of technology as positive, even though not all of them used technology as the regular mode of instruction. One possibility is that the question could have been underestimated or misinterpreted and, as such, provoked low-key responses. It may also be because lecturers concentrated more on content knowledge rather than technology knowledge, as 55.6 per cent of lecturers believed that before integrating technology into their classroom, they had to learn the subject content knowledge of their lesson. Albion and Ertmer (2002) emphasised the important role of beliefs in determining how teachers use technology in their classrooms. Related to this would be the positive valuation that the technological mode of instruction would enhance the lesson's consistency of mathematical ideas. This finding is consistent with Yushau's (2006) finding that teachers' attitudes toward information technology play a crucial role in the successful use of computers in teaching and learning. The question may arise as to why some of these lecturers, who highly valued the use and benefits of instructional technology, have to date not used it in their teaching and learning process. Petko (2012) found that teachers' beliefs about the importance of media literacy education were highly correlated with their use of information and computer technology.

In general, as the mean score of all statements is greater than the mean neutral score of three in Table 4 above, the overall belief of lecturers towards using technology in the classroom is positive.

Category 3: Factors affecting the use of instructional technologies

In Category 3 of Section 2, eleven statements were used to assess the factors perceived by lecturers to be affecting the use of instructional technologies, again using a five-point Likert-type scale to measure responses. Following the Rasch measurement model's outcomes in the pilot study, we dropped item FAT19 and retained ten items as shown in Table 5. The findings for Category 3 are tabulated in Table 5.

Table 5: Category 3: Percentage, mean and standard deviation of *the factor affecting using technologies (FAT) in the teaching and learning process.*

Items	SD	D	N	A	SA	Mean	SD
FAT7: I have no time in the classroom to use the Technology applet	22.2%	50.0%	16.7%	0.0%	11.1%	2.2778*	1.1785
FAT9: There is a problem of internet connection in my university	5.6%	5.6%	22.2%	50.0%	16.7%	3.6667	1.02899
FAT17: College unsure as to how to effectively integrate technology in the learning-teaching process	5.6%	22.2%	16.7%	33.3%	22.2%	3.4444	1.24722
FAT18: The current reward structure does not adequately recognize those utilizing technology	11.1%	0.0%	11.1%	66.7%	11.1%	3.6667	1.08465
FAT20: There is a lack of enough technology training in university	0.0%	11.1%	11.1%	61.1%	16.7%	3.8333	0.85749
FAT21: There is a lack of technical support regarding the technology for teaching	5.6%	5.6%	11.1%	66.7%	11.1%	3.7222	0.95828
FAT22: Technology training is offered at inconvenient times	5.6%	22.2%	55.6%	16.7%	0.0%	2.8333*	0.78591
FAT23: The curriculum does not allow enough time to integrate technology	11.1%	33.3%	22.2%	16.7%	16.7%	2.9444*	1.30484
FAT24: Classroom management is more difficult when using technology	16.7%	50.0%	11.1%	22.2%	0.0%	2.3889*	1.03690
FAT25: There is a scarcity of technology for faculty	11.1%	16.7%	16.7%	27.8%	27.8%	3.4444	1.38148
Overall	6 (3.35)	9 (5.02)	18 (11.67)	40 (22.23)	14 (7.78)	17.6	5.4

*Mean score near to the neutral level of 3.0.

Responses in this regard may be classified at the institutional and personal levels, the dominating hampering factors for the use of technology being ascribed to the first. At the institutional level, the majority of lecturers either agree or strongly agree that their use of technology is hindered by six crucial factors for which their university is responsible, as follows:

- Poor internet connection (66.7%)
- The institution's uncertainty as to how to integrate technology (55.5%)
- Absence of recognition for the use of technology in the reward structure (77.8%)
- Lack of technology training (77.8%)
- Poor or lacking technical support (77.8%)

At the personal level, as lecturers have too little time to use technology, difficulty with classroom management and fear not being able to cover the curriculum when using technology, a below-neutral score is recorded. This finding is in line with the study done by Durak and Saritepeci (2017) that the effect of technology use by teachers on classroom management seems to be moderate. The result in totality is also in line with the research findings of Teferra et al. (2018). It is not the curriculum itself or a lack of time that hinders lecturers from using technology, nor is it a lack of appreciation of instructional technology's benefits (see Category 2 responses) or even their knowledge of using instructional knowledge (see Category 1 responses). In fact, hampering factors are perceived to be of an external nature, in other words, out-of-their-control.

Respondents were also asked to rate the time used (or not used) for the application of technology, using various applications, namely Telegram, Microsoft Teams, Microsoft One Note, Zoom, email, Moodle, Google Suite and Google Classroom for their education purposes by using a three-level scale, 1=*never*, 2=s*ometimes* and 3=*always*. The finding are depicted in Figure 2.

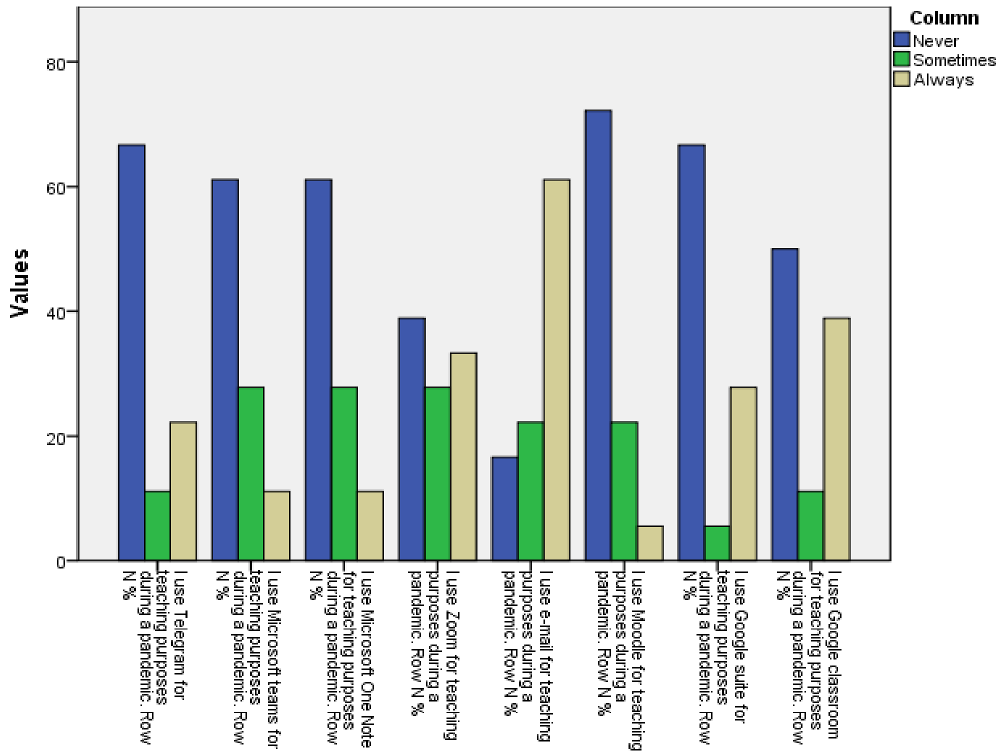

Figure 2: Responses towards the use of specific technologies for educational purposes.

Although there is varied use of the applications, in general we found that the Ethiopian mathematics lecturers were familiar with all six technologies. Additionally, respondents listed software and applications used for their teaching such as *Geometry sketch pad, GeoGebra applet, PowerPoint Presentations, C++, Turbo, Microsoft Excel, MATLAB, and Microsoft Math, SPSS, ATLAS.ti, RASH, Phys Lets, Physics Simulations, DrawPad, Video and PHET*. Be it as it may, respondents expressed the general opinions that integrating technology is one of the important solutions during a time like the COVID-19 pandemic, making the integration of technology mandatory, no longer optional. All this, on condition that training, connectivity and infrastructure be provided and maintained at the institutional level.

CONCLUSION

Synopsis of the study

The study aimed to investigate the perceptions of eighteen mathematics lecturers from three Ethiopian universities towards the use of instructional technology, a mode of teaching compelled by the COVID-19 pandemic. All participants were males ranging from 32 to 55 years, and they all held either a masters- or a doctoral degree. The research questions guiding the investigation were:

- What is the current status of mathematics lecturers' knowledge and skills in using technology during the COVID-19 pandemic?
- What are these lecturers' beliefs about using technology as mode of instruction in the virtual classroom during the COVID-19 pandemic?
- What are some factors affecting the use of technologies in the teaching and learning of mathematics at tertiary level?

In a quest to answer the research questions, the development of the data collection instrument (an online questionnaire) was underpinned by the available literature, which led the researcher to group questions in four sections: (1) demographic data, (2) knowledge of, beliefs about and factors influencing the use of instructional technology; (3) types of technologies used and (4) experience of the use of technology for teaching and learning. During a pilot study, the questionnaire was checked for validity and reliability using the Rasch measurement model. The result was that after the elimination of six unfit items, the new instrument with nineteen items was a reliable and valid instrument to measure the intended parameters in the study.

Interpretation of findings

According to their age range (32–55 years old), the Ethiopian mathematics lecturer participants in this study obtained their master's and doctoral degrees in the 21st century, or at the earliest, after 1995. That was the year that saw the arrival of the Internet. This means they have all been exposed to technology as a knowledge and research resource in their academic journey for decades now. Our research confirmed that they knew, used, experimented and experienced many technological applications and software packages – more than double the number we thought of including in our questionnaire as suggested technological instruction tools.

It was clear that an overwhelming majority (close to 90%) of the respondents had indeed previously made use of technology in teaching and that they were in the know of how to use a great variety of technological tools in instruction. In light of our first observation, that this cohort had emerged as academics in the era of the rise of technology, we have to conclude that knowledge- and experience-wise they were ready to deliver remote education via technological means.

Against the backdrop of participants' extensive exposure to some general and academic technological applications, it comes as no surprise that they also appraised the potential value of technology in instructional practice. Even those who had to date not made extensive use of instructional technology acknowledged the benefits for their professional practice. They admitted that their pedagogical and content knowledge would be enriched and improved once they used this mode of delivery. In fact, the questions in the research instrument inevitably stimulated their further consideration for some crucial benefits they could gain once they embarked on technological instruction. Each positive response is taken seriously since the study cohort are critical thinkers who are unlikely to produce ill-considered responses. Here, we mention but a few:

Most respondents realised that they could learn and re-learn mathematical concepts before and during their use of technology as mode of instruction. This benefit holds the promise that these lecturers are ready to improve their mathematical content knowledge and delve deeper than their existing knowledge.

The majority also acknowledged that their lessons would be more consistent, which by interpretation would mean that they judge that their pedagogical skills could be improved through technological teaching. Coherency holds that instruction by technology could be delivered more reliably and coherently than face-to-face classroom instruction. This, in turn, implies a raised standard of teaching.

Therefore, we conclude that, generally, in terms of knowledge and experience and motivation and willingness, respondents were ready for technological instruction. Lecturers admitted that they would not be hampered by a lack of time preparing and delivering technologically supported training; neither would they have difficulty with classroom management or fail to cover the curriculum when using technology. This view means that added to their knowledge, exposure, experience, motivation and willingness to teach technologically, they reckoned that they could reach their professional targets even if they were to conduct technology-driven training henceforth. All-in-all we cannot but conclude that the Ethiopian mathematics lecturers were all prepared – personally – to deliver technologically driven instruction.

However, the personal readiness – if not enthusiasm – of this cohort is somewhat dampened by factors of an external nature, over which they have little to no control.

Some prominent institutional factors hampered, frustrated and slowed down the use of technology in teaching and learning. As mentioned earlier, at the institutional level, the majority of lecturers either agreed or strongly agreed that their use of technology was hindered by some factors for which their university had to take responsibility, namely unreliable internet connection, wavering commitment by the university to support technological teaching, the lack of recognition for the use of technology in the lecturers' reward structure and insufficient technology training.

Our research's distressing conclusion is that lecturers' personal willingness to adapt to the demands of trying times, their readiness to develop and deliver instruction using technology, and their interest in self-improvement through technology are frustrated by the disabling institutional failure to promote this indispensable mode of instruction.

Lecturers are ready and prepared, but their institutions are not.

Limitations

This study was limited by the numbers of university teachers in Ethiopia that participated. The questionnaire was distributed online by using email, and the participants of the study were those who were eager to participate in the study by using their email. Had these issues been examined differently, a different result might have been obtained. The researcher needs to expand the study to all teachers in Ethiopian universities on using technology in the classroom for teaching and learning and recommend the government about the findings.

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