The Future of Technology-Based Learning at the Open University of Tanzania

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Abstract—Today, digital transformation in higher education reshapes traditional educational systems toward technology-based learning. In the wake of the global pandemic COVID-19, digital transformation has even accelerated at many universities worldwide due to the pressure put on policymakers and university management to adopt educational technology at their institutions to allow education to continue. Using the case of the Open University of Tanzania (OUT), this article discusses critical factors needed for the successful implementation of technology-based learning and other technological innovations like adaptive learning, for example, in higher education in an African context. We applied a Delphi design, a rigorous research method used for structuring a group communication process to allow a group of experts, as a whole, to deal with a complex problem effectively. In total, 24 experts (e.g., instructors, staff, and students) from different regional OUT centres participated in the Delphi study. The paper presents the results of the first round of the Delphi study on the challenges of technology-based learning identified at OUT providing the first insights into the perceived role, probability, and estimated realisation time of adaptive learning at OUT in the future. We argue that not only technological challenges linked to the internet, network, or technological equipment affect the adoption of technology-based learning in higher education, but also that pedagogical, organisational, and global challenges are indispensable for the successful transformation of higher education.

Keywords—technology-based learning, adaptive learning, Delphi study, distance education

1 Introduction

In 2015, all UN Member States adopted the new Agenda for Sustainable Development 2030 applied to industrial, emerging, and developing countries. Education is mainly addressed in the Sustainable Development Goal 4 (SDG 4), which aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all [1]. Nowadays, technology has become one of the disruptive enablers of the digital transformation of education and learning in higher education worldwide [2]. The global pandemic COVID-19 has even accelerated the digital transformation of

many universities. More pressure has been put on policymakers and university management to adopt technology-based learning (i.e., learning via all electronic technology, including internet and computer-based instruction) in their institutions to allow education to continue. African education is no exception. At least for two decades, Africa has begun to harness technological solutions for learning by taking advantage of internet connectivity, mobile devices and believing that such technological innovations would improve access to education and decrease its costs [3], [4], [5]. For example, the Ministry of Education in Tanzania has recently planned some initiatives with international partners to increase access to education in the future [3]. Despite widely recognised advantages of technology-based learning over traditional modes of learning and the compelling urgency evoked by the pandemic crisis to utilise technological solutions in higher education, Africa has been struggling with some challenges regarding its effective adoption. In the following, we review some key challenges that Africa and in particular Tanzania face today in utilising technology-based learning in higher education.

According to Mukuni [4], one of the relevant challenges in the context of Africa relates to digital infrastructure (e.g., internet access). A current survey conducted with more than 1600 EdTech experts on the effect of the COVID-19 pandemic on African education has found that limited access to technology, insufficient availability, and affordability of connectivity has remained the main barriers to learning during the pandemic [6]. Today, 43% of Africa's and 37.6% of Tanzania's populations have access to the internet [7]. Student access to eLearning management systems at universities remains even lower. According to Elletson & Stromeyer [3], less than 4 % of students and academic staff used learning platforms at the University of Dar-es-Salaam. Other infrastructural challenges have included network issues and unreliable power grids [8], [9], [10]. A study by Ngeze [10] has found, for example, that an unreliable network was one of the key challenges that hindered the use of a learning management system at the University of Dodoma. Other identified challenges have been related to students' negative attitudes toward technology-based learning [10], inadequate computer literacy skills among students and staff [8], [11], [12], [13], and inappropriate curricula for distance learning [6].

Despite the key challenges African education faces today, educational specialists remain positive and anticipate that the current crisis will catalyse the broader dissemination of technology-based learning in higher education in the future [6]. Thus, alternative solutions to the challenges have become important as never before. Fomunyam [14] has suggested that adaptive learning could be a solution to the challenges in the African context. As an alternative approach to teaching in blended and online learning environments, adaptive learning uses either rule-based or machine learning algorithms to monitor learners' progress. Based on the collected data from learners, it provides personalised instructions adapted to students' individual needs during the learning process [15]. According to Fomunyam [14], adaptive learning can solve common problems such as overpopulated classrooms, depleted ICT infrastructure, and access to education, especially in remote areas.

However, little is known about regulatory and global challenges related to cultural, political, and economic issues, particularly the adoption of adaptive learning in the African context. To fill the research gap described above, a Delphi study on the future of

technology-based learning has been conducted at the Open University of Tanzania (OUT). The main objective of our study was to investigate the challenges of technology-based learning and to explore the potential of adaptive learning at OUT. The article aims at presenting the results of the first round of the Delphi study. We then discuss the identified challenges and provide the first insights into the perceived role, probability, and estimated realisation time of adaptive learning at OUT in the future. We argue that not only technological challenges linked to the internet, network, or technological equipment impact the implementation of technology-based innovations in higher education, but also that pedagogical, organisational, and global (e.g., cultural challenges) are indispensable for its successful digital transformation.

2   Methods

The Delphi method was used to investigate the challenges of technology-based learning for OUT and explore the potential for adaptive learning at the university. The Delphi method is a research method used to structure a group communication process to allow a group of experts to deal with a complex problem [16] effectively. A typical Delphi procedure consists of multiple rounds of data collection, usually through qualitative and quantitative online surveys and includes various data analysis strategies. The responses of Delphi participants are treated anonymously. After each round of data analysis, researchers summarise the results in a feedback report provided to the participants together with the following survey. Based on the anonymous results presented in the reports, the participants have an opportunity to reconsider their opinion on a researched topic in the following rounds. This leads to a high quality of expert group opinions on a research problem at the end of the Delphi process [17]. The Delphi method is a well-accepted research method in higher education [18]. It is widely used to generate new ideas, predict technological developments, evaluate experts' opinions, and find consensus between experts.

2.1   OUT Delphi process

We used a three-stage rating Delphi method (Figure 1). First, we gathered a wide range of experts' opinions on the challenges related to technology-based learning at OUT (1. qualitative round). Then, to identify the most relevant challenges, the participants were asked to rate and re-rate the same challenges in the following rounds. The Delphi method also allowed us to make predictions for implementing adaptive learning at OUT in the future.

Fig. 1. Delphi process

2.2 Data collection (1. round)

This article presents the results of the first qualitative survey, which comprised three parts: demographic characteristics of Delphi participants, challenges of technology-based learning, and adaptive learning.

The first part of the survey collected demographic information of the participants, including gender, age, education degree, current occupation, profession, geographical location, experience in using technological innovations in teaching and learning, and the familiarity with adaptive learning (Table 1).

The second part of the survey consisted of open-ended questions about the positive and negative challenges of technology-based learning for OUT. The participants were asked to identify and describe the challenges across five dimensions: technological, pedagogical (teaching and learning), organisational, regulatory, and global. In addition, they were asked to propose the solutions to the challenges or how the indicated challenges could be overcome. To increase the interpretive validity of the responses, we estimated the difficulty of each question ("I felt it was difficult for me to answer that question") on a 5-point Likert scale ranging from "strongly disagree" to "strongly agree".

The third part of the survey (the forecasting part) focused on identifying the potential of adaptive learning for OUT. The participants were first asked to read the explanation of adaptive learning. Then, they were asked to estimate the realisation time, probability, importance of adaptive learning for OUT, and their intention to use it in the future. Finally, similarly to the technology-based learning part, the adaptive learning part consisted of open-ended questions related to the possible benefits, disadvantages, and challenges specific to adaptive learning. The difficulty of the questions related to the challenges of adaptive learning was estimated in a similar way as in the part of technology-based learning. The survey was administrated on the website Unipark, and the links to it were distributed via email.

2.3 Data analysis of the first round

Descriptive statistics were used for the analysis of demographic characteristics of the participants, responses to the difficulty of the questions, and the potential of adaptive learning at OUT. The qualitative data from the open-ended questions were analysed with the NVivo Pro 12 software [19]. For coding, two principal researchers used inductive and deductive coding techniques [20]. Three other members of Tanzanian research team validated the emerged codes and categories. The quality of the data analysis was ensured through documentation of the research process and researcher triangulation strategies [21].

2.4 Qualitative sample and recruitment strategy

A purposive sampling strategy was used to select the experts for the Delphi study based on the recommendations proposed by Creswell & Poth [22] and Adler & Ziglio [23]. The following three selection criteria were applied: (1) extensive knowledge and

experiences in technology-based learning and educational technological innovations; (2) capacity and willingness to participate; (3) sufficient time to participate in the Delphi study. Those requirements were specified in a recruitment questionnaire used as a checklist in the recruitment process. In addition, the sample included participants from various geographic regions and occupations including e.g., teaching, technical, and administrative staff, researchers, and students, to ensure differentiated perspectives on the research problem through the maximal heterogeneity of the sample [22]. The experts from the OUT staff were identified with the help of its HR office. For students, the selection was made in collaboration with the student union organisation and its leaders in the regional centres. Out of 26 experts recruited, 24 participated in the first round of the study. Table 1 gives an overview of the participants' demographical information.

Table 1. Demographic information of the first round

Number of participants	n = 24
Gender	
Female	9
Male	15
Age	
25 – 29	4
30 – 39	10
40 – 49	6
50 – 59	4
Occupation	
Professor/ lecturer/ researcher	4
Assistant lecturer	6
Technical staff/ IT	2
Administrative staff	1
Students	9
Others	2
Highest degree obtained	
BSc	6
MSc	12
PhD	4
Other	2
Years of experiences in using technology or e-learning innovations for teaching/ learning	
1. 1 year and less	2
2. 2 – 5	7
3. 6 – 9	2
10 years and more	13
Regional centres the participants work/learn most of the time, international	
HQ Dar es Salaam, Tanga, Morogoro, Tabora, Kinondoni, Arusha, Rukwa, Mwanza, Ilala, Sumbawanga, Kigoma, Iringa, Ruvuma, international (e.g., Nairobi)	

2.5   Ethics

Ethical approval for the study was granted by the local FFHS Ethics Committee. All participants signed informed consent for participation in the study and the first online survey. All personal data were handled in accordance with the Swiss Federal Law on Data Protection (DSG) and the research policy of OUT.

3   Results

The first part of the result section presents the findings on the technology-based learning challenges in the five main categories related to technological, pedagogical, organisational, regulatory, and global dimensions. The second part presents the implementation potential of adaptive learning at OUT (forecasting part). Twenty-four participants completed the first-round survey. Whereas all participants (n = 24) fulfilled the part on technology-based learning, only 17 participants completed the part on adaptive learning. Out of 24, 9 participants were knowledgeable or experts in adaptive learning, 13 were familiar or at least occasionally familiar with the concept, and only 2 participants were not familiar with the concept at all, one of which did not participate in the part on adaptive learning.

3.1   Technology-based learning

The primary goal of the first survey was to identify a wide range of statements related to the challenges of technology-based learning for OUT. Table 2 gives an overview over the identified topics across the pre-defined categories and their frequencies of mentions in the qualitative data. In the following, typical statements for each category are presented.

Table 2. Challenges of technology-based learning at OUT

Dimension	**Challenges of technology-based learning** The main challenges OUT faces today to utilise technology-based learning at the institution.	**F**
Technological	Unreliable internet, connectivity	21
	Lack of technological equipment to support technology-based learning	13
	Unreliable network	10
	Unstable electricity power	6
	Low level of ICT infrastructure	6
	Internet costs	1
	Lack of compatibility of technology	1
Pedagogical	Insufficient technological knowledge & literacy (instructors, students)	21
	Conventional learning mindset	4
	Reluctance to adopt technology by students	2
	Technophobia (i.e., fear to use technology)	2
	Low level of trust in online assessments	2

	Insufficient supervision due to large number of students supervised per instructor	2
	Inadequate time allocated for teaching and learning	2
	Inadequate learning interaction with instructors	2
	Lack of self-motivation to use available technology-based learning	1
	Reluctance to adopt technology by instructor	1
	Need to redesign the curriculum	1
	Lack of alignment of online sessions	1
Organisational	Insufficient budget for ICT infrastructure	6
	Insufficient human resources to support technology-based learning	2
	Insufficient common agreement on how to use technology-based learning	2
	Insufficient quality support for foreign student	1
	Limited technical support in regional centres	1
	Insufficient coordination of examinations for foreign students	1
Regulatory	Low awareness on TCU technology-based learning Guidelines	5
	Additional government support to OUT required	2
	Limitations to provide instruction adequately for some courses in distance mode	1
	Uncertainty about the usage of online assessment	1
Global	Global competition in distance learning	3
	Inadequate availability of internet services across providers	3
	Unfavourable perception of technology-based learning education among various stakeholders	2
	Impact of global pandemics on individual economy	2
	Low level of trust in distance learning	2
	Low level of promotion awareness of technology-based learning	2
	Unstable educational policies	2
	Low investment in national IT infrastructure by IT service providers relative to demand	1
	Poor collaboration among institutions	1
	Few international students	1

Note. F = frequencies of mentions, n = 24

Technological challenges. On the question "What are the main technological challenges OUT faces today to utilise technology-based learning?" most of the participants stated that OUT was facing the challenges linked to unreliable internet connectivity (n = 21), lack of technological equipment to support technology-based learning (n = 13), unreliable network (n = 6), and low level of ICT infrastructure (n = 6). Some participants characterised internet connectivity at OUT as "low", "poor", and "unstable" (id28, id31, id42, id49), pointing out that insufficient internet quality could be due to the "overload of university server" (id38), "networking devices" (id49), and "unstable networks of the internet service providers" (id49). Some participants emphasised that, in particular, "students from remote areas" (id17) suffered from slow internet and that internet is available "not in all areas" (id19). The following quotation describes the internet connectivity challenge at OUT: "Good internet connectivity is highly needed for both lecturers and learners to smooth both teaching and learning in online environments" (id13). Besides infrastructural challenges for OUT, some participants pointed

out the "lack of devices like laptops, PCs for students to access online materials" (id15). The same challenge applies to university staff: "Lack of technological equipment for some staffs, e.g., high-quality computers, writing pads" (id26); "inadequate support on ICT facilities like computers – an employee has to buy herself or himself a laptop" (id23); "limited ICT facilities for staff "(id36). Finally, unstable electricity power remains challengeable "especially to those working and learning from some upcountry regions" (id28).

Pedagogical challenges (teaching and learning). By far, the most mentioned challenge in the pedagogical category was insufficient technological knowledge and literacy both by instructors and students (n = 21). The majority of participants recognised that "computer literacy" (id13) and "knowledge and skills of using electronic devices" (id16) were lacking "for most of the students enrolled at OUT that makes them difficult to participate fully in technology-based learning" (id13). The participants stated that, similar to the students, some instructors were "not familiar with use of [the] ICT" (id15, id21), "struggled with Moodle [LMS]" (id19) and had "poor awareness of technology-based learning environment" (id26). One representative quote with the proposed solution to the problem was: "Lack of both familiarity and competence in utilising technology-based learning among OUT staff and students. This needs regular but well-scheduled training for capacity building among OUT staff and students in each department or regional centres" (id49). Interestingly, some participants (n = 4) mentioned that conventional learning mind-sets negatively impacted the implementation of technology-based learning at OUT, stating for example that "students are used to practice face-to-face mode of teaching" (id13).

Organisational challenges. The most frequently mentioned challenges in that category were linked to budget and human resources. Some participants (n = 6) recognised that technology-based learning required, for instance, "enough fund[s] to maintain the cost of network infrastructure and to have reliable bandwidth for smoothing eLearning" (id13). Two participants (n = 2) pointed to the lack of "expert[s] for technology-based learning", especially "instructional designers" (id13) and "experience[ed] technical personnel" (id38), who would better support instructors in the development of online content and improve the server. One participant stated the limited availability of "ICT technicians [...] in the regional centres" (id 36).

Regulatory challenges. The most frequently mentioned challenge (n = 5) in that category was linked to the awareness and attitudes toward technology-based learning and distance learning by the regulatory institutions (e.g., Tanzania Commission for Universities (TCU), Ministry of Education of Tanzania). Some participants assumed that regulations used for OUT were more tailored to conventional institutions and needed to be reconsidered specific to distance education: "Perhaps OUT is challenged by the TCU regulations which fit for conventional institutions" (id17); "[...] We need the ministry of education to think, how OUT can be treated differently from other conventional universities (id13); "Policies on higher education do not emphasise open distance learning" (id44). However, 11 out of 23 participants (one value is missing) experienced difficulties to answer the question in this category ("agree" (3), "strongly agree" (8)). Only 6 participants indicated that it was an easy question ("strongly disagree" (1), "disagree" (5)).

Global challenges (cultural, political, and economic). The participants were aware of the global challenges that might affect the utilisation of technology-based learning at OUT. The most frequently mentioned challenges are inadequate availability of internet services across providers (n = 3) and global competition in distance learning (n = 3). At the national level, some participants identified "poor hosting technology companies in the country" (id42) and "the national infrastructure for IT" (id29) as relevant challenges for technology-based learning at OUT. The following quote illustrates how the participants considered the global competition in distance learning as a challenge: "Due to global technological development, there are nowadays a lot of online schools, which provide competition to OUT. To takeover, OUT should now be more flexible to accommodate all kinds of challenges facing online-based learning (id26). Finally, a few participants reported some challenges linked to a perception of and negative attitudes towards technology-based learning. They reported on insufficient "awareness" (id13) about technology-based learning and "trust shortfall on tech[nological] education" (id12) among the Tanzanian community. Similarly, to the category related to regulatory challenges, almost half of the participants experienced difficulties in answering that question ("agree" (7), "strongly agree" (7)).

3.2 Adaptive learning (forecasting part)

Seventeen participants filled out the adaptive learning part of the survey. They were asked to imagine that OUT could use adaptive learning in teaching and asked to describe only its specific challenges, similarly to how it was done for the technology-based learning part of the survey. For an overview of the challenges, see Table 3. Very few comments were left in the categories related to regulatory and global challenges. That was probably because participants felt that it was difficult for them to answer those questions. Six participants agreed that the question on regulations was a difficult one ("agree" (2), "strongly agree" (4)), and 5 participants indicated the same for the global category ("agree" (2), "strongly agree" (3)).

In addition, the participants were asked to reflect on the benefits and threats of adaptive learning for OUT. Although few comments were left, the three most frequently mentioned benefits of adaptive learning were linked to the capability of adaptive learning to enhance learning flexibility (n = 4) covering a wider population of learners (n = 4), and improving the quality of education (n = 3). Some participants identified threats related to data issues like data insecurity and its incorrect interpretation. Finally, some participants expressed concerns about the diminishing roles of staff due to technology, disadvantages for learners with unreliable networks, and deterioration of work-life balance. The representative quotes were: "It will enhance the quality of education provided by OUT, will likely attract more younger people than the elderly learners" (ID31). "Workers might become less operational in taking advantage of the approach (ID28).

Table 3. Challenges of adaptive learning at OUT (forecasting part)

Dimension	**Challenges of adaptive learning** The main challenges OUT would face to utilise adaptive learning at the institution in the future.	F
Technological	Inadequate knowledge and skills on adaptive technology	4
	Insufficient technical know-how on adaptive learning	1
	Lack of experts on adaptive learning	1
Pedagogical	Need for extra training on adaptive learning	4
	Psychological readiness for adaptive learning	3
	New scheduling of the sessions	1
	Huge investments for development of learning materials	1
Organisational	Insufficient funds for adoption	4
	Lack of knowledge on adaptive learning in the organisation	3
	Organisational readiness for adaptive learning	3
	High costs for implementing adaptive learning	2
	Need for more investment for adaptive learning	2
	Inability to adapt to the new market demands	1
	Collaboration needed between the stakeholders	1
	Different educational levels of students	1
	Different technology competence levels among stakeholders	1
Regulatory	Need of approval by the regulatory authorities	4
	Insufficient awareness on adaptive learning by legislator	2
Global	Global competition in the Higher Educational landscape	1
	Low community trust in adaptive learning	1

Note. F = frequencies of mentions, n = 17

The quantitative questions on adaptive learning referred to the estimated realisation time, probability, and importance of utilisation of adaptive learning, as well as intention to use adaptive learning systems in the future. Interestingly, most participants of the second part of the survey kept a positive outlook on the realisation of adaptive learning at OUT in the future (Figure 2). Ten participants out of 16 (one value missing) believed that adaptive learning could be realised until 2025. They justified the shortest period of its realisation, for example, through the experience of OUT in "using technology in learning" (id31). Some less optimistic participants noted that realisation could be possible between 2026 –2030, but it "needs environmental preparations" (id12), "time and resources" (id18), and "time for advocacy" (id19). However, one researcher believed that adaptive learning would never be realised at OUT at all.

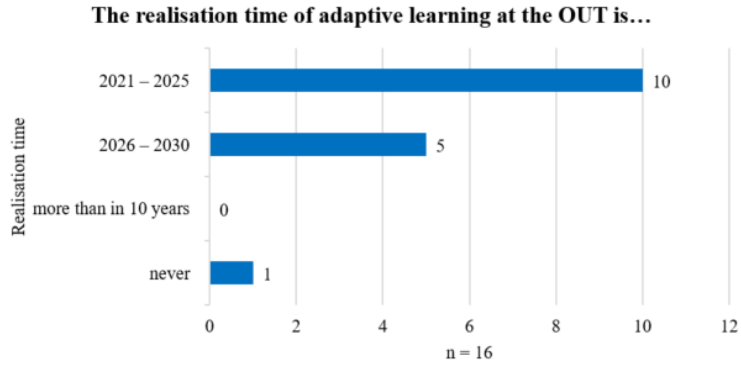**The realisation time of adaptive learning at the OUT is…**

Fig. 2. Realisation time of adaptive learning at OUT

Similarly, most of the participants indicated a high degree of probability that adaptive learning would be realised at OUT (Figure 3). They justified it by the fact that "OUT was investing in human resources capacity development, research, strategic partnerships and ICT infrastructure" (id18) and "already operating through online and distance learning mode" (id11). Some critical opinions about the high probability of realisation were linked to OUT's global challenges. They reported on the "nature of students, environment, politics, and economy" (id19) and that "the country itself was not well developed in terms of technology" (id10). However, 13 participants stated that it would be highly important to utilise adaptive learning at OUT because "it would be towards the achievement of operating totally online" (id11), "it [would] enhance transfer of knowledge to a wider population" (id16), and "it has capacity to promote OUT vision and mission to the advantage of the African region and global community" (id18).

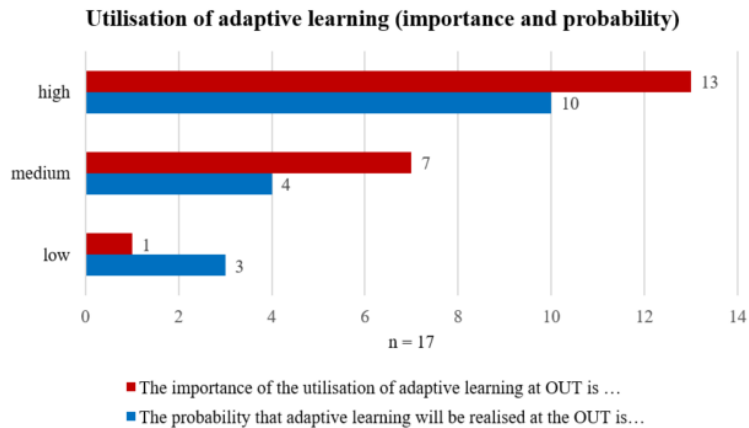**Utilisation of adaptive learning (importance and probability)**

Fig. 3. Utilisation of adaptive learning at OUT

Finally, all participants except one indicated that they would definitely use adaptive learning systems if they had an opportunity to do so (Figure 4).
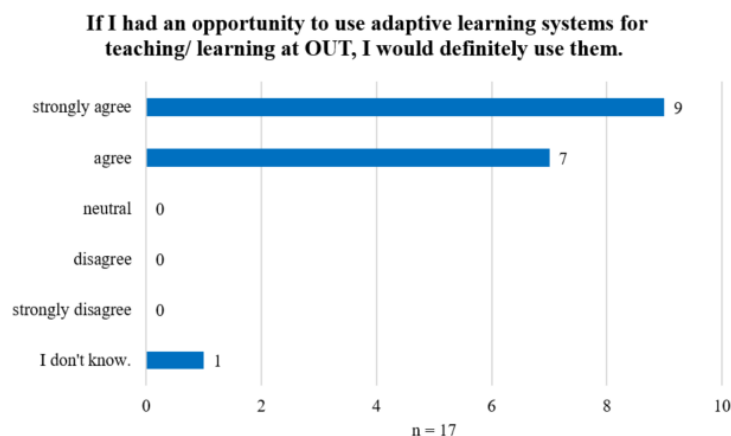
If I had an opportunity to use adaptive learning systems for teaching/ learning at OUT, I would definitely use them.

strongly agree	9
agree	7
neutral	0
disagree	0
strongly disagree	0
I don't know.	1

n = 17

Fig. 4. Intention to use adaptive learning systems

4 Discussion and conclusion

The first round of the Delphi study revealed a wide range of challenges that OUT faces today to utilise technology-based learning in distance learning and provided insights into the potential of adaptive learning in the future. In the following rounds, participants will rate and re-rate the challenges to determine their relevance and urgency for the OUT context. Although we cannot conclude after the first-round survey, which challenges are more important and which are less, the findings have shown that the identified challenges were mentioned with different frequencies. Our findings confirm the results of the recent survey that investigated the obstacles to effective distance learning in African countries [6]. This indicates that OUT is confronted with similar challenges as other African universities, which could be because the Delphi study has also been conducted during the pandemic. However, our study revealed more fine-grained challenges that covered several issues (e.g., trust, awareness, community attitudes, government support) at the regulatory and global dimensions. This provides valuable indications of where solutions to the challenges can be found, similar to what was proposed by Mukuni [4], who emphasised the role of national governments and development partners in meeting the key challenges. One participant of the eLearning Africa survey stated, for example, that "the government of Tanzania has invested in supporting ICT development by putting a fibre optic cable to most parts of the country. The aim is to improve, among other things, application of technology in education".

Regarding the utilisation of adaptive learning at OUT, the participants were at large optimistic. A fast realisation and its high probability were presumably due to a lack of practical experience in the adoption of adaptive technology in place, because the reali-

sation effort of adaptive learning is often underestimated [2], [24]. In addition, the qualitative responses have provided some sound arguments on why adaptive learning would be important for OUT, which goes in line with the participants' wish to use adaptive learning systems at OUT if possible. Such positive anticipation towards utilising adaptive learning at OUT in the future corresponds with the anticipation of 85% of eLearning survey respondents who have believed that the current pandemic will lead to more widespread use of technology in education [6]. Indeed, as Mawere & van Stam [25] concluded, technology-based learning can be successfully accepted and utilised by African communities, but only if it considers such topics as inclusivity and attainability of all learners.

In the following survey rounds, we determine the relevance of all identified challenges and explore further the role of the regulatory and global challenges for OUT and African distance education. We will provide practical recommendations for policymakers and university managers on how to get ready for the successful adoption of technology-based learning and other innovative teaching approaches that fit the future needs of African higher education.

5   Acknowledgment

6   References

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