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Perceived prospects of extended reality in improving efficacy for teaching and learning among students with hearing impairment at Cape Coast School for the Deaf, Ghana

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ABSTRACT

Extended Reality (XR) has become one of the emerging technologies with great educational possibilities that is being adopted at different educational levels including children with hearing impairment. This study was designed to investigate the prospects of XR in improving the efficacy of teaching and learning of students with hearing impairment at the Cape Coast School for the Deaf. The specific objectives were to examine the awareness level of the teachers about XR technologies: determine the extent to which XR can be incorporated into the school's educational system: and ascertain the extent to which XR improves the efficiency of teaching and learning. The study employed a quantitative descriptive survey design. The population consisted of 41 teaching staff who were selected through the census sampling technique. A digital questionnaire was used as an instrument for data collection. The results indicated that all participating teachers were prepared and deemed it important for XR technologies to be incorporated into the teaching and learning of students with hearing impairment, which would greatly improve the efficiency of the output. Based on the findings of the study, the authors recommend that Ghana Education Services allocate resources to XR technologies for students with hearing impairments.

Keywords: *Extended Reality (XR); Virtual Reality; Augmented Reality and Mixed Education; Hearing Impairment.*

INTRODUCTION

In the 21st century, technology has become an integral part of human life, particularly in the area of education. As a result, educational institutions are tasked with the responsibility of equipping students with the skills and knowledge needed to thrive in an increasingly digital and knowledgeable society. To achieve this goal, integrating technology into the curriculum has become essential (Ghavifekr, Afshari & Alma Salleh, 2012). This is because technology has the potential to create a dynamic and forward-looking instructional environment (Hatlevik & Arnseth, 2012). It is, therefore, expected that the introduction of information communication technology (ICT) into the educational system would improve educational outcomes and increase technological skills among the citizenry. In the field of education, it is crucial to acknowledge that each student has unique needs due to individual differences. Because of the unique characteristics of learners with hearing impairments, it is important that appropriate pedagogies and technologies are employed to meet the educational needs of such individuals. Extended Reality (XR) has become one of the emerging technologies with great educational possibilities that could be adopted in the education of students with hearing impairment.

Research Problem

The need for an effective technologically based curriculum is one of the core elements in strategic planning for technology integration in the Ghanaian educational system. It is an undeniable fact that teachers of hearing-impaired students deliver lessons to their students using sign language and a lot of visual materials. However, XR technology can make learning more accessible for students with disabilities by providing alternative modes of engagement and interaction (Tegoan, Wibowo & Grandhi 2021). In using XR technologies, the students can have real-life experiences in their learning where their practical sessions will be automated. Employing XR technologies implies hearing impaired students can comfortably practice or learn without the guidance of the teachers. Despite the numerous benefits that technology offers, it appears teachers in Ghana, including teachers of the hearing impaired, are not exposed to these technologies and thus are not aware of the importance and the efficiencies of using XR technologies to enhance teaching and learning. Studies on XR technologies are mostly carried out in countries in such as Europe, America and Asia, and the findings in Africa, particularly Ghana, are rather scarce, especially using extended reality with students with special educational needs and in this context learners with hearing impairments. In support of this assertion, Soetan et. al (2020) opined that in Africa, the adoption of augmented reality (AR) and virtual reality (VR) in schools is currently in its infancy stage. Few studies conducted in Africa have examined the adoption and integration of ICT into teaching and learning in regular schools. The present study aims to fill this gap. It has become imperative for the researchers to investigate the perceptions of special needs education teachers at Cape Coast School for the Deaf regarding the integration and application of XR technology in the education of students with hearing impairments.

RESEARCH QUESTIONS

The study aimed to address the following research questions:

1. To what degree are teachers at Cape Coast School for the Deaf aware of the utilization of XR technology in facilitating teaching and learning for students with hearing impairments?
2. How well have teachers at Cape Coast School for the Deaf been trained to embrace the incorporation of XR technology for teaching students with hearing impairments?
3. To what extent have teachers at Cape Coast School for the Deaf been prepared to accept the use of XR technology in teaching students with hearing impairment?
4. What perceived views do teachers at Cape Coast School for the Deaf hold regarding the effectiveness of XR technology in educating students with hearing impairments?

RESEARCH METHODOLOGY

A non-experimental survey design was used in collecting and analyzing the data to meet the objectives. The survey study was conducted at Cape Coast School for the Deaf, located in the Central Region of Ghana. The study population consisted of all the 41 teachers of the Cape Coast School for the Deaf who were made up of 25 females and 16 male teachers. A census sampling technique was employed in selecting the forty-one (41) teachers because of the small size number of the teachers. A self-developed digital questionnaire was administered through Google Forms. Prior to data collection, the researcher visited the headmaster who also introduced the researchers to the teachers. During the interaction, the participants were informed of the study's objectives and the researchers clarified the participants' understanding of the study. The researchers informed the participants that the questionnaire would be administered online and entreated all to participate in the study. The link to access the questionnaire was sent to participants via social media platforms, specifically WhatsApp, for them to respond to the questionnaire. The questionnaire was hosted online for data collection for sixteen days (16) from the 24th of March 2023 to midnight 8th of April 2023. To ensure anonymity and confidentiality, data collected during the study were kept private,

unlinked with names, and protected from unauthorized parties. Data were analysed quantitatively using frequencies, percentages, mean, and standard deviation. Pie charts and histograms were also used to support the analysis.

PRESENTATION OF FINDINGS

This study sought to investigate the perception of teachers of the deaf on the adoption and utilization of extended reality technology in teaching students with hearing impairment. Specifically, the study intended to establish the efficacy of using XR technologies in improving teaching and learning processes at Cape Coast School for the Deaf. The questionnaire was administered to the 41 teachers of the school out of which 22 teachers completed the online questionnaire for a response rate of 53.7%. Out of the 22 teachers who responded to the online questionnaire, 14 (63.6% were females while eight (36.4%) were males. The low rate of returns by study respondents could be attributed to inadequate technological skills to respond to digital questionnaires, and unstable Internet connectivity. The analyses of the findings based on the research questions are presented below.

Research Question 1: To what degree are teachers at Cape Coast School for the Deaf aware of the utilization of XR technology in facilitating teaching and learning for students with hearing impairments?

The study sought to evaluate special education teachers' level of awareness of XR technologies in the education of the hearing impaired. Shown in Figure 1, is the pie chart representing the participants' awareness level of XR.

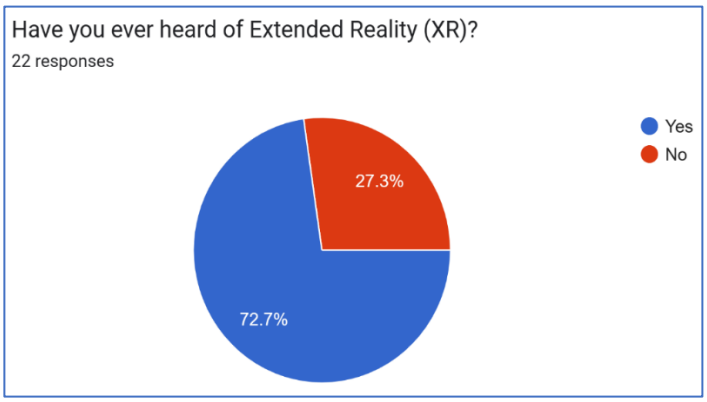

Figure 1: Awareness of XR by Participants

Analysis of the data in Figure 1 revealed that 16 (72.3%) respondents had heard of the technology at least once while six (27.3%) had not heard of the XR technologies at all. The 16 teachers who responded that they had heard of XR technology were further asked to indicate how they became aware of the technology. Figure 2 provides a summary of their source of information.

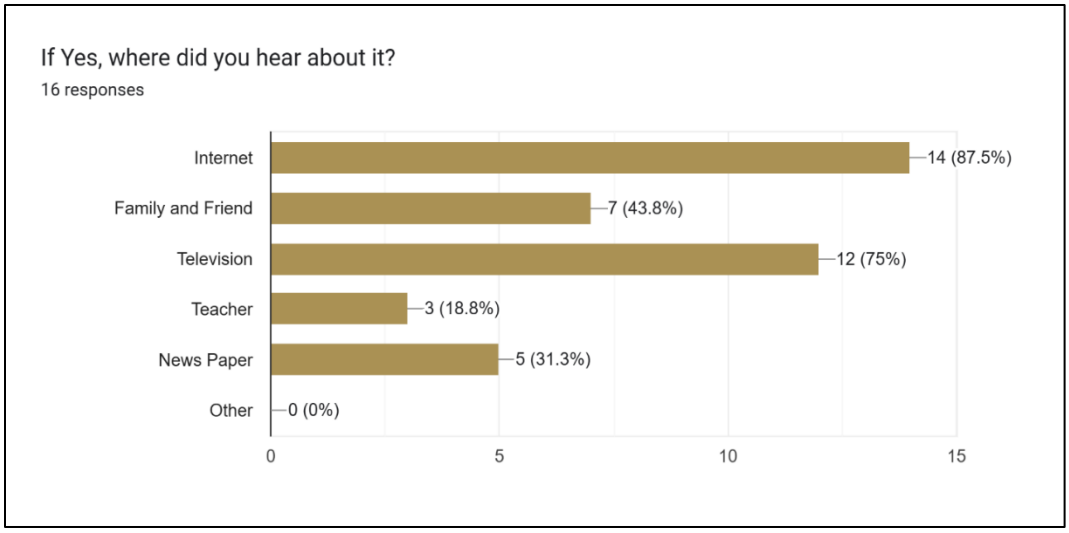

Figure 2: Source of Information on XR technologies

Analysis of the data in Figure 2 revealed that the Internet was identified as the major source of information with 14 (87.5%) participants indicating that they got to know of XR technologies through the Internet while 3 (18.8%) teachers reported that education was the least source of information to the study participants. Moreover, 7 (43.8%) and 12 (75.0%) of the respondents reported that their sources of information were through family and friends, and television, respectively. This finding supports Meccawy (2023) who explored teachers' attitudes and views on the feasibility of applying XR technologies in the school in Saudi Arabia and found that all teachers were very much aware of the application of XR technologies in teaching and learning processes. This was further confirmed in an earlier study by Soetan et al. (2020) which investigated teachers' awareness of virtual reality for instructional purposes in Nigeria and established that most teachers were aware of virtual reality facilities which are being used for instructional purposes.

Research Question 2: How well have teachers at Cape Coast School for the Deaf been trained to embrace the incorporation of XR technology for teaching students with hearing impairments?

The aim of was to evaluate the level of training provided to teachers in adopting XR technology for the education of students with hearing impairments. This was measured using 4 items. The teachers were requested to indicate how well they have been prepared to use XR technology in teaching students with hearing impairment. Simple frequencies were run to ascertain respondents' level of agreement or disagreement with the statement.

Table 1: *Responses on Teachers' Level of Training*

	Statement	Agreed *n* (%)	Disagreed *n* (%)
1.	Have been trained as a special needs educator	19 (86.4)	3 (13.6)
2.	Have been trained to deliver lessons using XR technology.	-	22 (100)
3.	Have taken a course on XR technology in teaching during my teacher training.	-	22(100)
4.	Have had special in-service training on how to deliver lessons using XR technology	-	22(100)
5.	Have the skills in ICT to enable me to teach the hearing impaired using computers.	15(68.2)	7(31.8)

As indicated in Table 1, the majority of the teachers (86.4%) reported that they had been trained as special needs education teachers while only 3 (13.6%) said they did not receive training as special educators. Also, the analysis revealed that all the teachers (*N*= 22, 100%) agreed that they had not been trained at all in the use of XR technology in teaching children with hearing impairments during either their pre-service or in-service training. However, as many as 15 (68.2%) teachers agreed they had the basic skills in ICT to teach their students whilst 7 (31.8%) disagreed with the statement. From the results of the analysis, it could be concluded that although a higher number of teachers have acquired basic ICT skills to enable them to incorporate technology in their teaching, they have not been trained specifically to use XR technology in teaching and learning processes in the school. The analysis above clearly demonstrates the fact that teachers at Cape Coast School for the Deaf have not had the opportunity to be trained in using XR technology in the education of the deaf. These findings stress the importance of teacher training in the use of technology. This finding is supported and affirmed from the findings of an earlier study by Edumadze (2016) when he stated that a significant proportion of educators refrain from incorporating technology into their teaching practices because they lack the requisite skills to effectively utilize these technologies. This was further confirmed by Lawrence & Tar (2018) who found that teachers' level of knowledge influenced their adoption and integration of technology in teaching and learning processes in Nigeria.

Research Question 3: To what extent have teachers at Cape Coast School for the Deaf been ready to accept the use of XR technology in teaching students with hearing impairment?

This question was designed to assess teachers' readiness to accept the adoption of XR technology in teaching students with hearing impairment. A list of 4 items that assess teachers' level of acceptance of the adoption of the XR technology in the school was presented to the teachers in the questionnaire. The teachers were asked to indicate their level of agreement or disagreement with the items on a Likert-scale. To analyse the teachers' responses, descriptive analysis was conducted to establish the means and standard deviation values.

Table 2: *Teachers' Responses on preparedness to accept XR technology*

S/N	Statement	*M*	*SD*
1.	Will support the introduction of XR technology in teaching the hearing impaired in my school.	3.89	1.254
2.	Will be willing to integrate XR technology in the education of the hearing impaired.	3.72	1.275
3.	Will be happy if the Government makes it a policy for teachers to use XR technology in teaching the hearing-impaired	3.58	1.247
	Grand Mean	3.73	1.259

XR= Extended Reality: *M* =Mean Values: *SD* = Standard Deviation Values

Results from Table 2 show that the mean values were very high for the items indicating that a significant number of teachers agreed that they were ready to embrace XR technology when they were directed to adopt it in their schools. The teachers unanimously agreed (*M*=3.89; *SD*=1.254) that they would support the introduction of XR technology in teaching the hearing impaired in their school. Again, when asked whether they agreed with the statement on willingness to integrate XR technology in the education of the hearing impaired, all the teachers responded favourably (*M*=3.72; *SD*=1.275). When teachers were further asked whether they would be happy if the Government made it a policy for teachers in the schools for the deaf to use XR technology in teaching the hearing impaired, almost all the teacher respondents strongly agreed (*M*=3.58; *SD*=1.247).

From the average grand mean (*M* = 3.73, *SD*= 1.259) as shown in Table 2, it can be concluded that even though, special education teachers at Cape Coast School for the Deaf indicated that they were not trained to teach children with hearing impairment using XR technology, they confirmed that they fully embraced the adoption and utilization of XR technology in the education of the students with hearing impairment. Based on the analysis, the study found that teachers at Cape Coast School for the Deaf showed a high level of acceptance of XR technology to support teaching and learning in the school.

This finding has been supported by earlier studies such as Adu Gyamfi (2016) who explored factors that influence pre-service teachers' readiness for technology adoption using the technology acceptance model approach, and found that teachers' perceived usefulness of technology in teaching and learning processes significantly influence their acceptance and actual use of computer technology. The findings are further supported by the study conducted by Bervell & Umar (2017) who found that teachers and students perceived usefulness and performance expectations as the major determinants of technology acceptance and adoption.

Research Question 4: What perceived views do teachers at Cape Coast School for the Deaf hold regarding the efficacy of XR technology in educating students with hearing impairments?

This question aimed to assess the teachers' perceived views on the effectiveness of XR technology in enhancing the teaching and learning interaction at Cape Coast School for the Deaf. The teachers were asked if XR technologies would improve the efficiency of teaching and learning with regard to the hearing impaired. Figure 3 presents the responses of the teachers.

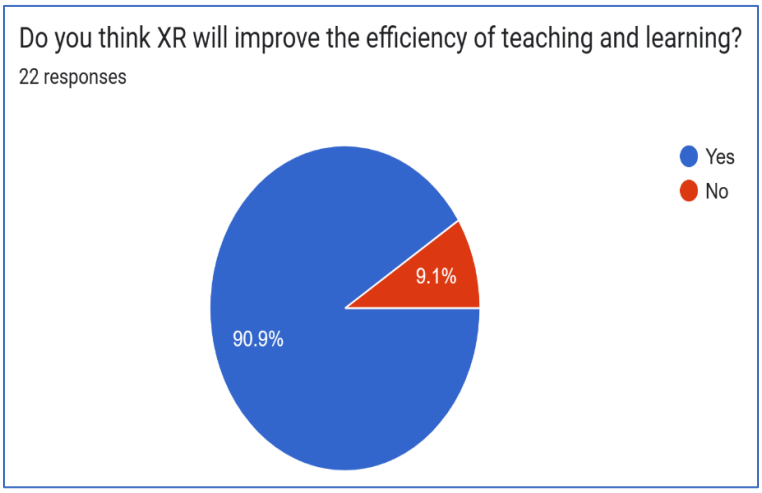

Figure 3: XR Technology on Teaching and Learning

As shown in Figure 3, when the participants were asked whether XR technologies would improve the efficiency of teaching and learning among the students with hearing impairment, only 2 (9.1%) teachers responded "NO" to the question implying XR would not improve teaching and learning while 20 (90.9%) of them responded "Y" indicating that XR would improve the efficiency of teaching and learning. The data revealed that majority of the study participants hold the view that the adoption and utilization of XR technologies in teaching the hearing impaired may improve the efficiency and efficacy of the learning outcomes of the students. The negative responses given by the two teachers could be attributed to the fact that they have never used the technology before though they are aware of it. Since they have not experienced it, they may not know the importance of XR in educational settings in the modern era.

The findings of the present study are in consonance with the findings by Petrov & Atanasova (2020) who discovered that extended reality positively affects students' learning and achievements due to the nature of its flexibility, efficiency, and accessibility. The results of this study further collaborate with most of the existing findings regarding the efficacy of XR technology in improving educational outcomes of learners with hearing impairments (Badilla-Quintana et. al 2020: Wells & Miller: 2020: Carreon et.al 2022: Chitu et.al ,2023). For instance, Badilla-Quintana et.al (2020) investigated augmented reality as a sustainable technology to improve academic achievement in students with and without special educational needs in Chile and found that despite classroom diversity, immersive technologies enhanced students' learning regardless of whether they had special educational needs (SEN) or not. This finding is further supported by a recent study conducted in Romania by Chitu et al. (2023) which found that the application of virtual reality technology could improve the educational process for children with disabilities.

STUDY CONCLUSIONS

Several conclusions were drawn from the study conducted on the perceived prospects of XR technology and its efficacy in improving teaching and learning in Cape Coast School for the Deaf, Ghana.

For research question one on special education teachers' level of awareness of XR technologies, the findings of the study indicated that the teachers of the hearing-impaired students at Cape Coast School for the Deaf are very much aware of the application of XR technology in educational settings. The teachers indicated various sources of information about XR technologies. Based on the findings of the study, it was concluded that the high level of teachers' awareness of the existence and use of XR technologies makes it possible to adopt such technologies in teaching hearing-impaired students in Ghana.

In relation to the conclusion on research question two, the study established that, none of the teachers had ever had the opportunity to be trained on how to use the XR technologies in the delivery of their lessons. The findings of this study have therefore led the researchers to conclude that the teachers have not taken any course on XR technologies either during the pre-service teacher development programmes or as part of their in-service training sessions.

According to findings based on research question three, the study found that special education teachers were ready to accept the adoption of XR technology in teaching students with hearing impairment in their school. The results of the study led the researchers to conclude that the majority of the teachers held favorable opinions about XR technologies, and were receptive to its possible implementation in the school.

The analysis of the responses on research question four on the perceived effectiveness of XR technology in teaching students with hearing impairment, revealed that the majority of the teachers held the view that the application of XR technologies in teaching the hearing impaired has a huge potential to improve the efficiency and efficacy of the learning outcomes of the students. The researchers therefore conclude that by using XR technologies as an instructional medium in the school, many students with hearing impairment could be effectively engaged in the learning process, and XR technologies could positively impact their educational outcomes.

POLICY RECOMMENDATIONS

Based on the findings of the study and the conclusions derived from the findings, the following recommendations were made with the view of considering the future possibility of adopting and utilizing XR technologies as a medium of instruction in the Ghanaian educational system.

1. With reference to the findings on research question one, it is recommended that the Government of Ghana through the Ministry of Education should make intentional efforts to create deeper awareness among stakeholders particularly teachers about the use of XR technologies in the educational field. By such intervention, both special needs education teachers and regular teachers may become more aware of the importance and benefits of using XR in teaching and learning processes.

2. With regard to the findings on research question two, the study recommends that the Ministry of Education should task the Ghana Education Service to re-design the initial teacher training curriculum to incorporate application of XR technologies in teaching and learning to enable teacher trainees to be equipped with the knowledge and skills required to effectively utilize XR technologies in teaching. Frequent school based in-service training should be organized for practicing teachers to build their capacities in XR technology usage in the schools. The researchers also recommend that individual teachers develop their own knowledge and skills related to XR technology applications in teaching and learning. Teacher professional development opportunities in which XR technologies are being used will help increase exposure and generate ideas for applying the technology in teaching.

3. Even though the findings on research question three established that the teachers were ready to accept and incorporate XR technologies, policy makers should not take it for granted that when it is implemented, all teachers will be willing to accept even after training them. Teachers' usefulness of technology in teaching and learning processes is found to significantly influence their acceptance and actual use of computer technology. The researchers therefore, recommend that all perceived challenges should be identified and resolved to ensure the ease of use of the technology by teachers.

4. Although the conclusion on research question four indicated that the application of extended reality technologies could enhance students' learning and improve the educational fortunes of children with hearing impairment, the researchers recommend that the Government of Ghana should support the Ghana Educational Service to commit resources to developing tutorials, exercises, and practical sessions for students, since XR technologies could provide enhanced benefits for teaching and learning in the schools. The Ghana Education Service should consider pursuing grant funds from educational foundations and international communities to support the implementation of XR technologies in the Ghanaian educational system.

RECOMMENDATION FOR FUTURE RESEARCH

The present study on perceived prospects of extended reality technologies in improving the teaching and learning of students with hearing impairment at the Cape Coast School for the Deaf could be the first of its kind in Ghana. Therefore, we recommend that further research on extended reality technology application in education be conducted on special education teachers from the various categories of special needs schools in Ghana using a mixed methods approach. This will help the Special Education Division of the Ghana Education Service and other stakeholders to develop an in-depth understanding of special education teachers' perception of XR technologies and it adoption in the schools.

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