Determining the Effectiveness of the Developed Prototype That Translate Pakistan Sign Language into English Text and Speech

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The present research aims to evaluate the effectiveness of the developed prototype, which translates Pakistan sign language into text and speech while using convolutional neural networking. Due to the lack of sign language teaching, unimpaired teachers face problems while teaching deaf students. The development of a translation tool can fill this communication gap. Research indicates that the gap was highlighted and to bridge the communication gap among impaired and unimpaired people, the prototype was conceived, which can translate the Pakistan sign language into English text and speech. The study employed a qualitative approach. Eight teachers were selected as sample using purposive sampling technique who were teaching deaf students. The present research incorporates the practical application of the sign translation tool in the separate article. Data was collected through focus group interviews. Data were analyzed using Nvivo. Findings of the results revealed that the tool proved to be effective in overcoming the communication barrier between deaf learners and unimpaired teachers. Moreover, the sign to speech translation option is more effective because it facilitates visually blind learners. This tool helps the teachers and other people to teach and communicate with deaf people, efficiently and quickly.

**Keywords:** Pakistan Sign Language (PSL), Sign language (SL), Translation, Deaf, Unimpaired.

**INTRODUCTION**

Language is a medium through which people communicate with one another. They interact, communicate and share their ideas using language. Language is known as the system of human communication, both the written and spoken languages, including the use of words in a structured and manner (Abbas & Sarfraz, 2018). Similar to language, sign language varies in different countries and regions. Many of the advanced countries have established their sign languages. These countries have all the essential mechanisms of sign language, such as formation, grammatical constructions, and clear signals. America, China, and Arabic countries are the most important countries which have their sign languages. But in Pakistan, this process is under investigation.

The information technology field has kept on influencing human life strongly. Different technologies, tools, and devices have been developed to assist humanity in solving various issues. Human beings have tried to overcome the communication barrier between the deaf and normal individuals using information technology. The notion behind such IT-based tools facilitates the deaf to communicate in a better way with the unimpaired people and vice versa. There can be various situations in which such IT-based tools can be proved helpful to eliminate this communication gap (Khan et al., 2015).

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There are 72 million deaf people in the world and they want to interact with other people through a language (Abbas & Sarfraz, 2018). Deaf people use gestures to communicate with each other. When a deaf person starts to communicate with anyone, he/she can make some gestures using his or her hands. Every particular gesture means a different letter, word or expression (Haseeb & Illiyas, 2012). When it comes to education setting unimpaired teachers and impaired students also face a serious issue of understanding and comprehending each other's language that results as a communication barrier. To remove the communication barrier between the deaf and unimpaired, an interpreting mechanism is needed, either it is an interpreter or any mechanism which convert signs into text or either convert text into signs language.

The whole world is working in the way to pave the way for communication between the deaf people, for example, the people who are disabled and blind. Across the world, a lot of research has been done with the help of state and private organizations and also on the basis of the individual (Mettis, 2000). As nowadays in the advancement of technology can mould it for the betterment of humanity.

Many countries have computerized the interpreting mechanisms that are available to communicate with deaf persons. These systems take speech as an input and then convert it into appropriate signs. For example, in Great Britain, the system known as TESSA (Text and Sign Support Assistant) is designed to translate speech into British sign language, but this system is specific to post office (Cox et al., 2002). Unfortunately, the development of such tools is a farfetched idea in Pakistan. Hence, a human translator is needed to communicate with deaf people. Some attempts have been made in Pakistan like GesTalk. However, the system requires a high cost Data Glove and a static gesture made by the user (Khambaty et al., 2008). Moreover, Naseem et al., (2019) developed a prototype that translates Pakistan sign language into the English language particularly in the educational setting. The current study extends that study and attempts to explore the perceptions of the unimpaired teachers about the effectiveness of the developed prototype.

Objectives of the Study

- To explore the applicability of the sign translation tool to help the unimpaired teachers to understand the communication of deaf learners.
- To determine the effectiveness of the developed prototype of Pakistan Sign Language to English text and speech translation tool, particularly in education settings.

LITERATURE REVIEW

The entire world is working on the development of the sign language, so as Pakistan for its deaf community. This work aims to benefit the unimpaired and deaf people to interact with others.

As of now, there is an urgency to renew the PSL translation device for the improvement of text and speech and to understand the effectiveness of these devices that how much they are beneficial in learning structure and the conversation among deaf students and unimpaired teachers (Pakistan Sign Language, 2015).

Various institutes are trying to present a balanced PSL; however, they are still unable to accomplish their goal. PSL is in establishing-state. Various institutions are in the process of establishing the PSL, but the significant institutions which play an essential role in establishing PSL are as follows:

1. ABSA, Karachi
2. SDA, Rawalpindi
3. PAD, Karachi
4. NISE, Islamabad

As stated by Sulman & Zuberi (2000), SDA published its first PSL dictionary, and it consisted of 750 signs which were used in the Rawalpindi region only.

ABSA also pays a significant role in establishing PSL. Over the years, they successfully regulated and reported the PSL. ABSA publication is given below:

1. The Anatomy and Body Actins in Sign Language
2. A series of stories
3. Numeration in Sign Language
4. Time and Seasons in Sign Language
5. Interacting development of new signs with teachers
6. A Dictionary of Pakistan Sign Language

In 1976, the responsibility was taken by NISE to establish the centers for education, and its focal point was to use the old signs that were area-based for developing a renowned SL that all deaf communities in Pakistan agreed to accept it.

PAD is being run privately in Karachi, Pakistan. The whole deaf communities in Pakistan also recognized the SL developed by PAD. After the discussion over SL, they published four books which are as follows:

1. 500-word dictionary with new words and modified words
2. Workbook of Alphabet signs in Urdu
3. Traffic signs for deaf drivers
4. Workbook of Alphabet signs in English

Family Educational Services Foundation (FESF) is a charitable educational institute which is working in Pakistan. This particular program names ‘Deaf Reach’ for deaf people. FESF was successful in creating and documenting a digital lexicon of 5,000 words in PSL, Urdu and English.

They published a book called ‘Pakistan Sign Language 1000 Basic Sign’. FSEF also conducted a series of
workshops based on the lexicon of PSL for the deaf teachers and families so that they can communicate with one another. The advancement of SL is recognized globally. The researchers around the world are trying to overcome the gap between people with hearing problems and unimpaired people. Technology plays a vital role in overcoming this gap. Countries which have advanced in technology developed devices to translate the text and speech to SL and vice versa. Moreover, some countries are in progress to develop the devices to fulfill the needs for communication between unimpaired and impaired people.

The world has shown significant progress towards reducing the communication gap between impaired and unimpaired. Colas et al., (2006) in Spain that revealed to help the people with hard of hearing to communicate with others by introducing the video calling feature from a 3G mobile device that converts the voice of an unimpaired person into SL and vice versa.

In another research Foong et al., (2008) developed a tool that can change the sign into voice (S2V). Moustakas et al., (2006) also developed a tool for the intercommunication between mute, impaired and deaf people that is called as multimodal tools and interfaces and later was introduced by the researchers over ‘Interface-(2006) in a summer workshop to allow the blind and hard of hearing people for intercommunication between them the same approach was utilized by Noberto et al., (2015) in Portugal to develop a game based program. Moreover, in Tunisia, Othman & Jemni (2011) conducted a research for the translation of English text into ASL, and it used modified Mosses device, and their results were synthesized over a 3D avatar for analysis (Othman & Jemni, 2011). A similar study was conducted for the deaf people in 2012 by National Technical Institute to help with the 3D avatar system that was used for SL translation device and making awareness for the use of this tool. Kumar et al., (2014) developed a useful tool as well, its goal was to enable the deaf people to communicate on their own with others. Its focal point was to produce the speech sound for deaf people.

Technology has also taken slowly and gradually over Pakistan, and the researchers in Pakistan are one of the people in the world who are working to overcome the communication gap among impaired and unimpaired people. Mehdi & Khan (2002), developed a sensory glove for the translation of ASL into text and its goal was to overcome the communication among ordinary and disable people. This vital program is known as ‘Talking Hands’. A similar study conducted by Bukhari et al., (2015) about the making of communication accessible and among the unimpaired and deaf people. The developed sensory glove was able to change the ASL into speech, and this glove had the quality to recognize the movements of the fingers to convert into speech. In another study by Raziq & Latif (2016), it revealed the conversion of PSL into text. They introduced a sign recognition system for PSL by the usage of the leap motion tool. Kausar et al., (2008) also developed a fuzzy classifier to identify the signs of deaf people that used joint colored gloves for the translation and identification of each finger.

A study by Fatima and Huma (2011) revealed about the Urdu alphabets in PSL. This device converted the signs into text and displayed it on the screen of a computer. Haseeb & Ilyas (2012) developed a prototype for the translation of speech into PSL. The research was administered to analyze the recognition of speech and MT techniques used to design and develop a particular and automatic system, and to translate speech into PSL. Khan et al., (2015) made the challenges prominent enough for the development of the system or tool for SL translation in Pakistan. In their study, they further introduced an architectural framework which helped in the translation of Urdu or English speech/text into the animated form of PSL and vice versa. To overcome the communication barrier between deaf and unimpaired teachers (Abbas & sarfraz, 2018) made a prototype which translate text into Pakistan sign language and in their future recommendation that there is a need to develop any sign translation tool which convert Pakistan sign language into text and speech so for that purpose the present study and check its effectiveness that how much it is helpful to overcome the communication barrier between the deaf and unimpaired teachers.

In the recent years, many researches in Pakistan have been conducted for the development of programs that can aid in reducing communication barrier between impaired and unimpaired. However, no such study has been conducted till date that reports the effectiveness of these programs. Therefore, the current research focuses on identifying the effectiveness of the Prototype that Translate Pakistan Sign Language into English Text and Speech.

METHODOLOGY

Research Design

The present study explores unimpaired teachers’ perceptions of the applicability and viability of the sign translator tool in the educational setting using a qualitative approach. In the qualitative approach, the participants of the study get an opportunity to answer in a more comprehensive way and in much higher details than using quantitative research methods (Eisner, 2017)

Population

The population of the study was the teachers of Hamza foundation who are teaching the deaf students using this sign translation tool.
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Sample

Eight unimpaired teachers were selected as sample using purposive sampling technique as (Patton, 2002) mentioned in his article Purposeful sampling is a technique widely used in qualitative research for the identification and selection of information-rich cases for the most effective use of limited resources. The main goal of purposive sampling is to focus on particular characteristics of a population that is of interest and will enable to answer the research questions (Black, 2009). The demographic details of the participants are given below in Appendix C.

Program Specifications

The functioning of the developed prototype is described in appendix A.

Data collection Tools

In order to collect data, a focus group interview was developed to gauge unimpaired teachers’ perceptions of the applicability of the sign translation tool.

Focus group

The interview of eight university teachers who are teaching deaf students at Hamza Foundation was conducted to get their opinions about the effectiveness of sign translation tool in educational settings to teach deaf students and to communicate with them. The interview mainly focused on eight questions (Appendix. B) related to the different aspects of sign translation tool ranging from its quality and effectiveness. The demographic details of the participants are described in Appendix C. Their answers were audiotaped and transcribed in the English language as they used the Urdu language during the interviews. It was made sure that participants of the study would take part voluntarily in the research. Once the transcriptions were completed, the audio data was destroyed from the tape recorder and the computer.

Qualitative Results

Qualitative analysis of focus group interview transcript unveiled five main themes related to the use of sign translation tool, viability, the effectiveness of modules and application in public places.

The themes are given below:
1. Communication barrier
2. Effective use in Public places
3. User-friendly
4. Effectiveness of Sign to speech and text module
5. Problems of sign language users

Communication barrier

The Figure 1 shows the responses of the participants in a nutshell and self-explanatory that the developed tool overcomes the communication barrier between a deaf learner and a teacher.

![Figure 1: Response of the participants.](image)

The last theme of the focus group interview is the effectiveness of the sign translation tool and how much it is helpful to overcome the communication barrier between a teacher and deaf learner. A participant said that “We can use it as a prop.” Similarly, another participant shed light on the importance of this sign translation tool by saying, “Step 1 sign is best, the second one is also easy, but in third step sign there is a barrier also called as a short key, so with the help of this tool we can overcome this barrier as well”.

All the participant found this sign translation very useful as one of the participants said that “It is effective for deaf students because they can replay it many times to understand it is effective for parents to convey that what they want to say to their deaf children and overcome the communication barrier.” The participant found that the sign-translation tool is effective and viable in the classroom as it communicates directly, easy and reduces the need for interpreters. It makes the communication process easy and smooth. Another participant said that if the tool works well then “Rather than in the classroom setting, it is more useful in a social setting like shopping malls, markets.” So, one can conclude that the application of this sign translation tool can give independence to the people of society to communicate with deaf people and overcome the communication barrier.
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Figure 2: Effectiveness of the sign translation tool.

Effective use in Public places

Figure 2 is showing the responses of the participants about the effectiveness of the sign translation tool.

Participants were asked how this sign translational tool can be useful in public places to communicate with deaf people. Participants showed a very positive response to the effectiveness of applying this tool in public areas. A participant said that “Through this tool communication gap will start diminishing.” Similarly, another participant shed light on the importance of the application of this tool on public places because it can help to save the confidential information of an individual.

Another participant said that “If there is a child who loses her eyesight, as I have an example that one of my student who is not speaking already but at one moment losing his eyesight as well, I was too much worried about him that what he will do in his future, but now after seeing this tool I am so happy that it would be surely so helpful for such type of students who are visually blind.”

All the participants found the application of sign-translational tool very useful and effective in public places. The participants suggested that with the help of government it should be installed in the public places to give the liberty to the deaf people in communicating with unimpaired people of society as it will help them to independently communicate with people in society without any third person help. A participant said that “Of course the availability of sign language interpreter is not available everywhere and every time so yes this will be effective in public places to communicate with the deaf students.”

So one can conclude that the application of the sign translation tool can give independence to the people of society to communicate with deaf people and reduce the dependability on the sign language interpreters.

User friendly

Figure 3 is showing the responses of the participants is that this tool is user-friendly for direct communication among the teachers and deaf students.

A participant elaborated that this tool is effective but not user-friendly so one of the participants said that “To make it user-friendly that anybody who does not know about the technology can use this easily.”

The participants said that the translation tool is useful and viable in the classroom because it can communicate process easy and smooth. Similarly, another participant noted that if the tool works well, then “the connection between teacher and deaf students will be much better and effective learning will take place.”

Another participant highlighted the point that “It is very beneficial but try to improve it further while going to simple sentences.” Another participant shed the light on the importance of the application of this tool by saying “Because it is a very unique idea and we are so happy to see that someone is doing work for unimpaired as well, you have to proceed it further as well by making it user friendly via through any app or any handheld device”. The participant suggested that with the help of the government, it should be installed on the public places as well to give the liberty to the deaf people in communicating with unimpaired people of society.
The results that the most frequent word used in the focus group interview is “communication” as the PSL translation tool bridges the communication gap between the deaf and unimpaired people, so the results showed the same. Second, the most frequent word is “deaf” which shows that the PSL translation tool is for deaf and they have the central position in the current study. Third most common word is “direct” because the PSL translation tool enables the direct communication between impaired and unimpaired people. Fourth most frequent word is “effective,” and the fifth is “help.” It shows that the translation tool enables effective communication and help the teacher to communicate with their deaf students.

The sixth most frequent word is “Interpreters”, and the seventh is “language” which denotes that the sign language interpreters also play an essential role in conveying the lecture to the deaf students by using sign language.

Eighth and ninth most frequent words are “students” and “teachers,” respectively, which symbolizes that the translation tool act as a communication bridge between deaf students and unimpaired teacher.

Tenth most frequent word is “time” which means that the PSL translation tool saves the time of teacher by elimination the role of third-person for communication purposes. Moreover, speech to PSL translation option also saves the time of teacher instead of text to PSL translation option because it reduces the typing effort of a teacher which is a time-consuming task. The detailed table of the ten most frequent words is mentioned in the appendix.

Effectiveness of Sign to speech and text module

In the sign translation tool, there is an option to translate the speech and text module to translate the Pakistan sign language directly into speech. Teachers can opt the speech or text option according to their wish and ease. The eight participants spoke in favour of the speech module option and found it more comfortable than the other option, which is the sign to text translation. A participant spoke in favour of speech module that “It is easy to use because it takes less time while I am giving a lecture to the whole class, it picks my sign and translates it into speech.”

Participants found the sign to speech option time-saving and easy as another participant said that “It is time-saving and easy to use.”

Figure 4 generated with the help of NVIVO to shows that the speech module is time-saving, easy to use and overcome the communication barrier.
Problems of sign language users

Focus group participants were asked about the problems of sign language users while communicating in the classrooms. They were asked about their needs for direct communication with their students. Two participants talked about their problems while using sign language in classrooms. The teachers pointed out some issues which they face in the classroom due to the lack of sign language understanding. One teacher said “Some people come with training, and those who do not have proper training of sign language they have to learn some specific signs while communicating with deaf learners, otherwise they face many difficulties while conveying their message.”

Similarly, another participant pointed out the problem that being an unimpaired teacher, their lack of understandings of some signs while communicating with deaf learners severely affects the learning process of a classroom. As most of the teachers are unaware of Pakistan sign language, they use interpreters in the classrooms, but sometimes in the absence of an interpreter, one of the participants try to communicate with deaf students while communicating, a participant said “The problem which I had faced as a sign language user was when had no idea about few signs and I had to communicate with the deaf students and convey my idea, so we used to communicate in the written form which was time-consuming and not applicable every time due to the heavy strength of students and time shortage.”

Another participant supported the statement as mentioned earlier by saying that, “lack of understanding of sign language can cause many problems and become very time-consuming.” It strengthens the viewpoint of the previously mentioned participant.

Figure 5 generated with the help of NVIVO shows the existence of the “problems while communicating” in the transcripts of the participant’s interview.

![Figure 4: Problems in communication.](image)

DISCUSSION

The study aimed to explore the effectiveness of the Pakistan sign translation tool, particularly in the educational setting. This chapter provides a discussion of significant findings concerning the research objectives and earlier studies. The chapter concludes with the discussion of implications, limitations and suggestions for the future studies.

The result showed that teachers found the sign translation tool viable in the educational setting and they also supported the idea to implement it to the public places to overcome the communication gap and get maximum benefits.

Significant communication gap exists due to the lack of knowledge about sign language. The process of communication seizes when there is an unawareness of PSL (Hassan et al., 2015). The technological tool that enables the communication between deaf and unimpaired people (Haseeb & Ilyas, 2012) reduces the need to learn the sign language for communication purposes as it reduces the need for them. The findings of the present study are in line with the previous studies and showed that most of the teachers believe that in the presence of a sign language-translation tool, sign language learning is not essential. Same is the case with the need for interpreters in the classroom while translation tools are available in any context. In any society, the communication is limited
among the deaf and unimpaired people due to unawareness of sign language. This factor is making the deaf people limited, and they become compartmentalized. The implementation of sign translation tools on public places can allow deaf people to participate like unimpaired people in society equally.

There is an association between the preferable options, i.e., sign to text and speech, for PSL translation tool. The results of previous statements showed that the teachers are much concerned about time utilization in the classrooms. Both the options of sign translation tool are helpful because it saves the time of the teachers. They do not need to type their text in the user interface (UI) of the tool, which can save much time. They only need to sign and sign translation tool can translate their signs automatically into speech and text. The results are in-line with the findings of Haseeb & Ilyas (2012) who found the speech to PSL translation option applicable and useful. The constraint of time can be eradicated using the speech option.

The findings are also related to communication gap. A considerable communication gap exists between the deaf and unimpaired people of society, mainly Pakistani society due to the lack of awareness of SL. The results of statement 13 and 14 showed a significant association between the statements and the findings. The results revealed that communication gap could be filled using PSL sign translation tool as it is a useful technique to bridge the communication gap. Nowadays the technology is very advanced; it has eliminated the boundaries which can cause the communication gap among the people. The statement 13 is also associated with the statement 15 which showed that the as an effective technique of bridging the communication gap also reduces the need for sign language interpreters because it gives independence to the teachers to communicate. It reduces the need for a third person to convey their ideas to the students. It shows the tool is an effective technique to bridge the communication gap; that is why the results showed the association with the statement that it also reduces the need for the interpreters in the classrooms.

According to the responses in focus group interview teachers pointed out several problems related to the unawareness of sign language and in result using the SL, interpreters in the classroom. The teachers depend upon the interpreters for teaching and communication purposes, and their unavailability creates many problems. The results of the qualitative analysis also showed the need for direct communication between the teacher and deaf students which also correspond with the findings of quantitative results.

Teacher, in focus group interviews, showed that the PSL translation tool is a useful technique for communication among the deaf and unimpaired people. Moreover, it develops effective communication without involving any third person.

CONCLUSION

The main objective of the study was to determine the effectiveness of the developed prototype to translate Pakistan sign language into text and speech in order to help the unimpaired teachers to understand the communication of deaf learners and use this sign translation tool as a useful technique to bridge the communication gap, particularly in educational settings. The development of sign translation tool revolves around a basic idea which is to bridge the communication gap between deaf and unimpaired people, specifically in educational settings. The sign translation tool is developed to meet the needs of a teacher who are teaching deaf students.

By using the sign-translation tool, the communication gap is reduced between teachers and deaf students. It reduced the needs of learning sign language. It also enhanced direct and effective communication among teachers and deaf students. Moreover, according to the teachers, this sign translation tool is beneficial for them.

The responses of the focus group interview indicate that the most teachers are unaware of the sign language and they face difficulty while communicating with deaf students, so this tool overcome the communication barrier between the deaf and unimpaired people. Moreover, the sign translation tool is easy to use and effective in educational settings. Findings also unveiled that the sign to text and speech translation both the options are preferable because it can save much time and teachers do not need to put extra effort to type their lectures on user's interface of the sign translation tool.

LIMITATION

The findings of the present study reveal that the use of the sign translation tool in educational settings is an effective method. The teachers found the use of the sign translation tool easy, which releases them from the dependability of sign language interpreters and overcome the communication barrier between the deaf and unimpaired teacher. Although these are promising findings related to the sign translation tool, there are still several limitations that need to be considered — certain limitations of the study such as programming expertise, a limited number of the dataset. Initially, to develop a sign translation tool, the researcher lack in the expertise which a computer or software engineer has for developing software.

RECOMMENDATIONS

Regarding the application of the sign translation tool in the classroom and public places, teachers highly recommend it. According to the findings of focus group interviews, teachers believe that it will improve the teaching
mechanism while eradicating the need for sign language learning to convey their lecture to the students. Moreover, they recommend it to apply in public places like banks and shopping malls because it will give equal rights of communication to the deaf people do not want to share with other people.

REFERENCES


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Appendix A

Figure 6 is architectural design that how system accepts the input in the form of a picture from camera and translates sign into text as well as voice.

![Architectural framework of translation tool.](image)

**Figure 5:** Architectural framework of translation tool.

Multi-layers convolution neural network (CNN) and artificial intelligence. Usually, each layer has its feature extraction (Figure 7).

![Multi-layers’ convolution neural network (CNN).](image)

**Figure 6:** Multi-layers’ convolution neural network (CNN).

The dataset was made by making a video and then extracting its frame via Mat lab’s image processing toolbox (Figure 8).
The feature from each picture was extracted, and then important features were saved as bottlenecks to save computational expense. Capturing of the picture of the sign and then that would be fed to the deep learning classifier model, and the best-suited result would be generated as shown in Figure 9.

Figure 8: Output in Sign.

Output was as be like Figure 10.
Appendix B

Interview questions

1. What problems do you face with sign language user while communicating in the classroom?
2. Why there is a need for direct communication between the unimpaired teacher and a deaf learner?
3. To which extent this sign translation tool overcome the communication barrier between a teacher, student and parents?
4. Why is the sign to text and speech translation tool preferable and easy to use?
5. What are the positive points you noted in sign to text translation tool?
6. What are the positive points you noted in sign to speech translation tool?
7. How can this translation tool be effective in public places to communicate with deaf learners?
8. What are your suggestions for the improvement of this tool?

Appendix C

Table 1: Details of the participants according to work experience

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Table 2: Details of the participants according to the last degree of qualification.

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Figure 11: Demographic details of the participants according to work experience.

Figure 12: Demographic details of the participants according to last degree of qualification.