THE POTENTIAL OF THE TESLA AUTHENTICATION SYSTEM TO SUPPORT ACCESS TO E-ASSESSMENT FOR STUDENTS WITH SPECIAL EDUCATIONAL NEEDS AND DISABILITIES (SOFIA UNIVERSITY EXPERIENCE)

Roumiana Peytcheva-Forsyth, Blagovesna Yovkova, Tarja Ladonlahti

Abstract: Digital technologies create opportunities for people with special educational needs and disabilities to be included in quality e-learning experiences and receive support adapted to their individual educational needs. However, the requirements of assessment often mean that SEND students are required to attend exam centres at times and places which are inconvenient for them. The current paper presents a study of opinions and attitudes of students with different types of disabilities of Sofia University about the potential of an innovative authentication system (the TeSLA system). Based on empirical evidence, the paper draws out the implications of the TeSLA system for supporting better access to e-assessment for SEND students.

Key words: authentication system for e-assessment (TeSLA), students with special educational needs and disabilities, accessibility and usability.

1. Introduction

Over the last two decades worldwide there has been a trend towards increased integration of e-learning in higher education, which opens access to education without time and space limitations, and provides control and more flexibility to the training process, which can be adapted to the needs and interests of each learner. Technologies create real prerequisites for helping learners with special needs and different types of disabilities (SEND students) and have the potential to increase access to education, to create supportive and inclusive learning environments adaptable to their individual needs in accordance with the requirements of the EC Convention on the Rights of Persons with Disabilities and the European Union Guidelines set out in the European ‘Strategy for People with disabilities for the period 2010–2020’ (European Commission 2010) for their equal participation in education and in public life. A number of researchers have highlighted accessibility, adaptability, opportunities for personalization, greater autonomy and independence in learning as main advantages of e-learning which contribute to the successful training of SEND students (Betts et al. 2013, Coombs 2010, Seale 2006). As e-learning becomes more integral to the learning process it is natural to increase the use of technology in the assessment process as well. Brown et al. (Brown & Smith 1996) comments that “due to paradigm shift in educational technology, it may become unfair to train students online and then use pens for assessments.” Online assessment though provokes many doubts about student authentication and authorship. “Online examinations are reported to be more vulnerable to academic dishonesty and authentication attacks due to lack of physical interaction” (Harmon et al. 2010). Research in this regard comes to different and even contradictory conclusions, but they lead to the emergence of doubts about the authenticity of the results of online exams. Due to the lack of trust in e-examination most of the institutions that offer online or blended courses are still reluctant to integrate online assessment and examinations. They offer e-learning but the exams are done in a classroom setting. This creates some barriers to SEND students.
This paper presents some of the results of a study conducted within an EU Horizon2020 project – An Adaptive Trust-based e-assessment System for Learning (TeSLA) – which aims to provide reliable verification of students’ identity and authorship in online and blended learning environments. A special focus in this project is the study of the views and attitudes of SEND students on the possibilities and prospects of the TeSLA authentication system, focusing on some possible technological and pedagogical solutions to overcome the difficulties and improve access to e-assessment of these groups of students. By analysing the SEND learners’ perceptions of the use of the TeSLA system’s instruments: face recognition, voice recognition, keystroke dynamics, forensic analysis and plagiarism detection we identified to what extent TeSLA might be used by SEND students to support the authentication and authorship checking of on-line assessment, and thus enhance accessibility and study opportunities. The paper also offers a set of recommendations for improvement of the system arising from the feedback gathered from students with different types of disability.

1.1. Defining the concept of accessibility and usability in the context of send students education

"Accessibility is defined as meaning that people with disabilities have access, on an equal basis with others, to the physical environment, transportation, information and communications technologies and systems (ICT) and other facilities and services" (European Commission 2010).

In the TeSLA context accessibility is seen in relation to e-learning (e.g. virtual learning environments, digital repositories, multimedia, web portals and discussion boards). It is understood as ensuring that learners are not prevented from accessing technologies or content and experiences offered by technologies on the grounds of their disability (Seale & Cooper 2010). It means removing barriers to participation and engagement in online experiences and the degree to which someone can access an online resource regardless of their disability, technology or environment. Accessibility can be seen from three points of views: as accessibility by everyone, any technology and in any environment or location (Seale 2006).

While designing a product or system with disability in mind it will serve better the needs of all users, including those who are not disabled. On the other hand, it is commonly asked if it is not possible to create a product which is usable by everyone or under all circumstances. Parallel concepts for design for all are e.g. universal design, barrier free design and inclusive design (Seale 2006). Ball (Ball 2009) also suggests that using accessibility specifically related to adjustments created for disabled users may meet the requirements of disability legislation but can be even a hindrance to other users.

Usability is about making products easy to use and seeing things from the user's perspective: user experience and satisfaction (Seale 2006). ISO 9241 standard for Ergonomics of Human System Interaction defines usability as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO 9241 2017). Usability is not focused on disability or impairment, but rather on good design that can be utilized by all who approach it. Therefore, usability is much more all-embracing, more in tune with the social
model of disability and in terms of e-assessment, a more desirable goal (ISO 9241 2017). Accessibility, like other parallel concepts as well, is specifically related to design or adjustments created for disabled users (ISO 9241 2017).

1.2. TeSLA project – new opportunities and challenges for e-assessment

The TeSLA system provides to higher education institutions adequate and adaptive technological solutions to authenticate distance learning students. The goal is to prevent false identity and/or plagiarism, which will increase confidence in online assessment and distance education as a whole, and provide a powerful impetus for the further development and recognition of distance learning in European universities. TeSLA aims to improve the e-assessment process by introducing biometric instruments (face recognition, voice recognition, and keystroke dynamics) for authenticating student identity and authorship checking instruments – forensic analysis and anti-plagiarism software. Table 1 briefly summarizes the TeSLA instruments with their description.

Table 1. TeSLA instruments.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Instrument/ type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Face recognition</td>
<td>Biometric</td>
<td>This instrument analyses complex information, such as facial expressions, to carry out recognition, which is difficult to trick and makes identity theft harder. Such methods require working with continuous sequences of good-quality images. The facial recognition process consists of two stages: face detection and recognition. It takes 10 seconds for the system to build a learner's face model. This instrument is suitable for all types of online assessment.</td>
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<tr>
<td>Voice recognition</td>
<td>Biometric</td>
<td>This instrument uses state-of-the-art audio description methods. The instrument analyzes the learner's voice and compares it to the pre-built pattern (enrolment activity). In order to build a trustworthy model, a minimum of three entries per learner's voice is required in a period of at least 48 hours between the individual entries.</td>
</tr>
<tr>
<td>Keystroke dynamics</td>
<td>Biometric</td>
<td>This instrument measures how a user writes using the keyboard. To recognize a person two key features can be extracted from a standard keyboard connected to a Personal Computer: the amount of time each key is held down (dwell time), and the elapsed time between the release of the first key and the depression of the second (flight time). The instrument analyzes the rhythm of the student's writing in real time and compares it to the pre-built pattern (enrolment activity). The minimum text volume requirement is 500 words.</td>
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| Forensic analysis      | Authorship      | This instrument comprises mechanisms and devices for determining the authorship verification and authorship attribution of written documents. It aims to analyze the learner's individual style of writing and to compare it to the pre-set pattern (enrolment activity). Every document uploaded by the learner is automatically scanned and the results are provided to the lecturer.
who can make a decision when assessing the student's work. The minimum text volume requirement is 1000 words. This assessment mechanism is capable of confirming/refuting the authorship of reports, essays, homework and exercises or even detect sections of the document not written by the author.

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<tr>
<th>Automated plagiarism detection</th>
<th>Authorship</th>
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<tr>
<td>This instrument detects similarities between documents. The comparison is performed based on text matching without taking into account the semantic meaning of the text.</td>
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The aim of the developed system is to ensure the identification and authorship of the students, in compliance with all the ethical, legal and cultural aspects of the assessment process.

In view of guaranteeing plausible and tangible solutions the TeSLA is designed by a consortium of institutions working in the domain of higher education and, specifically, in distant learning in cooperation with both technological companies specializing in security, encrypting and online identification, and agencies accrediting quality on a national and European level.

The TeSLA project has a strong commitment to consider the accessibility issue, and so SEND students are included as potential users of the TeSLA system. The commitment follows the EU action to promote inclusive education and lifelong learning for students with disabilities (European Commission 2010). The TeSLA will help to reduce the current limitations of time and physical space in teaching, learning and assessment, which it is hoped will open up new opportunities for learners with motor and sensory disabilities, psychological problems, psychosocial problems and other disabilities.

2. Methodology

2.1. Context of Research

To ensure the functionality and reliability of the TeSLA system, large-scale pilot studies are planned to involve over 20,000 students across Europe, including SEND students. They are carried out in three stages: Small Educational Pilots, Medium Test-bed Pilots and Large Scale Pilots. To the present moment over 5,600 students from the seven pilot institutions (Anadolu University, University of Jyväskylä, Open University of the Netherlands, Open University in the UK, Sofia University, Technical University of Sofia and Open University of Catalunya) took part in the first and the second pilots by testing the TeSLA instruments in both enrollment and real assessment activities during 2016/2017 academic year in a variety of educational contexts.

The total number of SEND students who agreed to take part in the second pilot was 287. Of these, 204 signed the informed consent for participation in the project and took part in at least one enrolment and one real assessment activity. The SEND student-participants in the pilot from all seven universities cover a wide range of special educational needs and disabilities: with a majority of students with psycho-social problems (105), followed by
students with restricted mobility or motor disability (71) and chronic illness (61). Less well represented groups were blind or partially sighted students (17) and deaf or hearing loss students (14). Some of the students reported more than one disability.

All these SEND students participated in the pilot on an equal basis with other students. But there was a large drop out from this group, resulting in a much smaller number completing the minimum requirements for participation in the project. The reasons for this high dropout included: lack of time; being busy with the exams; having health problems; technical problems. Despite these difficulties participating institutions managed to involve SEND students in the pilots and were able to some extent to study their experiences with TeSLA.

2.2. Research methods

The study of students' opinions, attitudes and expectations towards the online system for authentication and authorship checking within the project was carried out with the help of a survey and focus groups. SEND students were able to choose if they wished to identify themselves as students with disabilities or not when completing the questionnaire.

The TeSLA participants including SEND students were also invited on a voluntary basis to take part in focus group interviews. In some of the universities participating in the pilot, no SEND students responded to this invitation.

Since the survey data alone was not sufficient to identify the specific problems that SEND students encounter in using TeSLA in terms of accessibility and usability, we carried out some additional research in Sofia University, Bulgaria, through individual interviews with SEND students. The present paper presents only the results of the 1st and 2nd pilots with a focus on the experiences and opinions of SEND students at Sofia University, which is a large campus-based university with face-to-face teaching making its first steps in distance education.

In this case study research, we interviewed 12 SEND students - five female and seven male students who attend a range of programmes in the field of educational studies. The courses in these programmes could be defined as ‘blended’ using MOODLE for performance of some of the learning activities as well as e-assessment whilst a sufficient part of teaching and learning takes place in face-to-face format. The participants in the research are divided into the following four groups according to their disability: a) Blind or partially sighted - 4 students; b) Deaf or hearing loss - 1 student; c) Restricted mobility or motor disability - 5 students; d) Specific learning difficulty (e.g. dyslexia) – 2 students.

The identification of SEND students in the Sofia University was determined from the pre-pilot questionnaire and from personal contacts of the teachers with such students in their modules who volunteered to take part in the project. In the case study research only students who had completed enrolment activity with each specific TeSLA instrument and at least one real assessment activity took part. The following authentication instruments were tested: face recognition, voice recognition, keystroke dynamics and authorship checking instrument – forensic analysis.
For the aims of the pilots students had to complete a few steps. As it is shown on fig.1, at the beginning they started with signed of the informed consent, followed by a pre-questionnaire. On the next step students completed enrolment activities – one or more specific activity per instrument. This is a key stage in testing the system as it builds a sample of the voice, face, the way the user writes, on the basis of which the authentication is realized. Then the TeSLA system was integrated in real and relevant learning and teaching contexts in a variety of real assessment activities. On the next step SEND students completed the post-questionnaire and took part in individual interviews.

**Figure 1. Steps of the pilot.**

The individual interviews with SEND students followed the individual sessions for pilot testing of all the instruments of the system in the presence of a lecturer. The aim of the individual interviews was to examine in depth the students' experiences and expectations towards the specific instruments of the TeSLA system: face recognition, voice recognition, keystroke dynamics, forensic analysis. Most of the questions aimed at establishing the participants’ opinions on the accessibility and suitability of the system to the specific needs of each learner, stemming from the type and specificity of his/her disability. Another part of the questions were related to suggestions for improvement of each TeSLA instrument.

Within the context of the interview, the answers to two types of questions were sought: a) issues common to the Tesla system in general and b) specific - in relation to the individual instruments.

The general questions are as follows:

• Which are the main strengths and weaknesses of the TeSLA authentication system in relation to e-assessment from the perspective of SEND students?

• How might TeSLA be adapted in the best possible way to support their specific needs?

• What are the students’ recommendations for increasing the accessibility of the system in relation to their specific needs?

The specific questions are as follows:

• Is the interface of this particular instrument available for students with your disability?
3. Results

The opinions, expectations and assessments of the students participating in the individual interviews are analyzed in relation to the technological, pedagogical and psychosocial aspects of the use of TeSLA and its instruments in the context of the e-assessment.

In general, the SEND students highly appreciate the opportunities to take the exams from home without having to physically attend an examination auditorium. The greatest benefit in this respect would be for students with severe physical disabilities who rely exclusively on wheelchairs to move. Two of them shared that they have tremendous mobility difficulties and are often struggling to reach the university building. This is what one of them said: ‘TeSLA can save a lot of the obstacles associated with the physical movement of students. Such an e-assessment system is a necessity for people with disabilities and for all who, for good reasons, cannot attend classes. It could overcome the need for physical presence during testing’.

3.1. Technological, pedagogical and psychosocial aspects of TeSLA accessibility and usability from the point of view of SEND

3.1.1 Technological aspects

As it was clarified in part 1.2. of the paper the main attributes of the accessibility are: a) ensuring that learners are not prevented from accessing technologies or content and experiences offered by technologies on the grounds of their disability (Ball 2009) and b) removing barriers to participation and engagement in online experiences and the degree to which someone can access an online resource regardless of their disability, technology or environment. While usability was defined as the "extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (Karim & Shukur 2015).

In our analysis we tried to identify the students’ opinions on their positive (access/usability) and negative (barriers/obstacles) experiences when using TeSLA and its instruments for authentication in the context of e-assessment.

The data analysis allows the systematisation of student responses in four groups responding to four aspects of technological accessibility and usability in terms of: user interface; flexibility and adaptability of instruments; feedback; and reliability of the system as a whole.
a) **User interface.** In the table below are summarized positive versus negative opinions and experiences of the SEND students with TeSLA.

**Table 2. SEND students’ opinions on the TeSLA user interface.**

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
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<tbody>
<tr>
<td>● User friendly</td>
<td>● Complicated interface for blind users</td>
</tr>
<tr>
<td>● Easy to work with</td>
<td>● Cumbersome, difficult and confusing navigation</td>
</tr>
<tr>
<td>● Comfortable to use</td>
<td>● The system does not work with different browsers</td>
</tr>
<tr>
<td>● Easy navigation</td>
<td>● Small size icons</td>
</tr>
<tr>
<td>● Ease of work with the instruments</td>
<td>● Difficulty in using the system for blind and partially sighted users at home</td>
</tr>
<tr>
<td>● Retains attention</td>
<td></td>
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</tbody>
</table>

The user interface of the system is essential for the convenience of work and motivation in online assessment. As it can be seen from the table above the views of students from different disability groups differ significantly. The data analysis shows that for one group the interface is "easy to navigate" (8 of the participants), for another group (4 students with visual disturbances) - it has "cumbersome, difficult and confusing navigation". When locating data to the affected group, it is clear that different navigation elements require different adaptation of users depending on the specificity of the disability. The most critical are the notes of blind students. Obviously, TeSLA does not meet their individual needs under this benchmark. In their view, the interface is very complex for the blind: "the system is complicated in terms of navigation, it is clumsy." Already on the first step of signing the informed consent document, blind students face a problem - the screen reader does not find where in the course the informed consent is located and the students cannot sign it without the help of a lecturer or another student, which hampers further evaluation work. The same problem also occurs when searching for the section that includes enrolment activities. Another major issue is that the system is not available through a variety of browsers and technologies, which was also identified by students participating in the study of other types of disability. For some SEND students who use specific software to help them learn online, for example, electronic readers that work with a particular browser, it is very important that the authentication system works with all browsers.

b) **Flexibility and adaptability of the instruments.** Again blind students are the most critical of this of accessibility aspect. When registering for the face and voice recognition instruments, the difficulty comes from the lack of an alternative textual description of the start and end buttons of the registration as well as the lack of indication in the sound format when submitting their work for assessment. In addition, they indicate the lack of a sound equivalent of the timer, which counts the timing of the registration activity as a barrier. In this case, a student cannot upload their work or start the voice recording without help, which is a serious obstacle to using TeSLA for online assessment purposes. As another limitation, blind students point out the lack of audio presentation of the registration instructions for each of the instruments.

**Table 3. SEND students’ feedback on the flexibility and adaptability of instruments.**
Some of the students' views on the adaptability of the system are of a general nature and do not refer to the specific features of particular disability groups. For example, all students reported the long registration process for the Voice Recognition Instrument to be a serious negative (three times in different days). Their opinion coincides with the opinion of the other non-disabled students who participated in the focus group. This, to a large extent, creates difficulty for deaf students and students with communication-speech problems. With the keystroke dynamics instrument, all SEND students consider an obstacle to be the large volume of 500 words required for registration, and difficulty in correcting keyboard text input errors. Probably for this reason, this is the least preferred instrument for the students surveyed (only 5 out of 12 have expressed preference for working with it). This instrument is the most inappropriate for students with damaged fine motorics of the upper limbs. The critical remarks by students regarding the flexibility and adaptability of the individual instruments of the system, however, have a positive effect on the further improvement of the product in order to increase its usability by people with special needs.

c) Feedback. To ensure technological accessibility of the system, a very important factor is the way in which the interaction between the user and the software takes place. Table 4 presents the opinions and evaluation of students on this indicator, which also differs to a certain extent depending on the type of disability. Everyone, except for blind students, assesses positively the system's adequate response to registration - the timer for the voice and face recognition instruments is a good reference for the time spent by the learners on performance; the keystroke counter on keypad writing dynamics makes it easier to perform the activity. The main problem with blind learners is that feedback is not designed in an appropriate format that meets their needs. The proposed version of the current stage with "Start" and "Stop" blinking buttons does not give any information and makes registration difficult. A similar problem also emerges in the Keyboard dynamic instrument, which does not have an adequate response from the system, a clear indication of the start, end, and current status of the activity. The lack of indication in sound format when transmitting a paper for evaluation is also a serious technological obstacle.

Table 4. SEND students’ opinions of the TeSLA feedback system.
d) Reliability. Interesting are the opinions and assessments of students regarding the reliability of the system for prevention and reduction of plagiarism and attempts to cheat during the exams. They are presented in Table 5. Most of them (9 students) believe that the system is sufficiently reliable to guarantee the identity of the student during the exams and will reduce copy-paste practices. This in turn will positively influence the assessment by encouraging students not to copy from their peers. According to other opinions, TESLA's could not completely prevent attempts to cheat. These are some of the ideas that the students produced about the possibilities of fraud: ‘the student can use a talking device to cheat’, ‘a student may not be alone or someone else could help them in the test because the camera records a very small range, there is no full capture of the room in which the exam is held’. They also have some concerns about whether the voice recognition registration has been successfully completed and that the examined artefacts have been received by the lecturer after the submission. SEND students like other students in the focus group recommend that instruments are used in combination in order to ‘reduce cheating and ‘increase the reliability of the system as a whole’.

Table 5. SEND students’ opinions on the TeSLA feedback system

<table>
<thead>
<tr>
<th>Positive</th>
<th>Negative</th>
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<tbody>
<tr>
<td>Guarantees the identity of the student under examination</td>
<td>Uncertainty whether voice recognition registration has been successfully completed.</td>
</tr>
<tr>
<td>Reduces copying attempts</td>
<td>There is no clarity as to whether the examination papers have been received by the lecturer.</td>
</tr>
<tr>
<td>Personal data is well protected</td>
<td>There may always be a breakthrough in the system.</td>
</tr>
<tr>
<td>Stimulates students not to copy from their peers</td>
<td></td>
</tr>
<tr>
<td>Fair evaluation</td>
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</table>

The accessibility in the context of e-assessment also has its pedagogical and socio-psychological aspects. Below are discussed some of the most important advantages and limitations of the TESLA system from the perspective of the SEND students in this regard.

3.1.2 Pedagogical aspects
TeSLA provides opportunities for students with different types of disabilities to be included on an equal basis with other students in online assessment. According to one of the interviewed students, ‘the system allows equal access to SEND students’. Overall, the surveyed students positively assess the pedagogical potentials of the TeSLA system. The majority of them (10) expect that it will increase the objectivity of student’s assessment. But, along with the positive evaluation, quite a few limitations in this direction have been indicated by the students. More than half of them (8) indicated the higher workload compared to traditional exams. Here, it is worth noting that the system constraints outlined above regarding its technological accessibility can negatively affect the learning outcomes. For example, using an inappropriate format when formulating the instructions for a task execution can negatively affect the performance of the task, or/and the assessment of its results. Students with dyslexia and deafness are afraid they will not understand the instructions correctly. The deaf student feared that if the online exam requires an oral presentation of the student (a voice recognition instrument is used) and the teacher evaluates the audio file, she may not fully understand her speech due to the speech deficiency typical of deaf people, and this may lower her grading. For the student with arm paralysis, the use of the keystroke dynamics and forensic analysis instrument is difficult and tiring due to the large volume of writing and time-consuming performance. She says: ‘It is likely that I will not be able to succeed if the tasks require too much keyboard writing such as course projects, research papers and reports.’ This increases her sense of anxiety, and would draw her back from the course.

The above examples lead to the recommendation that the tutor should make an informed choice of the most appropriate a) technologies to be used for students’ assessment and b) technologies/instruments used to authenticate the student carrying out the assessment in order the needs and preferences of different groups of SEND students to be addressed.

3.1.3 Socio-psychological aspects

The extent of the usability of a technology largely depends on a number of social factors and the psychological comfort of the user during its utilisation. This is why it was important for us to study how the students felt during work in the online environment with integrated TeSLA instruments and what psychological barriers and difficulties they have encountered. It appears that some of the instruments are suitable for some of the students, whilst for others they create certain inconveniences and discomfort. For example, the deaf student says she would feel most confident if the face recognition instrument is combined with an opportunity to present the assessment tasks through sign language. But with frustration, she says, there is no practice in the university to provide a gesture translator for students with hearing deficiencies and this issue is not resolved at institutional level. A student with limited handwriting capacity is disqualified when using a keyboard due to high tension and does not prefer to use the instruments for keystroke dynamics and forensic analysis. The student with dyslexia and stuttering feels discomfort in using the voice recognition instrument due to the specificity of the disability "thought is faster than speech" and this increases his stuttering, which can negatively affect the assessment if the assessment is recorded sound. He prefers written tasks, which are easier for him. He recommends that the
voice recognition instrument should not be used by students who stutter because it would distract them and lower their rating. A high degree of motivation when working with the system is an important factor for the successful passing of the exam. Therefore, it is necessary to apply an individual approach when choosing an instrument for student identification with SEND.

4. Conclusions

Previous research has shown that among the knowledge-based, possessions-based and biometric-based user authentication methods the biometric-based one is considered the most accurate and popular method in online exams (Karim & Shukur 2015). Our study came to a similar conclusion. According to the SEND students involved in our research TeSLA system creates new opportunities for e-assessment. They express a very positive attitude, defining it as innovative, reliable, convenient and easy for examination purposes.

The students’ opinions and assessments on the access and usability of the TeSLA system as well as its instruments vary according to the type and degree of their disability. The analysis of the data suggests that, due to the heterogeneity of SEND students and the specificity of different disability groups, it is virtually impossible for such a system to satisfy equally the needs of such a diverse group of learners in terms of accessibility and usability. That is why the deep knowledge and systematisation of the specific needs of the students with SEND are very important in constructing such types of systems for learner authentication and authorship. Tutors should also design the evaluation activities with alternative options for the use of TeSLA instruments. This could be a combination of instruments allowing a student to choose which of them is most accessible and least disturbing for her in terms of her disability. In general, the recommendation is that the further development of TeSLA and similar systems seeks to address identified restrictions in terms of accessibility and usability.

It turned out that the students with visual impairments are most affected by most of the limitations of the TeSLA. This means that the optimisation of the user interface, flexibility and adaptability of the individual instruments and interactivity/feedback of the system should be done taking into account by priority the specific needs of this particular group of students. The interface should be easy to navigate and accessible for assistive technologies such as screen readers, and the system should be accessible through different browsers. In order to increase the usability of the system, the registration procedure needs to be as simple and clear as possible and the real assessments activities should be tailored to the student's individual abilities. It is essential to take into account the guidelines and specifications for the design of accessible software ISO 9241 standard for Ergonomics of Human System Interaction (see part 1.1).

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