Hacettepe University Journal of Education

Hacettepe Üniversitesi Eğitim Fakültesi Dergisi

e-ISSN: 2536-4758

E-Değerlendirmede Kimlik Doğrulama ve Yazarlık Kontrol Sistemi Kullanımına Yönelik Öğrenci Deneyimleri*

Ana Elena GUERRERO-ROLDÁN, M. Elena RODRÍGUEZ-GONZÁLEZ*** , Abdulkadir KARADENİZ****, Serpil KOCDAR*****, Lyubka ALEKSIEVA******, Roumiana PEYTCHEVA-FORSYTH*******

Makale Bilgisi

Geliş Tarihi: 20.12.2019

Kabul Tarihi: 01.09.2020

Erken Görünüm Tarihi: 29.09.2020

Basım Tarihi: 30.09.2020

ÖZET

Bu çalışmanın amacı, e-değerlendirme sürecinde kimlik doğrulama ve yazarlık kontrol sistemi kullanımında öğrencilerin deneyimlerini belirlemektir. Çalışma, Avrupa Komisyonu tarafından finanse edilen Horizon 2020 projesi kapsamında geliştirilen TeSLA Projesi (Öğrenme için Uyarlanabilir Güvene dayalı bir e-Değerlendirme Sistemi) kapsamında gerçekleştirilmiştir. TeSLA sistemi, e-değerlendirmede kimlik doğrulama, yüz tanıma, ses tanıma, tuş vuruşu dinamikleri, yazarlık kontrolü ve intihal araçları gibi çeşitli araçları içermektedir. Çalışma, kesitsel anket çalışması olarak tasarlanmıştır. Katılımcılar, İspanya, Bulgaristan ve Türkiye'de TeSLA sistemini kullanan üç üniversiteden toplam 735 öğrencidir. Öğrenciler, 2018-2019 Bahar Dönemi boyunca 92 lisans ve lisansüstü düzeydeki derste e-değerlendirme faaliyetleri için TeSLA sistemini kullanmışlardır. Veriler, derslerde TeSLA sisteminin uygulanmasından önce bir ön anket ve sistemi test ettikten sonra bir son anket aracılığıyla toplanmıştır. Veri analizi için tanımlayıcı istatistikler ve tek yönlü ANOVA Testi kullanılmıştır. Sonuç olarak, öğrencilerin TeSLA sistemini kullanırken farklı algıları ve deneyimleri olduğu; olumlu görüşlerin yanında olumsuz görüşlerin de ortaya çıktığı görülmüştür. Bu sonuçlara bağlı olarak elde edilen bulgular, ilgili literatür kapsamında ayrıntılı olarak tartışılmıştır.

Anahtar Sözcükler: E-değerlendirme, kimlik doğrulama, yazarlik denetimi, öğrenci deneyimleri, e-öğrenme, yükseköğretim

Students' Experiences on Using an Authentication and Authorship Checking System in E-Assessment

Article Information

Received: 20.12.2019

Accepted: 01.09.2020

Online First: 29.09.2020

Published: 30.09.2020

ABSTRACT

The aim of this study was to identify students' experiences in using an authentication and authorship checking system in e-assessment. The study was carried out within the context of the TeSLA Project (an Adaptive Trust-based e-Assessment System for Learning), which was developed under a Horizon 2020 project funded by the European Commission. The TeSLA system involves several instruments such as face recognition, voice recognition, keystroke dynamics, forensic analysis, and plagiarism tools for authentication and authorship checking in e-assessment. The study was designed as a cross-sectional survey. Participants were 735 students from three universities in Spain, Bulgaria and Turkey. Students used the TeSLA system during 2018-2019 Spring Semester for their e-assessment activities in 92 undergraduate and graduate courses. Data was collected via a pre-questionnaire before the implementation of the TeSLA system in the courses and a post-questionnaire after testing the system. Descriptive statistics and one-way ANOVA Test were used for data analysis. As a result, students had different perceptions and experiences in using the TeSLA system; while some students had positive views, some of them expressed contrary opinions. The findings of the study were discussed in detail in the context of relevant literature.

Keywords: E-assessment, student authentication, authorship checking, students' experiences, e-learning, higher education

doi: 10.16986/HUJE.2020063670 Makale Türü (Article Type): Research Article

Kaynakça Gösterimi: Guerrero-Roldán, A. E., Rodríguez-González, M. E., Karadeniz, A., Kocdar, S., Aleksieva, L., Peytcheva-Forsyth., R. (2020). E-değerlendirmede kimlik doğrulama ve yazarlık kontrol sistemi kullanımına yönelik öğrenci deneyimleri. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 35*(Özel Sayı), 6-24. doi: 10.16986/HUJE.2020063670

* This study was supported by the European Commission H2020-ICT-2015 TeSLA project "An Adaptive Trust-based e-assessment System for Learning", Number 688520.

** Ph.D, Universitat Oberta de Catalunya, Spain, aguerreror@uoc.edu (ORCID: 0000-0001-7073-7233)

*** Ph.D, Universitat Oberta de Catalunya, Spain, mrodriguezgo@uoc.edu (ORCID: 0000-0002-8698-4615)

**** Ph.D, Anadolu University, Turkey, abdulkadirkaradeniz@anadolu.edu.tr (ORCID: 0000-0001-9364-8786)

***** Ph.D, Anadolu University, Turkey, skocdar@anadolu.edu.tr (ORCID: 0000-0001-9099-6312)

****** Ph.D, Sofia University, Bulgaria, l.aleksieva@fppse.uni-sofia.bg (ORCID: 0000-0002-7877-5792)

******* Ph.D, Sofia University, Bulgaria, r.peytcheva@fp.uni-sofia.bg (ORCID: 0000-0002-3720-2242)

Citation Information: Guerrero-Roldán, A. E., Rodríguez-González, M. E., Karadeniz, A., Kocdar, S., Aleksieva, L., Peytcheva-Forsyth., R. (2020). Students' experiences on using an authentication and authorship checking system in e-assessment. *Hacettepe University Journal of Education, 35*(Special Issue), 6-24. doi: 10.16986/HUJE.2020063670

1. INTRODUCTION

The proliferation of digital technologies in a wide range of educational contexts during the last few decades has led to an increased interest in e-assessment (Brink & Lautenbach, 2011; Appiah & Van Tonder, 2018). Assessment is fundamentally important for learning and one of the key components in the instructional process (Jones, 2005; Guardia, 2016). E-assessment covers a range of activities in which digital technologies are used in assessment (JISC, 2007) since it involves the use of digital devices to assist in the construction, delivery, storage, or reporting of student assessment tasks (Crisp, 2011). According to Joint Information Systems Committee (JISC) "assessment lies at the heart of the learning experience: how learners are assessed shapes their understanding of the curriculum and determines their ability to progress" (JISC, 2018). Moreover, e-assessment now "makes more sense than ever because it encourages students to modify, complement and improve their learning" (Guardia, 2016). As Crisp summarises, e-assessment involves many possibilities that allow teachers to evidence student learning in a much deeper and often more authentic way than has been possible with traditional (paper-based) assessments (Crisp, 2011).

It is acknowledged by many researchers that e-assessment offers a range of potential advantages for teachers and students (Appiah & Van Tonder, 2018; Crisp, 2011), yet the same researchers reflect on its potential challenges, mainly related to security and authentication issues (Appiah & Van Tonder, 2018; Brink & Lautenbach, 2011; Crisp, 2011). For instance, Crisp (2011) noted that "the increased flexibility afforded to students by their being able to complete an e-assessment from any computer can sometimes cause issues with individual student authentication for high stakes exams" (p. 9). The authentication of students is considered as a major challenge for educational organizations offering e-learning (JISC, 2016; Obeidallah, Al Ahmad, Farouq, & Awad, 2015; Okada, Whitelock, Holmes, & Edwards, 2018) since it plays an important role for preventing academic dishonesty which has increased a lot over the past years (McCabe, 2016; Mellar, Peytcheva-Forsyth, Kocdar, Karadeniz, & Yovkova, 2018; QAA, 2016). On the other hand, there are systems which can validate the identity of learners doing assessment (JISC, 2016) and the research interest in their effectiveness to deter academic dishonesty is increasing (Adkins, Kenkel, & Lim, 2005; Bailie & Jortberg, 2009, Pittam, Elander, Lusher, Fox, & Payne, 2009; Levy & Ramim, 2007; Obeidallah et al., 2015). Two types of technologies which address academic dishonesty are recognized in the literature: 1) authentication technologies which seek to establish that the student taking the assessment is really who claim to be (Peytcheva-Forsyth, Mellar, & Aleksieva, 2019, McNabb, 2010); and 2) authorship checking technologies which seek to establish whether a document was actually written by the student who submits it (Peytcheva-Forsyth et al., 2019). While authorship checking technologies are mainly related to text-matching, the authentication systems can be used anytime a student logs into the learning management system, in proctoring situations, and during synchronous class sessions (Aceves & Aceves, 2009). There are a variety of identification technologies available, which Aceves & Aceves (2009) classify as biometric (e.g. fingerprint and iris scanning, keyboard typing cadence, speech recognition, etc.) and non-biometric authentication (e.g. web cameras that record the student's testing environment; onsite, remote proctors who monitor the student taking the exam at the student's location; "out-of-wallet" data mining of personal data that randomly requires students to answer personal questions before or during the exam; lockdown browsers that prohibit students from Internet; IP address verification and secure password and identification systems).

While the utilization of plagiarism detection system is a popular practice in universities, (Peytcheva-Forsyth, Yovkova, & Aleksieva, 2019; Halgamuge, 2017) the use of authentication systems, and more precisely the use of online proctoring systems for assessment is still quite limited in European universities (Draaijer, Jefferies, & Somers, 2017). The reasons for this could be related to the potential issues of implementation of such authentication systems. McNabb (2010) pointed out that when considering implementing authorship or authentication technologies, problems common to most technology implementations arise as well as new ones, such as the frequency of authentication and students' privacy issues which can affect students' experiences with technology. Therefore, it is crucial to explore students' perspectives and experiences with authorship and authentication checking systems in order to identify their impact on e-assessment and thus to use them effectively. Students' views and attitudes towards using such systems and factors, which may affect them, are a point of increasing interest in recent studies (Peytcheva-Forsyth et al., 2018a, 2018b, 2019; Okada et al., 2018, 2019), but yet students' experiences are poorly explored. This study aims to investigate students' experiences in using the student authentication and authorship system – TeSLA (An Adaptive Trust-Based E-Assessment System for Learning). Developed during 2016 and 2019, the TeSLA System, which constitutes the rationale of this study, aimed to create an integrated system in virtual learning environments to support authentication and authorship checking in e-assessment. This system has been developed under a Horizon 2020 project funded by the European Commission. The project consortium was composed of 18 partners, consisting of 8 universities, 3 quality agencies, 4 research centres and 3 companies. The TeSLA system was tested in three stages across seven institutions with the participation of more than 23.000 students. The data for this study is collected from three of the seven institutions taking part in the third and final stage of the pilot. These three institutions have been selected as representatives of three different contexts – an institution that offers wholly or principally online courses in Spain (University A), a campus-based institution that offers a range of blended courses in Bulgaria (University B) and an institution that offers both on-campus and online courses in Turkey (University C).

University A has 70,000 students, and its educational model is based on personalization and provision of guidance and support to the online students in their activities. The assessment activities are diverse, and the assessment model is mainly based on continuous and formative assessment, and additionally, there could be final face-to-face examinations. Course instructors supervised by the responsible teachers, design the assessment activities and conduct the assessments.

University B is a campus-based university with 25,000 students, and it is in the process of transforming some master's degree programs from face-to-face to online mode. A professor designs the assessments as a course leader, and an assistant professor provides the assessment feedback. The most common assessment type combines written online assignments or tests and a final face-to-face examination.

In University C, there are 22,000 on-campus students enrolled in a range of face-to-face and blended learning courses, and a much larger number of students are enrolled in its Open and Distance Education System (1,100,000 students). The faculty and the teachers establish the assessment model in on-campus courses. It may include face-to-face or online examinations and assignments. The Open Distance Education System involves courses and assessments designed by a group of course designers and academics. The assessment model is determined by the Assessment Department and it involves face-to-face mid-term and final examinations.

The specific impact of different institutional contexts on TeSLA system piloting is discussed in-depth in another study about the design and execution of large-scale pilots (Peytcheva-Forsyth & Mellar 2020), and it is taken into consideration in this research which main focus is on the impact of TeSLA system on students' attitudes and experience with the system. This paper first provides a description of the TeSLA system. It then sets out the research questions, methods, and findings of the study. Finally, findings are discussed within the relevant literature in the discussion section, and conclusions drawn from the study are presented.

1.1. The TeSLA System

The TeSLA system provides authentication and authorship verification. Several instruments (or tools) are integrated into the system for ensuring authentication and authorship of users that can be used in all e-assessment models and activities to prevent cheating and plagiarism. The instruments used for assuring authentication are Face Recognition (FR), Voice Recognition (VR), and Keystroke Dynamics (KD), whereas Forensic Analysis (FA) and Plagiarism (PL) are used to check authentication and authorship. FR and VR rely on who you are, whereas KD and FA respectively rely on how you type and how you write. A brief description of the instruments is provided below (Knuth, 2016):

- Face recognition (FR): The instrument analyses visual data such as images or videos and tries to recognize a face within the given data that has been derived during the enrolment; a webcam and a browser extension are required to capture images or videos.
- Voice recognition (VR): It analyses audio data of the user by comparing the characteristics of the voice with a model that has been derived from an example of speech during enrolment; it requires a microphone connected to the computer.
- Keystroke Dynamics (KD): This instrument recognizes patterns based on the timing information from pressed and released keys when a candidate is typing on a keyboard.
- Plagiarism (PL): It detects word-for-word copies in a given set of documents.
- Forensic analysis (FA): Authorship verification verifies that a document has been written by a specific author; it has to be trained with a set of text files written by the author.

The TeSLA system is capable of supporting diverse types of assessments such as formative, summative, continuous, or diagnostic. It is a modular system, and the individual instruments can be switched on or off as well as used in different combinations to match in the best possible way to the specifics of the particular assessment activity. When assessment activities are being designed, the available TeSLA instruments are presented as a list in the Virtual Learning Environment. (Mellar et al., 2018). The teacher creates e-assessment activities, where the security instruments are enabled so that she/he can select the most appropriate TeSLA instruments for the respective activity (Mellar et al., 2018). Two types of activities are required for authentication and authorship verification of students, which are enrolment and real e-assessment activities. An enrolment activity is the first step in which the learner introduces himself/herself to the system by recording 10-second video of his/her face for FR; recording speech samples of himself/herself for a given duration for VR; typing at least 30 samples, which must be extracted from 125 consecutive pressed keys for KD; submitting around 1000 words of written document that has been written by him/her before for FA (Okada et al., 2019). However, PL instrument does not require an enrolment activity. The enrolment activities are used as a reference for authentication and authorship checking in subsequent real activities for user registration, which are not graded. Then, the student performs real e-assessment activity. Finally, the system compares the samples collected in the enrolment and actual activities and indicates the degree of matching between the samples as a percentage. The system does not recommend a threshold percentage; it is the decision of the teacher or the institution to determine a threshold value to verify the authentication and authorship of the learner. The information that integrates the data collected by the authentication and authorship instruments is provided through dashboards (Guitart-Hormigo, Rodríguez & Baró, 2020). These dashboards are oriented to assist the decision-making process of teachers, above all, in case of suspicion of students' dishonest academic behaviour.

1.2. Research Questions

RQ1. What is TeSLA's impact regarding:
- trust in online assessment and e-authentication?
- personal data sharing and e-authentication?
- cheating and plagiarism?
- online assessment advantages and disadvantages?
- e-authentication advantages and disadvantages?

RQ2. What are the students' experiences of using:
- the TeSLA system?
- the tools in the TeSLA system; face recognition, voice recognition, keystroke analysis, anti-plagiarism, and forensic analysis?

2. METHOD

The study was designed as a cross sectional survey. Participants were 735 students who completed both pre- and post-questionnaire from University A, University B and University C (Table 1) from 92 undergraduate and graduate courses in various fields such as arts and humanities, science and social science. 58% of the 735 students were male, whereas 42% of them were female. 15% of the students were 21 or under 21 years old, 43% were between 22-30 years old, 25% were 31-40 years old, 14% were 41-50, 2.4% were 51 and over 51 years old. 0.6% of them preferred not to tell their age.

Table 1.
Number of Students who Completed Questionnaires

	University A	University B	University C	Total
Number of Students Completed Pre-Questionnaire	662	232	240	1134
Number of Students Completed Post-Questionnaire	627	219	171	1017
Number of Students Completed Both Pre&Post-Questionnaire	507	58	170	735

2.1. Data Collection

Two questionnaires were designed: a student pre-questionnaire before testing the system and a student post-questionnaire after experiencing the TeSLA system. The pre-questionnaire consisted of 10 parts, including 18 questions, and the post-questionnaire involved 10 parts with 17 questions, with similar questions of the pre-questionnaire. Items were prepared using a 5-point Likert type scale including "strongly agree", "agree", "neither agree nor disagree", "disagree", and "strongly disagree" except two parts which were "Online assessment advantages and disadvantages" and "Online assessment advantages and disadvantages regarding e-authentication". Students were asked to select all the items that are suitable for them in multi-choice type questions in these two parts. Demographics of students were also collected in the questionnaire. The questionnaires were created in English in cooperation with experts from the seven partner universities in the Project. The items in the questionnaires were checked and edited by the experts. Then, the questionnaires were translated into local languages by professional translators and checked by a group of experts. They were also tested in a pilot study by small groups of students in each university and finalized before their implementation. The procedures for the data collection were:

- *e-Assessment design:* The TeSLA system was used in real assessment activities by the 150 teachers involved in the testing phase of the system in the three mentioned universities during 2018-2019 Spring Semester. The teachers selected the most appropriate instruments for each assessment activity in their courses, and the selected tools were turned on in the system. For example, typing or choosing answers in quizzes or online text submissions (FA, KD and PL), performing a presentation (FR, VR), creating artifacts (FR, VR, KD, FA and PL) or uploading documents in the assignment (PL, FA) (Okada et al., 2019). All the tools mentioned above were used by several teachers in three universities.
- *Implementation:* The teachers provided guidelines and immediate support via videos, face-to-face and online sessions and written instructions for the use of the system both for the enrolment and real activities. The students completed the e-assessment activities during the semester until the given deadlines.
- Evaluation: The students were required to fill in the pre-questionnaire before starting the e-assessment activities. After completing the e-assessment activities, they were asked to fill in the post-questionnaire. The data was collected by using the Bristol Online Survey (BOS) system (https://www.onlinesurveys.ac.uk/) involving the same set of questions, which were translated into native languages of the universities. Volunteer students answered the questionnaires. A consent form was required before answering the questionnaires and using the TeSLA system.

2.2. Data Analysis

SPSS statistical program was used for data analysis. The goal of this study was to identify the impact of TeSLA, experiences of students, and whether the outcomes of the TeSLA pilot differ across the three universities, thus descriptive statistics and one-

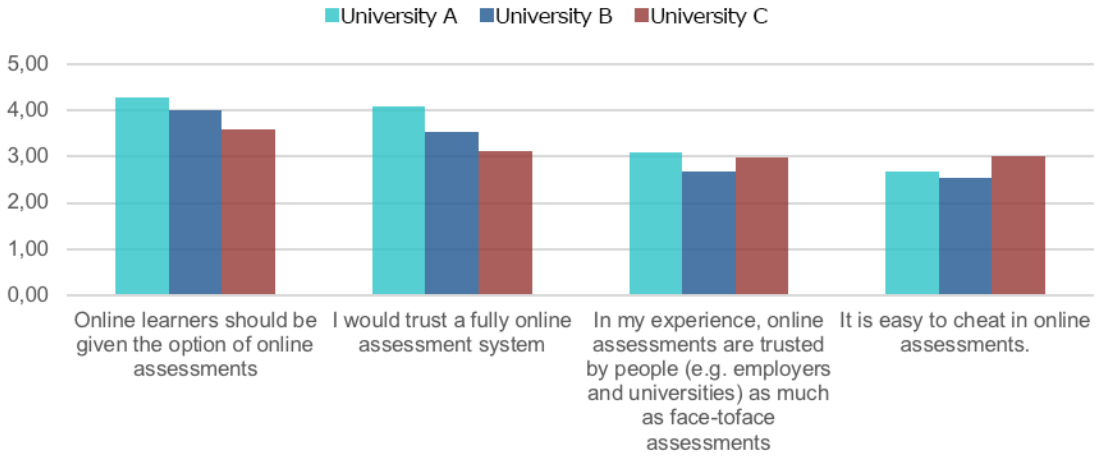
way ANOVA tests were performed, and the results were illustrated in the graphs. Items in the questionnaire were analyzed separately.

3. FINDINGS

3.1. TeSLA's impact

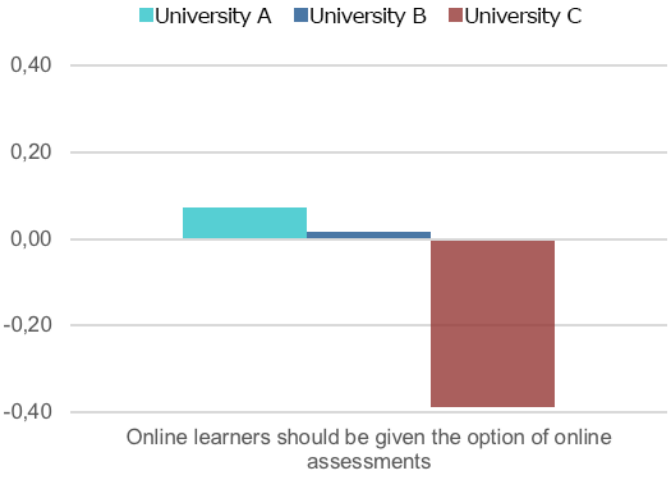
3.1.1. Trust in online assessment and e-authentication

Students were asked several questions about trust in online assessment before and after participating in TeSLA pilot. Figure 1 shows the after-TeSLA frequencies of these questions, and Figure 2 shows the changes between the situations before (pre-questionnaire responses) and after (post-questionnaire responses) the pilot. We only present the variables that have statistically significant differences across universities, as shown by the one-way ANOVA tests performed. We can see that University A students seem to have a higher trust in online assessments. On the contrary, University C students seem to be slightly more concerned that it is easy to cheat in online assessments. Moreover, after participating in TeSLA they seem less in favor of giving students the option of online assessments (see Figure 2).



N=507 (University A), 58 (University B), 170 (University C)

Figure 1. Attitudes towards online assessment (after TeSLA pilot)

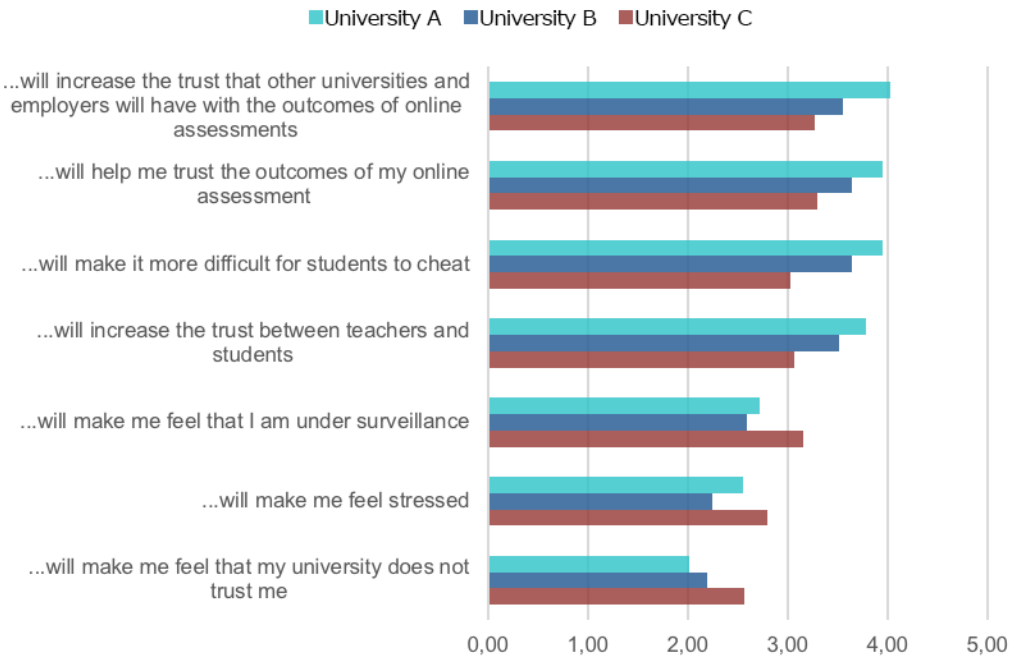


N=507 (University A), 58 (University B), 170 (University C)

Figure 2. Attitudes towards online assessment PRE - POST change

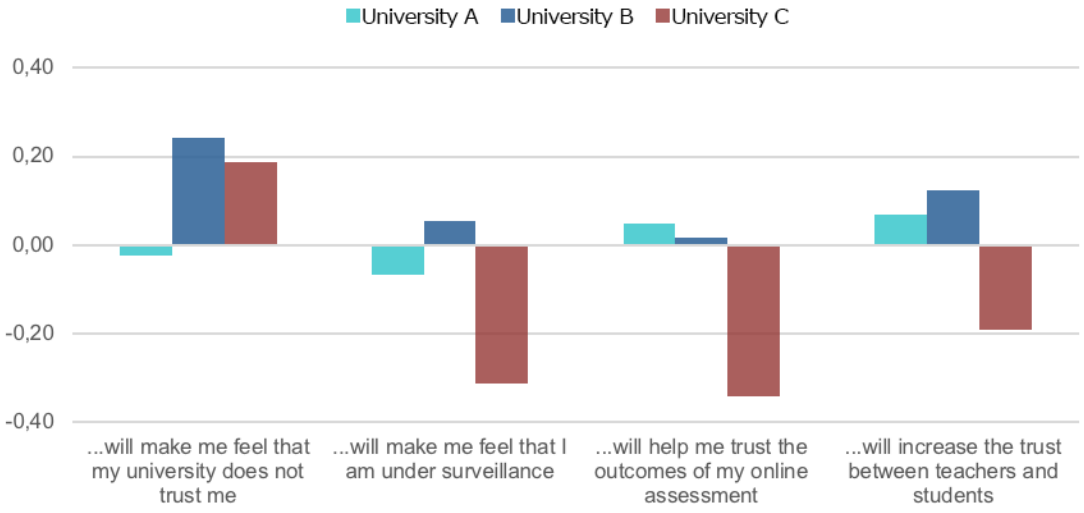
In addition to online assessment, students were asked specific questions about the use of e-authentication (security measures) for online assessment. Again, University A students have a more positive attitude towards e-authentication in comparison with students from the other two universities. They are more likely to agree that e-authentication will make it more difficult for students to cheat and that it will increase the trust between teachers and students, the trust of other universities and employers, and the trust of students on the outcomes of their online assessment (see Figure 3). In University C, students are more likely to disagree with these statements. In addition, there is a higher concern among the University C students that e-authentication might make students feel under surveillance and stressed and that they might perceive that the university does not trust them. After participating in TeSLA, University C students seem to have a worse perception on the potential impact of e-authentication on trust as they agree more that this mechanism may make students feel that the university does not trust them and less that it can help increase the trust of students in the outcomes of their online assessment and the trust between teachers and students. On the other hand, the concern that students may feel under surveillance has decreased after TeSLA pilot (see N=507 (University

A), 58 (University B), 170 (University C) Figure 4). University B students are the least concerned that authentication for online assessment may make students feel stressed and under surveillance.



N=507 (University A), 58 (University B), 170 (University C)

Figure 3. Attitudes towards authentication for online assessment (after TeSLA pilot)



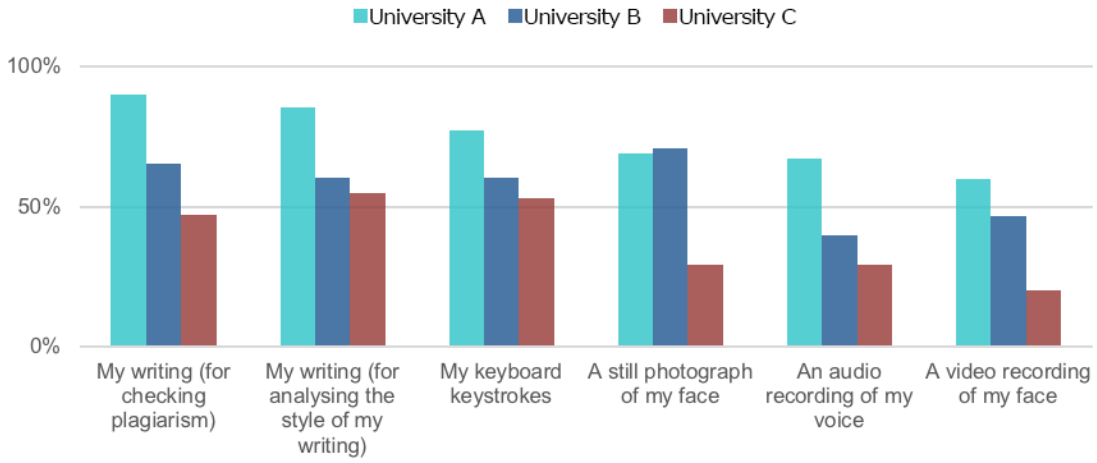
N=507 (University A), 58 (University B), 170 (University C)

Figure 4. Attitudes towards authentication for online assessment. PRE - POST change

3.1.2. Personal data and e-authentication

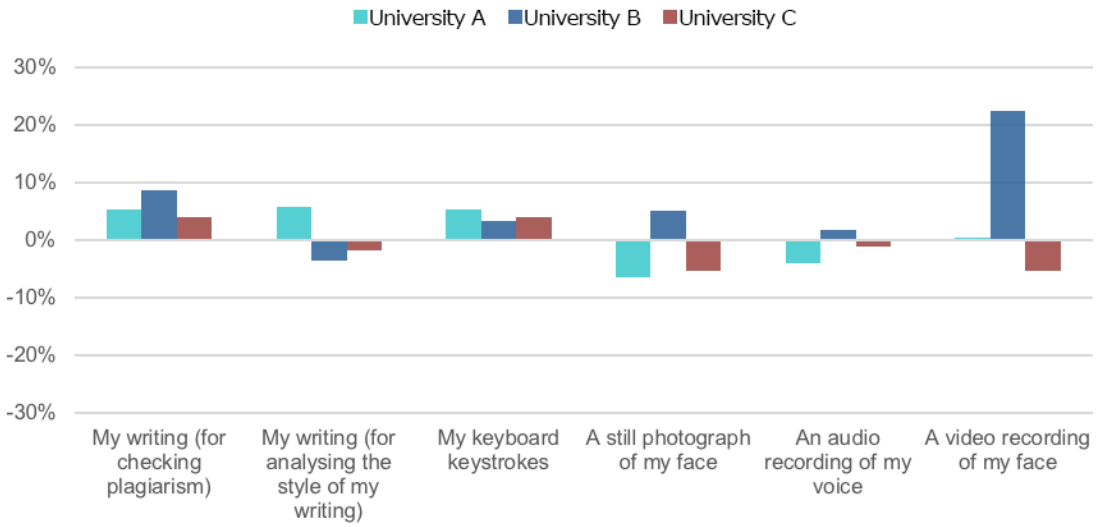
Students were asked what data they would be willing to share to authenticate and confirm the authorship of their online assessment before and after the pilot (Figure 5). University A students are more willing to share all types of data compared to students from University B and University C, except for the photograph of their face, for which percentages are almost the same in University A and University B. In fact, a photo of their face is the type of data that University B students are more willing to provide for the purpose of authentication. About 71% are willing to share such data, while less than one-third of University C students would do so. University C students are less willing to share all types of data, but they would rather share the data collected by the Keystroke Dynamics instrument than the other types of personal data. These are also the authentication mechanisms more often selected by University A students.

After the TeSLA pilot, there has been a noticeable increase (more than 20 percentage points) in the number of University B students willing to share a video recording of their face (Figure 6). However, this has slightly decreased in University C. In University A the largest change is a slight decrease in the willingness to share a photograph of their face.



N=507 (University A), 58 (University B), 170 (University C)

Figure 5. Willingness to share personal data (after TeSLA pilot)



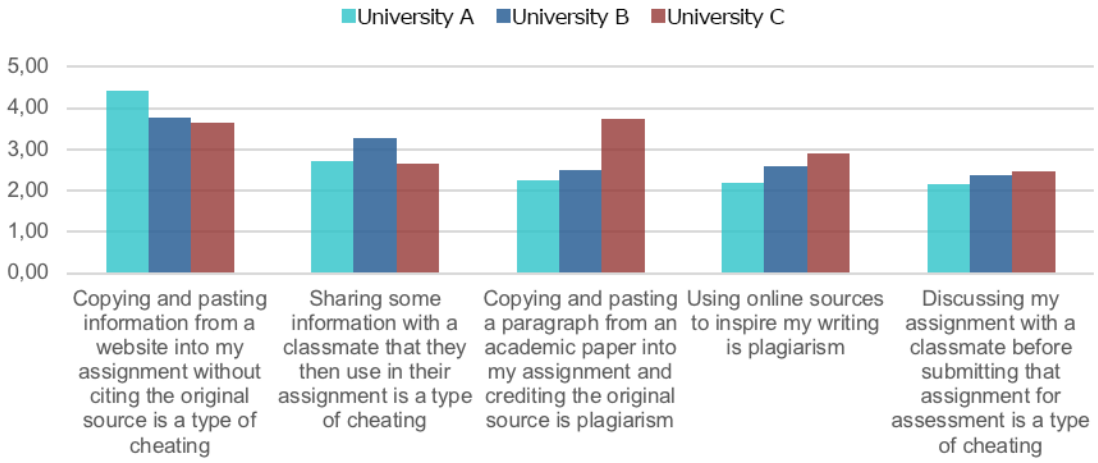
N=507 (University A), 58 (University B), 170 (University C)

Figure 6. Willingness to share personal data. PRE - POST change

3.1.3. Cheating and plagiarism

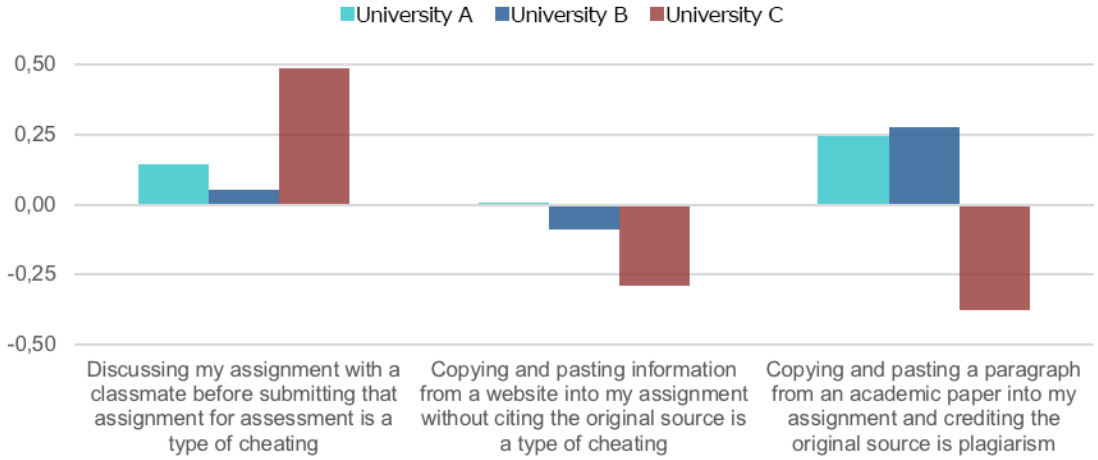
In addition to their willingness to share personal data, students were asked questions about cheating in online assessments (see Figure 7). The perceptions vary across universities depending on the specifics of the institutional context. University A students agree more that copying and pasting information from a website into my assignment without citing the original source could be defined as cheating. In University C students' opinions copying and pasting a paragraph from an academic paper into their assignment and crediting the original source is also plagiarism, but University A and University B students do not seem to agree on this. University B is the university where students agree more that sharing some information with a classmate that they then use in their assignment is a type of cheating.

Participation in TeSLA seems to have had an impact on some of these perceptions (Figure 8). Particularly, regarding the action of discussing the assignment with a classmate before submitting that assignment for assessment, as now University C students agree more that this is a type of cheating. Agreement has also slightly increased in University A. However, University C students agree less than before the pilot that the actions related to copying and pasting information from other sources are plagiarism.



N=507 (University A), 58 (University B), 170 (University C)

Figure 7. Attitudes towards cheating and plagiarism (after TeSLA pilot)



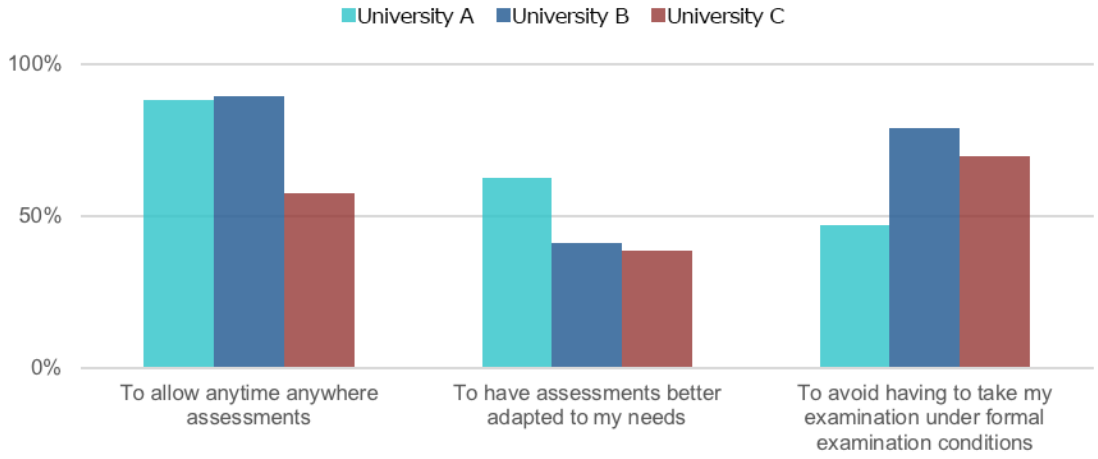
N=507 (University A), 58 (University B), 170 (University C)

Figure 8. Attitudes towards cheating and plagiarism. PRE - POST change

3.1.4. Online assessment advantages and disadvantages

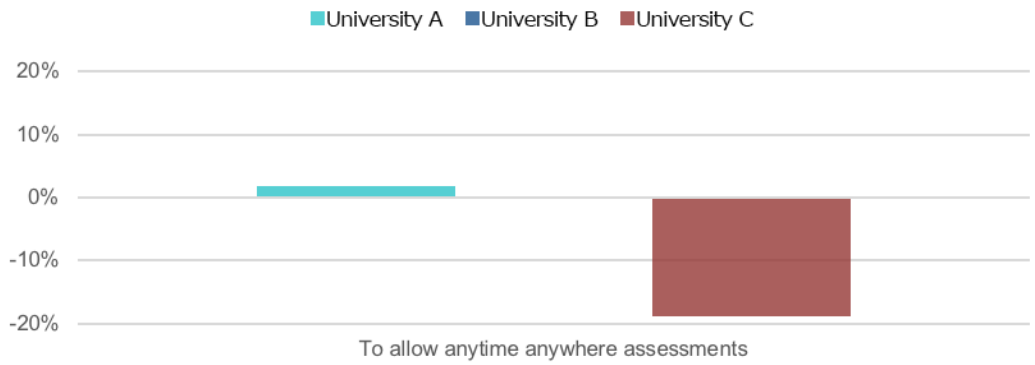
There are some differences across universities regarding the advantages of online assessments (see Figure 9). The far majority of students in University A and University B recognise that using online assessment allows anytime anywhere assessments. However, this percentage is lower in University C and it has clearly decreased after the TeSLA pilot (by 19 percentage points), while it has remained unchanged in the other two universities (see Figure 10).

On the other hand, a majority of University B and University C students think that one of the advantages of online assessments is that they avoid examinations under formal conditions, but only 47% of University A participants agree on this. However, University A students tend to select more the advantage of having assessments better adapted to their needs (Figure 9).



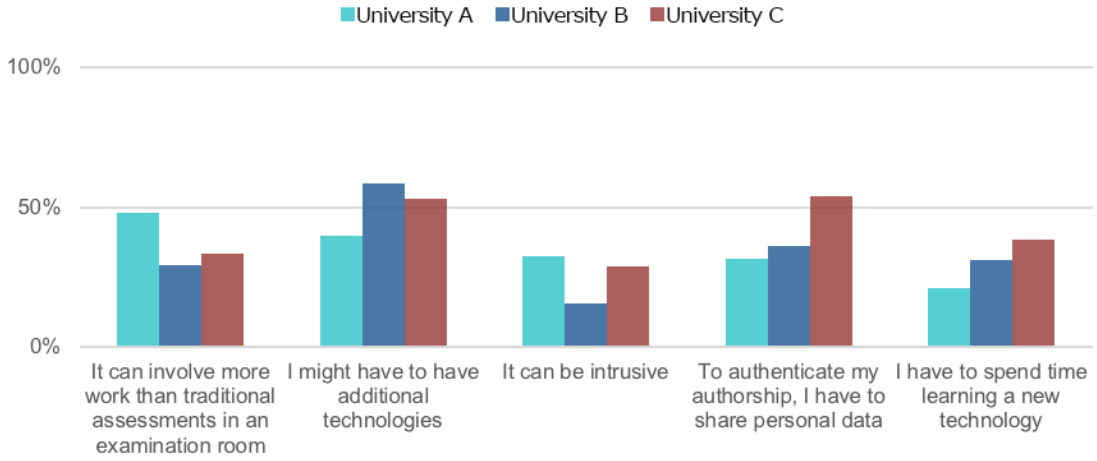
N=507 (University A), 58 (University B), 170 (University C)

Figure 9. Advantages online assessment (after TeSLA pilot)



N=507 (University A), 58 (University B), 170 (University C)
Figure 10. Advantages online assessment. PRE - POST change

Students were also asked about some disadvantages of online assessment. In this case, there are also differences across universities (see Figure 11). Compared to the other two universities, a larger number of University A students consider as disadvantages the fact that online assessment can involve more work than traditional assessments and that it can be intrusive. On the other hand, University C students are more concerned by the fact that online assessment might require them to share personal data and spend time learning a new technology. Lastly, University B students select more often as a disadvantage the need to have additional technologies.

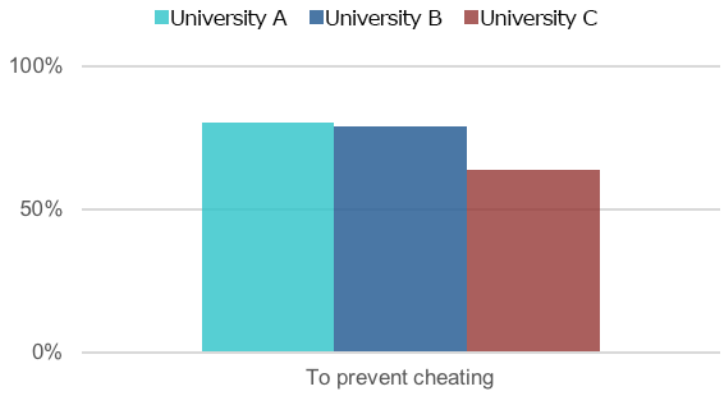


N=507 (University A), 58 (University B), 170 (University C)
Figure 11. Disadvantages online assessment (after TeSLA pilot)

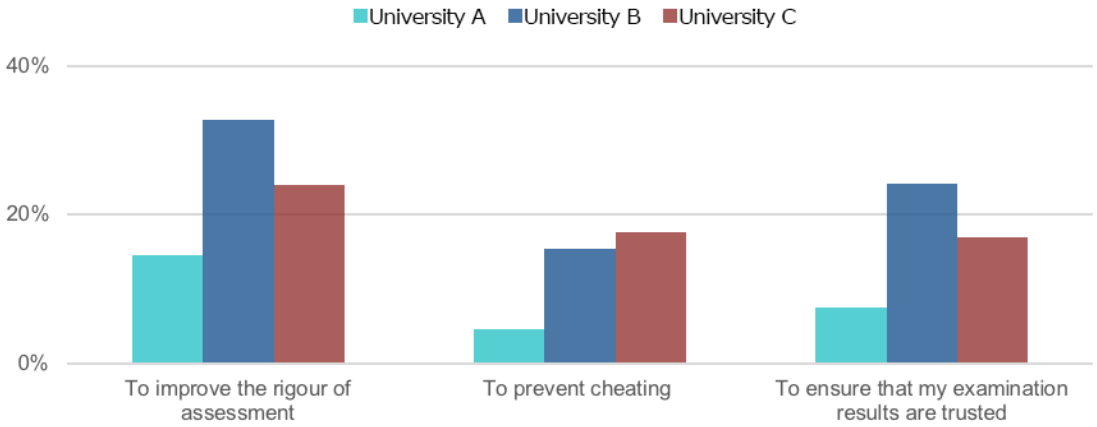
3.1.5. Online assessment advantages and disadvantages regarding e-authentication

Regarding the advantages of TeSLA e-authentication, there are significant differences in the percentage of students who selected 'to prevent cheating'. Around 70% of students in University A and University B consider that TeSLA e-authentication may prevent cheating, but this percentage is 15 points lower in University C (see Figure 12).

Participation in TeSLA had a positive impact on these perceptions, as Figure 13 shows that more students selected these items with regards to TeSLA e-authentication (after the pilot) than for e-authentication in general (before the pilot). In all three universities the highest growth refers to the perception that TeSLA e-authentication can improve the rigour of assessment. The 24 points increase in the percentage of University B students who consider that TeSLA can help ensure that their examination results are trusted is also remarkable.



N=507 (University A), 58 (University B), 170 (University C)
Figure 12. Advantages e-authentication (after TeSLA pilot)

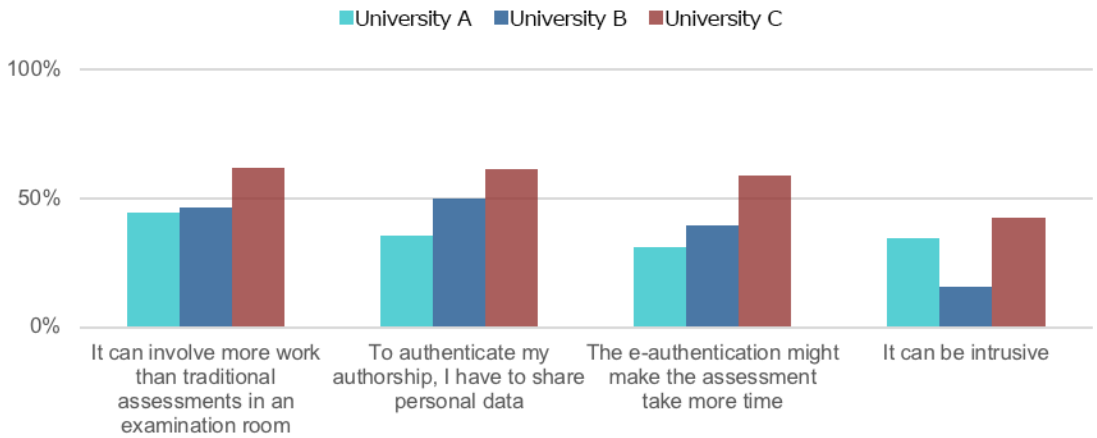


N=507 (University A), 58 (University B), 170 (University C)
Figure 13. Advantages e-authentication. PRE - POST change

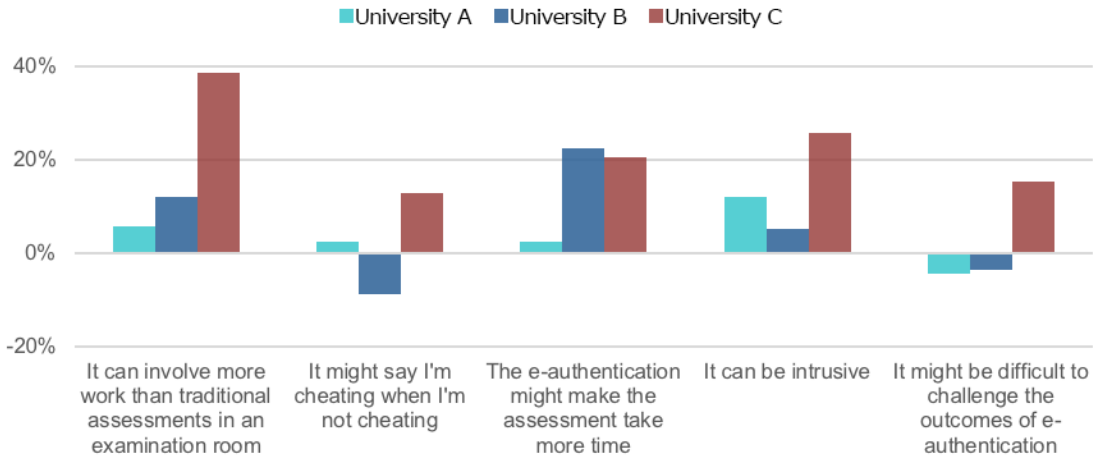
On the other hand, University C students identify more disadvantages in TeSLA e-authentication than students in the other two universities (see Figure 14). Moreover, participation in TeSLA had a negative impact on this, especially regarding the perception that TeSLA e-authentication can involve more work than traditional assessment (see Figure 15).

University A students are the least concerned about the fact that TeSLA e-authentication may require them to share personal data and that it may involve more time. However, after trialling TeSLA a higher percentage of respondents think that it can involve more work and that it can be intrusive.

University B students are those who reply less often that TeSLA e-authentication can be intrusive, but after the pilot the percentage of those who think that this type of authentication might make the assessment more time consuming has increased considerably (22 percentage points).



N=507 (University A), 58 (University B), 170 (University C)
Figure 14. Disadvantages e-authentication (after TeSLA pilot)

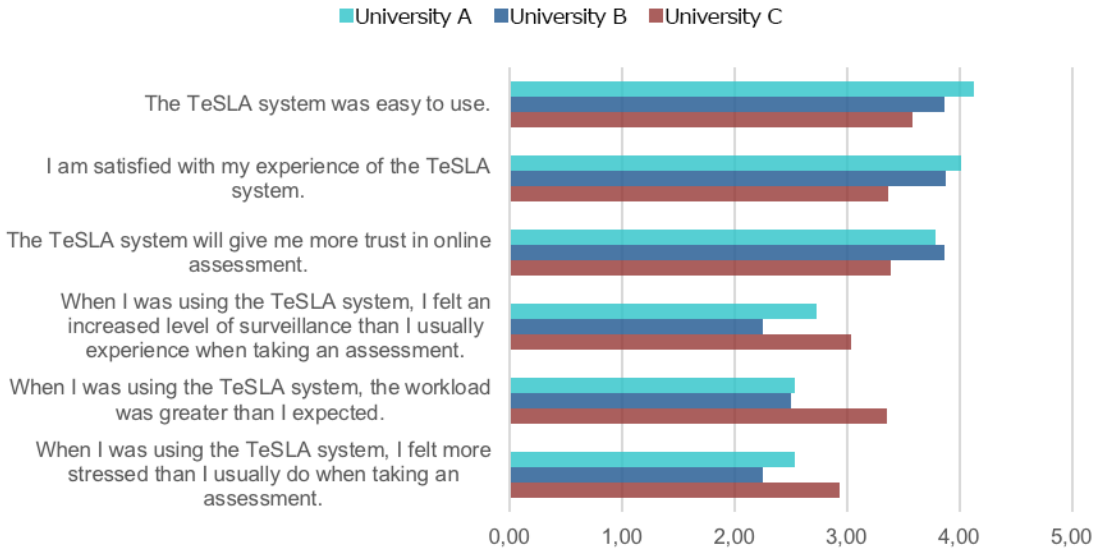


N=507 (University A), 58 (University B), 170 (University C)
Figure 15. Disadvantages e-authentication. PRE - POST change

3.2. TeSLA's experience

3.2.1. TeSLA system

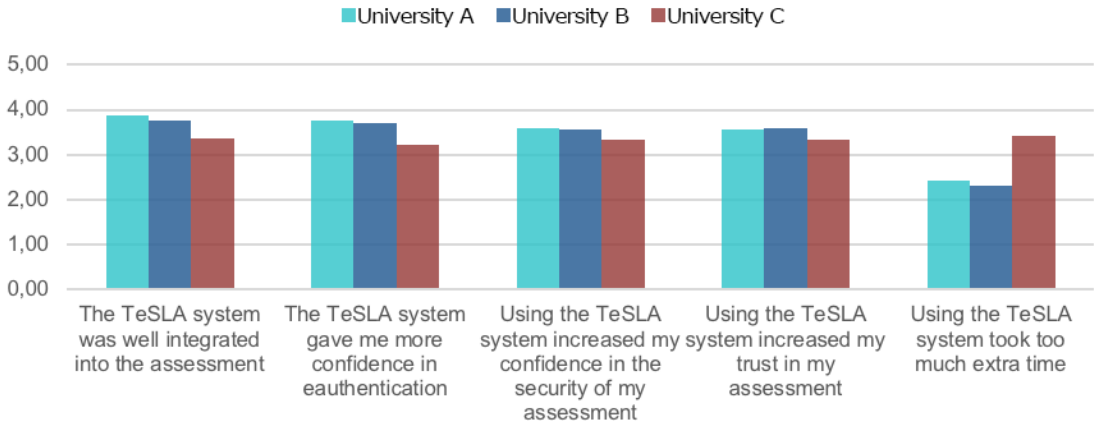
University A students seem more satisfied with TeSLA experience and perceive the system as easy to use (Figure 16). University B participants are those who agree more that TeSLA would increase their trust in online assessments. On the contrary, University C students appear to be less satisfied with TeSLA. Moreover, in University C there is a higher agreement on the fact indicated that the workload was greater than expected and that they felt stressed and under surveillance. University B students are those who agree less on these negative statements.



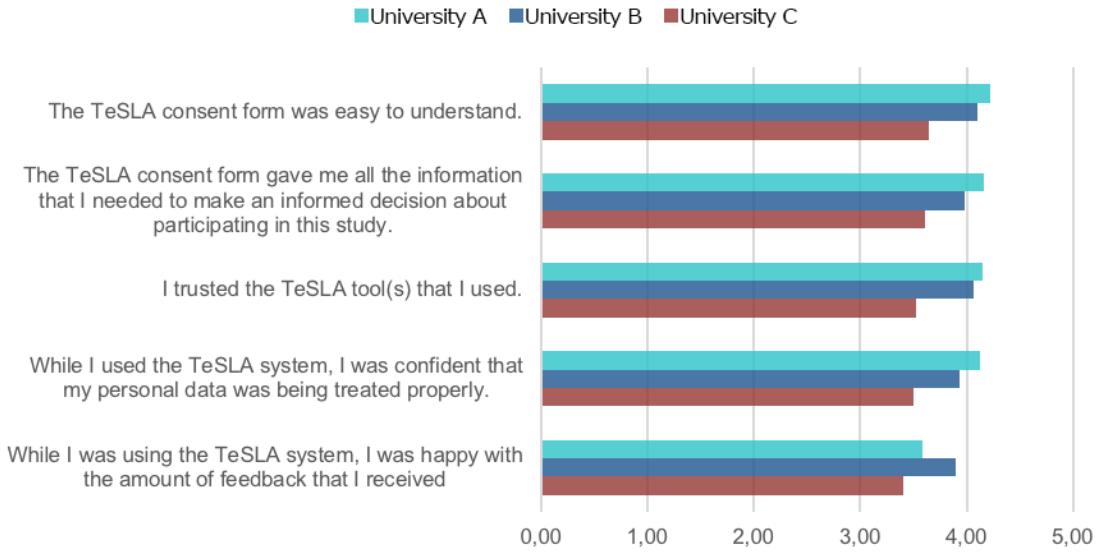
N=507 (University A), 58 (University B), 170 (University C)
Figure 16. TESLA general experience

In addition to their general experience, students were asked specific questions about trust after finalising the pilot. Generally, students in University A and University B tend to agree that the system was well integrated into the assessment and that it gave them more confidence in e-authentication. However, the level of agreement is lower among University C students (see Figure 17). The latter also tend to agree more that using the system took too much extra time.

Similarly, University C students are those agreeing less with the privacy, informed consent and feedback related questions (Figure 18). University A students agree more on these statements, except for "while I was using the TeSLA system, I received enough feedback", in which the level of agreement is higher in University B. University A students were more confident that their personal data was treated properly and indicated a higher trust in the TeSLA tool(s) they used.



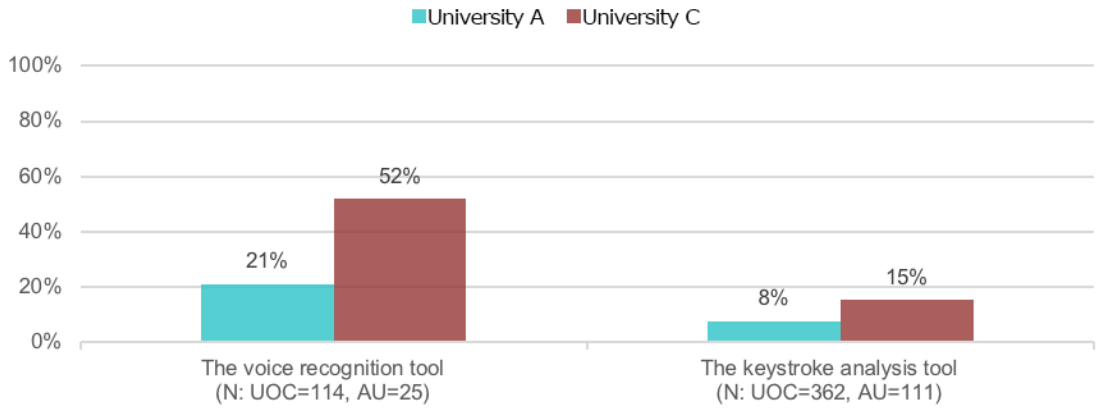
N=507 (University A), 58 (University B), 170 (University C)
Figure 17. TESLA Trust



N=507 (University A), 58 (University B), 170 (University C)
Figure 18. TESLA Privacy, informed consent and feedback

3.2.2. Tools

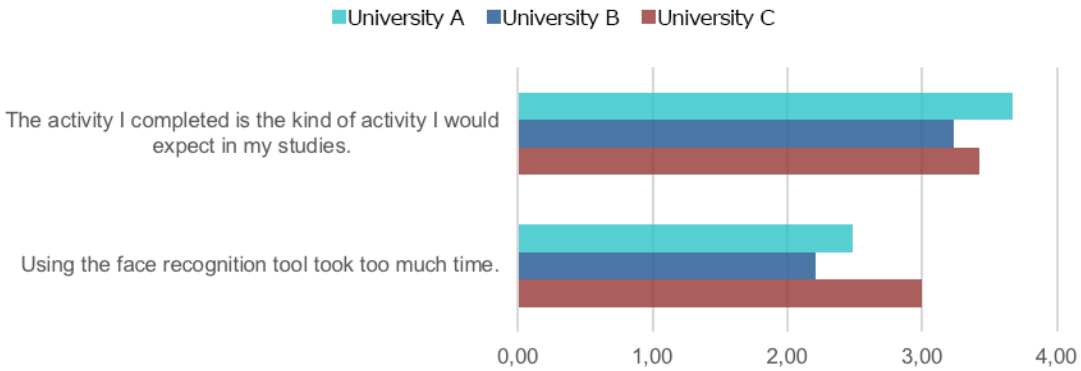
Students were using different tools during the pilots. University C students encountered significantly more difficulties than University A participants when using the Keystroke Dynamics and especially when testing the Voice Recognition tool, as about half of them experienced problems with this tool (Figure 19). Very few University B students trialled these two tools, therefore they have not been included in the figure.



N=507 (University A), 58 (University B), 170 (University C)
Figure 19. Students who experienced problems while using TeSLA tools

3.2.2.1. Face recognition

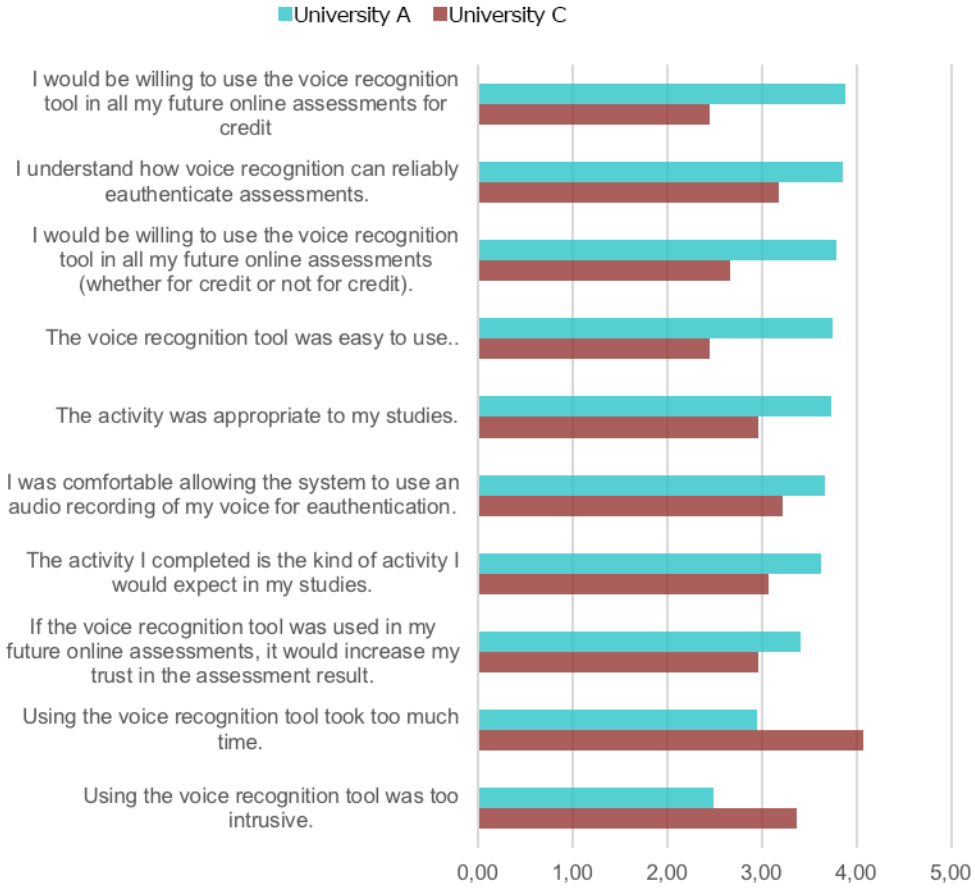
Students using the Face Recognition were enquired to assess their experiences (see Figure 20). Students in University A tend to agree that the activity completed was the kind of activity they would expect in their studies, and the level of agreement is higher than in the other two universities. On the other hand, University B and University A students tend to disagree that using the Face Recognition tool took too much time, but the opinions seem more divergent in University C (as the mean is equal to 3, that equals to neither agree nor disagree).



N=507 (University A), 58 (University B), 170 (University C)
Figure 20. Face recognition assessments

3.2.2.2. Voice recognition

University A students also have a better opinion about the Voice Recognition tool and are more willing to use it in their assignments (see Figure 21). Again, University C students agree more that using the tool took too much time and they also tend to agree that it was too intrusive.



N=507 (University A), 170 (University C)
Figure 21. Voice recognition assessments

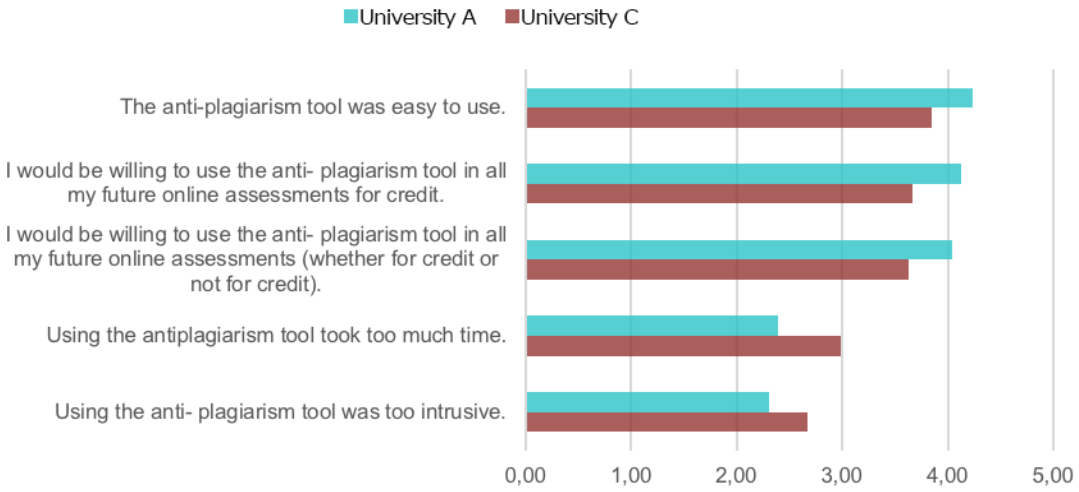
3.2.2.3. Keystroke Dynamics

Students in University A agree that the Keystroke Dynamics was easy to use, they were comfortable using it and express willingness to use the tool in the future. University C students' opinion about this tool is a bit worse than that of University A participants, and they tend to agree that using the keystroke analysis took too much extra time (Figure 22).

N=507 (University A), 170 (University C)
Figure 22. Keystroke analysis assessment

3.2.2.4. Anti-plagiarism

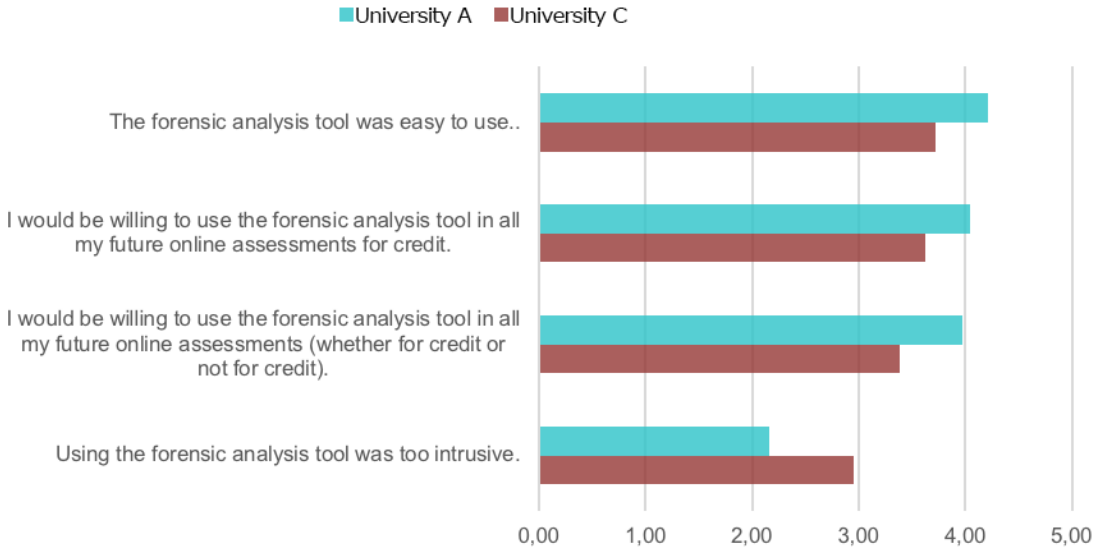
As seen with the other tools, University A students agree more that the anti-plagiarism tool was easy to use and have a higher willingness to use it in the future than University C students. Participants from University C agree more than those from University A that the tool was too time-consuming and intrusive, although the values are rather low in both universities (Figure 23). Very few University B students trialled this tool, therefore they have not been included in the figure.



N=507 (University A), 170 (University C)
Figure 23. Anti-plagiarism assessments

3.2.2.5. Forensic analysis

University A students generally have a positive view on the Forensic Analysis, they agree that it was easy to use and express willingness to use in their future online assessments (see Figure 24). The agreement on these statements is lower among University C students, who, in addition, disagree less that the tool was too intrusive. Very few University B students trialled this tool, therefore they have not been included in the figure.



N=507 (University A), 170 (University C)
Figure 24. Forensic analysis assessments

4. DISCUSSION

This section discusses the main findings, based on the results of the study conducted, in regards with the research questions (RQ) formulated at the beginning of this paper. The section also contextualizes the results with related research works on the field of e-assessment. RQ1 deals with TeSLA impact (RQ1). RQ2 evaluates the students' experiences on using the TeSLA system, and the tools it provides.

Concerning the impact of TeSLA systems (RQ1), University B participants are those who agree more that TeSLA would increase their trust in online assessments, which is similar to the findings of other studies. Bahar and Asil (2018) found out that the positive attitude to e-assessment is influenced by factors such as gender, computer usage, and level of education. Furthermore, Hettiarachchi, Huertas, and Mor (2015) indicated that e-assessment had a positive impact on students' performance and learning processes. However, our study revealed that University C students are less satisfied with TeSLA and they agree more that the workload was greater than expected and that they felt stressed and under surveillance. This may be related to the results that Rolim and Isaias (2019) emphasized in their study conducted in Portugal. They stated that e-assessment applications had just begun, and therefore resistance and distrust could be observed. It is thought that this could be the reason for the deficiency of positive opinions. In like manner, Husband (2017) also mentioned that despite the effectiveness of e-assessment tools to provide benefits for both students and teachers to improve their learning and management of assessment, the lack of literature is a proof that implementing e-assessment tools needs to be further researched with a focus on how to mediate validity and reliability challenges between paper and computer-based assessments.

Students recognise more advantages of TeSLA e-authentication (after the pilot) than of e-authentication in general (before the pilot), especially with regards to the perception that TeSLA e-authentication can improve the accuracy of assessment. There was also a remarkable increase in the percentage of University B students who consider that TeSLA can ensure that their examination results are trusted. This result directly contributes to the main advantages of using e-assessment (providing direct and immediate feedback for students, improving student performance, reducing the time and effort of the teacher, decreasing the cost for the institution, and encouraging high-order thinking, which is one of the educational aims) (Alruwais, Wills, & Wald, 2018).

University C students identify more disadvantages in TeSLA e-authentication, and participation in TeSLA had a negative impact on their perceptions. After trialling TeSLA, University A students agreed more that TeSLA e-authentication can involve more work and that it can be intrusive. Moreover, the percentage of University B students who think that the assessment might take more time increased considerably. Studies in the literature indicate that students have different perceptions and experiences about e-assessment. While most of the students are willing to take part in e-assessment, there are also pessimistic views (Attia, 2014; Dermo, 2009; Ferrao, 2010; Hillier, 2014; Sorensen, 2013). Dermo (2009) found that the positive feelings of students were only slightly stronger than the negative feelings about the validity, practicality, security and reliability aspects of e-assessment. Similarly, Lee-Post and Hapke (2017) found that one fourth of the students were pessimistic about the

implementation of e-assessment. These negative opinions should be taken into account by the teachers, administrators and instructional designers while designing and implementing instruments for e-assessment. Fluck, Pullen, and Harper (2009) and Hillier (2014) emphasize the importance of the first positive experience in e-exams for rapid adoption of such practices.

In order to authenticate and confirm the authorship of their online assessment, University A students are more willing to share most types of data except for the photograph of their face, which is the item most selected by University B students. University C students are less willing to share all types of data. University A and University C students would rather share their writing of their keyboard keystrokes than the other items. In fact, it can be observed that, with the exception of University B, the types of data students are willing to share are sorted from less intrusive to more intrusive (writing, keyboard keystrokes, voice samples, and face data samples). University A students were more confident that their personal data was being treated properly and indicated a higher trust in the TeSLA tool(s) they used. These results are supported by Okada et al. (2018). It is cited that students have affirmative acceptance and trust in e-authentication for online assessments. They also mentioned that e-authentication has the potential to enhance the quality and trustworthiness of online assessments.

Regarding the students' experiences on using TeSLA system (RQ2), University A students generally have more positive attitudes and opinions towards the TeSLA system and its tools than students from the other two universities. University C students are generally those expressing less positive opinions. This difference may be due to the difference among the modes of learning in the universities; as University A is an online university, students at University A may be more familiar with using online systems when compared with other universities. Thus, it can be concluded that the mode of learning may have an influence on the perspectives and experiences of students in using authentication and authorship systems. In a similar way, University A students seem more satisfied with TeSLA experience and agree more that the system was easy to use.

Also, the University A students have more positive attitudes/opinions towards TeSLA tools than University C students. For example, they tend to think that they are easy to use and they express higher willingness to use them in the future. Also, as previously explained, University C students agree more that using the tools took too much time, and they experienced some workload. Just a few students from University B tested the tools, except for the face recognition. It is worth mentioning that TeSLA system was under development during the project, meaning that students tested a beta version of the system. It is expected that in the future the feeling of workload can be reduced.

Wrapping up, results suggest that the educational context of each university is relevant. In spite of all students recognise the potential of TeSLA system in ensuring authentication and authorship, University A students express more positive opinions. This is probably related to the fact that this institution offers only online courses. Furthermore, its student profile is a person with family and professional commitments, this is why they are older than the average age of the other institutions. In addition, University A has detected an increasing number of students living abroad. For them, avoiding face-to-face examinations at the end of the semester means saving time, and to have a guarantee that their efforts can be trusted by quality assurance agencies and society at large. University B students have expressed positive opinions as a result of their participation in the pilot. This is consistent with the fact that this institution is incorporating blended courses to its educational offer.

5. CONCLUSIONS

The aim of the study presented in this paper has been to investigate students' expectations and experiences on using a system (the TeSLA system) that helps to ensure students' authentication and authorship in a real educational setting. In order to have a broad view, the study considers three universities with different educational contexts, which reflects the deep transformation that higher education institutions have suffered since the incorporation of the information and communication technologies into the teaching-learning process.

While e-learning is widely accepted and extended, on-site final examinations continue being the most usual instrument to assess learners and to ensure their identity. However, this is not aligned with the common principles which characterise e-learning, for instance, flexibility, mobility or accessibility. Assessment should not be a limiting factor in e-learning, on the contrary, e-assessment should facilitate the principles cited above. E-assessment could be considered a beneficial alternative to the traditional assessment. However, in relation to being considered trustworthy, not everyone agrees with this statement. It could be achieved that there is a strong correlation with trust and being sustained to the usage of e-assessment tools (Rolim & Isaias, 2019).

The use of tools oriented to ensure authorship and authentication, and the integration of these tools into the assessment process according to pedagogical criteria is a matter of interest in the field of technology enhanced learning, thus contributing that e-assessment could be considered a beneficial alternative to the traditional assessment. The development of systems as TeSLA system, clearly constitutes a step forward in this direction. Nevertheless, the use of this kind of systems requires the commitment of all involved stakeholders: faculty boards, teachers, students and quality assurance agencies. This paper presents and discusses the main findings concerning the expectations and experiences of the first class beneficiaries of this kind of systems, the students.

In this study, there were significant differences in opinions between institutions, which were conducted with students from institutions with three different cultures in three different countries. This situation has been tried to be interpreted for various reasons. Furthermore, it may be meaningful to focus on cultural differences to understand the rationale for this variation. Aparicio, Bacao, and Oliveira (2016) also emphasized that the culture variable should be taken into consideration in the studies since the effect of cultural diversity on the sense of satisfaction and acceptance is essential. The transformation of cultural values is quite complicated, and eliminating cultural differences is one of the most challenging situations to achieve while using e-learning tools (Carless, 2005). However, recognizing the cultural and social effects during the implementation of e-learning tools (Tarhini, Hone, Liu, & Tarhini, 2017), will allow being more sensitive to changes (Tapanes, Smith, & White, 2009). Therefore, future research may also consider the cultural differences dimension to investigate the acceptance of e-learning tools, such as e-assessment.

Research and Publication Ethics Statement

The authors declare that this study has been conducted in accordance with research and publication ethics rules. The authors further declare that they have not submitted this article to any other journal for publication before.

Contribution Rates of Authors to the Article

The authors contributed to the manuscript equally.

Support Statement

This study was supported by the European Commission H2020-ICT-2015 TeSLA project “An Adaptive Trust-based e-Assessment System for Learning”, Number 688520.

Statement of Interest

The authors declare that there is no conflict of interest.

6. REFERENCES

Aceves, P.A., & Aceves, R.I. (2009). Student identity and authentication in distance education: A primer for distance learning administrators. *Continuing Higher Education Review, 73*, 143-152.

Adkins, J., & Kenkel, C., & Lim, C. (2005). Deterrents to online academic dishonesty. *International Journal of Learning in Higher Education, 1*, 17-22.

Alruwais, N., Wills, G., & Wald, M. (2018). Advantages and challenges of using e-assessment. *International Journal of Information and Education Technology, 8*(1), 34-37.

Aparicio, M., Bacao, F., & Oliveira, T. (2016). Cultural impacts on e-learning systems' success. *The Internet and Higher Education, 31*, 58-70.

Appiah, M., Van Tonder, F. (2018). E-Assessment in higher education: A review. *International Journal of Business Management and Economic Research(IJBMER), 9*(6), 1454-1460.

Bahar, M., & Asil, M. (2018). Attitude towards e-assessment: Influence of gender, computer usage and level of education. *Open Learning: The Journal of Open, Distance and e-Learning, 33*(3), 221-237.

Bailie, J. L., & Jortberg, M. A. (2009). Online learner authentication: Verifying the identity of online users. *MERLOT Journal of Online Learning and Teaching, 5*(2), 197-207.

Brink, R., & Lautenbach, G. (2011). Electronic assessment in higher education. *Educational Studies, 37*(5), 503–512.

Carless, D. (2005). Prospects for the implementation of assessment for learning. *Assessment in Education: Principles, Policy & Practice, 12*(1), 39-54.

Crisp, G. (2011). *Teacher's handbook on e-assessment*. Sydney: Transforming Assessment.

Dermo, J. (2009). E-assessment and the student learning experience: A survey of student perceptions of e-assessment. *British Journal of Educational Technology*, *40*(2), 203–214.

Draaijer, S., Jefferies, A., & Somers, G. (2017). Online proctoring for remote examination: A state of play in higher education in the EU. *Proceedings of the International Technology Enhanced Assessment Conference (TEA 2017)*, 96-108. Retrieved from https://link.springer.com/chapter/10.1007/978-3-319-97807-9_8

Ferrão, M. (2010). E-assessment within the Bologna paradigm: evidence from Portugal. *Assessment & Evaluation in Higher Education*, *35*(7), 819–830.

Fluck, A., Pullen, D., & Harper, C. (2009). Case Study of a Computer Based Examination System. *Australasian Journal of Educational Technology, 25*(4), 509-523.

Guardia, L. (2016). Overcoming the challenges of e-assessments in 5 simple steps. *E-learning Design and Development*. Retrieved from https://elearningindustry.com/challenges-of-eassessments-5-steps

Guitart-Hormigo I., Rodríguez M.E., & Baró X. (2020). Design and implementation of dashboards to support teachers decision-making process in e-assessment systems. In D. Baneres, M.E. Rodríguez & A.E. Guerrero-Roldán (Eds.), *Engineering data-driven adaptive trust-based e-assessment systems: Challenges and infrastructure solutions* (pp. 109-132). Cham, Switzerland: Springer.

Halgamuge, M. (2017) The use and analysis of anti-plagiarism software: Turnitin tool for formative assessment and feedback. *Computer Applications in Engineering Education, 25*(6), 895-909.

Hettiarachchi, E., Huertas, M. A., & Mor, E. (2015). E-assessment system for skill and knowledge assessment in computer engineering education. *International Journal of Engineering Education, 31*(2), 529-540.

Hillier, M. (2014). The very idea of e-exams: Student (pre) conceptions. *Proceedings of the Australasian Society for Computers in Learning in Tertiary Education Conference*, 77–88. Retrieved from https://www.researchgate.net/publication/269105287_The_Very_Idea_of_e-Exams_Student_Preconceptions

Husband, R. (2017). Implementing e-tools for assessment. *Journal of Initial Teacher Inquiry, 3*(1), 98-101.

JISC (2007). Effective practice with e-assessment: *An overview of technologies, policies and practices in further and higher education.* Retrieved from https://webarchive.nationalarchives.gov.uk/20140702223032/http://www.jisc.ac.uk/media/documents/themes/elearning/effpraceassess.pdf

JISC (2016). *Technology and tools for online learning.* Retrieved from https://www.jisc.ac.uk/guides/technology-and-tools-for-online-learning

JISC (2018). *Effective assessment in a digital age: A guide to technology-enhanced assessment and feedback.* Retrieved from www.jisc.ac.uk/digiassess

Jones, C. A. (2005). *Assessment for Learning*. Learning and Skills Development Agency: London, UK.

Knuth, M. (2016). D5.3 – Instruments technical description and development scheduling. TeSLA adaptive trust-based e-assessment. Retrieved from http://tesla-project.eu/wp-content/uploads/2017/06/D5.3-Instruments-technical-description-and-developmenet-scheduling.pdf

Lee-Post, A., & Hapke, H. (2017). Online learning integrity approaches: Current practices and future solutions. *Online Learning*, *21*(1), 135–145.

Levy, Y., & Ramim, M. M. (2007). A theoretical approach for biometrics authentication of e-exams. 93-101. Retrieved from URL: http://telem-pub.openu.ac.il/users/chais/2007/morning_1/M1_6.pdfA.A.

McCabe, D. (2016). Cheating and honor: Lessons from a long-term research project. In T. Bretag (Ed.), *Handbook of academic integrity* (pp. 187–198). Australia: Springer Reference.

McNabb, L. (2010). An update on student authentication: Implementation in context. *Continuing Higher Education Review, 74*(1), 43-52.

Mellar, H., Peytcheva-Forsyth, R., Kocdar, S., Karadeniz, A., & Yovkova, B. (2018). Addressing cheating in e-assessment using student authentication and authorship checking systems: Teachers' perspectives. *International Journal for Educational Integrity, 14*(2).

Obeidallah, R., Al Ahmad, A., Farouq, F., & Awad, S. (2015). Students authentication in e-assessment sessions: A theoretical biometric model for smartphone devices. *International Journal of Business Information Systems, 19*(4), 450-464.

Okada, A., Whitelock, D., Holmes, W., & Edwards, C. (2018). e-Authentication for online assessment: A mixed-method study. *British Journal of Educational Technology, 50*(2), 861-875.

Okada, A., Noguera, I., Alexieva, L., Rozeva, A., Kocdar, S., Brouns, F., Ladonlahti, T., Whitelock, D., & Guerrero-Roldán, A.E. (2019). Pedagogical approaches for e-assessment with authentication and authorship verification in higher education. *British Journal of Educational Technology, 50*(6), 3264–3282.

Peytcheva-Forsyth, R., & Aleksieva, L. (2019). Students' authentication and authorship checking system as a factor affecting students' trust in online assessment. *Proceedings of the 13th annual International Technology, Education and Development Conference (INTED 2019)*. doi: 10.21125/inted.2019.0531

Peytcheva-Forsyth R., & Mellar H. (2020). Design and execution of large-scale pilots. In D. Baneres, M.E. Rodríguez & A.E. Guerrero-Roldán (Eds.), *Engineering data-driven adaptive trust-based e-assessment systems: Challenges and infrastructure solutions* (pp. 159-188). Cham, Switzerland: Springer.

Peytcheva-Forsyth, R., Aleksieva,L., & B. Yovkova, (2018a). The impact of technology on cheating and plagiarism in the assessment – the teachers' and students' perspectives. *Proceedings of the AIP Conference*. https://doi.org/10.1063/1.5082055

Peytcheva-Forsyth, R., Mellar, H., & Aleksieva, L. (2019). Using a student authentication and authorship checking system as a catalyst for developing an academic integrity culture: A Bulgarian case study. *Journal of Academic Ethics, 17*, 245–269.

Peytcheva-Forsyth, R., Yovkova, B. & L. Aleksieva, (2018b). Factors Affecting Students' Attitudes Towards Online Learning - The Case of Sofia University, In: AIP Conference Proceedings 2048, 020025 (2018). https://doi.org/10.1063/1.5082043

Peytcheva-Forsyth, R.,Yovkova, B., & Aleksieva, L. (2019). The disabled and non-disabled students' views and attitudes towards e-authentication in e-assessment. *Proceedings of the 13th annual International Technology, Education and Development Conference (INTED 2019).* doi: 10.21125/inted.2019.0763

Pittam, G., Elander, J., Lusher, J., Fox, P., & Payne, N. (2009). Student beliefs and attitudes about authorial identity in academic writing. *Studies in Higher Education, 34*(2), 153-170.

QAA (2016). *Plagiarism in higher education - custom essay writing services: An exploration and next steps for the UK higher education sector.* Retrieved from http://www.qaa.ac.uk/en/Publications/Documents/Plagiarism-in-Higher-Education-2016.pdf

Rolim, C., & Isaias, P. (2019). Examining the use of e-assessment in higher education: Teachers and students' viewpoints. *British Journal of Educational Technology, 50*(4), 1785-1800.

Sorensen, E. (2013). Implementation and student perceptions of e-assessment in a Chemical Engineering module. *European Journal of Engineering Education*, *38*(2), 172–185.

Tapanes, M. A., Smith, G. G., & White, J. A. (2009). Cultural diversity in online learning: A study of the perceived effects of dissonance in levels of individualism/collectivism and tolerance of ambiguity. *The Internet and Higher Education, 12*(1), 26-34.

Tarhini, A., Hone, K., Liu, X., & Tarhini, T. (2017). Examining the moderating effect of individual-level cultural values on users' acceptance of E-learning in developing countries: A structural equation modeling of an extended technology acceptance model. *Interactive Learning Environments, 25*(3), 306-328.