Pedagogical approaches and views about e-assessment used in conjunction with e-authentication and authorship verification in Higher Education

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Abstract. Checking the identity of students and authorship of their online submissions is a major concern in Higher Education due to the increasing amount of plagiarism and cheating using the Internet. Currently various approaches to identity and authorship verification in e-assessment are being investigated. However, the literature is very limited on the effects of e-authentication systems for teaching staff because it is a novel procedure for them. A considerable gap is to understand teaching staff' views, concerns and practices regarding the use of e-authentication instruments and how they impact their trust on e-assessment. To address this gap, this study presents cross-national data from the intermediate pilot of the system on face-to-face, blended and online education teaching staff' views on e-assessment using authentication and authorship verification technology. This investigation focuses on TeSLA - *Adaptive Trust-based e-Assessment System for Learning* funded by European Commission. TeSLA combines two types of instruments to enable reliable e-assessments: biometric and textual analysis. This mixed-method study examines the opinions and concerns of 108 teaching staff. Data includes observations, pre- and post-pilot questionnaires and focus group sessions in six countries: the United Kingdom, Spain, the Netherlands, Bulgaria, Finland and Turkey. The findings revealed some technological, organisational and pedagogical issues related to accessibility, security, privacy and e-assessment design and feedback. Seven recommendations have been proposed based on the findings: technical FAQ, audit report, data security and privacy awareness, e-authentication and authorship verification policies, manual about instruments, best practices on e-assessment and course team support.

Key words: e-Authentication, authorship verification, e-assessment, pedagogical approaches, cheating detection, trust, responsible research and innovation

Practitioner Notes

What is already known about this topic

- Checking the identity of students and authorship of their online submissions is a major concern in Higher Education.
- A growing body of literature recommended the use of security mechanisms to identify students and detect illegitimate behaviours in e-assessment.
- The relation between pedagogical approaches and e-assessment used in conjunction with e-authentication is under-explored.

What this paper adds

- Teaching-learning process with the support of e-authentication and authorship verification instruments.
- E-assessment activities supported by face recognition, voice recognition, keystroke dynamics, forensic analysis and plagiarism detection.
- Seven recommendations are suggested to support teaching staff with e-assessment used in conjunction with e-authentication and authorship verification.

Implications for practice and/or policy

- Increasing the awareness of the TeSLA data security and privacy among all end-users will be important to increase the trust in the system.
- Universities must develop and share best procedures for verifying fraud supported by the system based on combined instruments.
- Universities should support course teams to plan useful activities and assessment tasks with e-authentication and authorship verification instruments.

1. Introduction

A number of researchers have investigated the benefits of e-assessment (Ferrell, 2014; Novakovich & Long, 2013; Rastgoo, Namvar, & Iran, 2010) which comprise, for instance, improved learner engagement (Ivanova et al. 2016), location and time flexibility (Mellar, 2016); instant feedback (Whitelock & Bektik, 2018), improved reliability (Noguera et al. 2018) and saving time/money (JISC, 2010). However, one of the main concerns for the adoption of e-assessment is to ensure that the person who performs the assessment is the correct claimant (authentication) and to demonstrate that the work performed is original (authorship) (Okada et al, 2015; 2018; Noguera et al. 2017). A growing body of literature has explored and recommended the use of security mechanisms to identify students and detect illegitimate behaviors in e-assessment (Harmon, Lambrinos, & Buffolino, 2010; Osman, Salim, & Abuobieda, 2012; Simon et al., 2013; Watson & Sottile, 2010). Therefore, the time is ripe to investigate at scale these types of authentication systems (Bedford et al., 2011; Ivanova et al. 2017; Kambourakis & Damopoulos, 2013; Kiennert et al, 2016).

According to European research on the impact of policies for plagiarism in Higher Education (IPPHEAE, 2013), internet usage is considered as one of the catalysts for cheating. Moreover, no simple solutions have been found to tackle this problem (Usoof et al., 2014; Bermingham et al., 2010). In order to reduce academic malpractice in online programmes, the authentication of student work through the use of digital identities has become increasingly important for universities that offer online and blended courses (Chew et al, 2015, Ardid et al, 2015). E-assessment systems are perceived as secure and appropriate when the instruments successfully identify and authenticate the examinee (Apampa, Wills & Argles, 2010; Karim & Shukur 2016; Gao, 2012). There are various types of e-authentication and authorship verification instruments, which are classified through 3 main categories (Okada et al, 2018): **(1) Knowledge** *(what you know),* which refers to students' knowledge of private information such as user ID and password; (**2) Biometrics** *(who you are)* includes two sub-categories, physical characteristics *refers to* analysis of facial expressions and voice recognition. Furthermore, behavioural patterns, refers to keystroke dynamics, based on the analysis of the rhythm and speed of typing when using the keyboard and the personal style of writing - forensic analysis;

and finally **(3) "Written text"** *(what you do)* refers to the process of checking the authorship of students' assignments based on anti-plagiarism and forensic analysis instruments, which enable teaching staff to verify the originality of students' learning outcomes.

This paper focuses on the use of these types of e-authentication and authorship instruments by seven pilot institutions involved in the EU-funded *TeSLA* project - *Adaptive Trust-based e-Assessment System for Learning* (http://tesla-project.eu). Over 5,000 students participated in the pilot during the spring semester of the 2016-2017 academic year. The aim of this pilot was to test the *TeSLA* system which consists of the following combination of student authentication and authorship instruments. Those instruments based on biometrics are used to authenticate students while the instruments that analyse text serve for verifying the authorship. The Forensic Analysis instrument can also be used for authentication purposes. The instruments are described in detail below.

- Biometrics:
    - Facial Recognition (FR): analyses the face and facial expressions.
    - Voice Recognition (VR): analyses voice structures.
    - Keystroke Dynamics (KD): analyses the rhythm and speed of typing when using the keyboard
- Textual analysis:
    - Plagiarism detection (PL): detects similarities between documents using text matching.
    - Forensic Analysis (FA): analyses the personal writing style by detecting similarities among written documents submitted by each student.

The approach adopted for this study is that of Responsible Research and Innovation (RRI), which implies that teachers, researchers, technologists and students interact during the whole process of research and innovation to better align both its process and results with the values, expectations and needs of society (EC, 2017). Society and innovators through RRI become mutually responsive to each other with a view about the ethical acceptability, societal desirability and sustainability of the innovation process (Von Schomberg, 2011). This RRI work examines teaching staff perceptions of e-assessment with e-authentication. It analyses teaching staff concerns and practices with assessment activities combined with e-authentication of students' identity and authorship verification, including students with Special Educational Needs and Disabilities (SEND). Such findings will be of interest for higher education institutions, course developers, pedagogical teams and policy makers.

2. Opportunities afforded by technology enhanced assessment

A recent research review (Timmis et al., 2015) presents seven features of technology enhanced assessment (TEA) approaches. It highlights the critical role of technology enhanced assessment, which offers many potentially creative opportunities for innovation and for rethinking assessment purposes. Digital media provide students with new opportunities for representing knowledge and skills. Students can benefit from new ways to record achievement, such as, open badges and awards from gaming environments (Law, 2016). However, there are also various concerns, such as ethical issues and the implications for data protection and ownership of making, mixing and publishing media online and consent about how such data should be collected, used and stored. Another issue is social exclusion, for example, students might not feel comfortable with the assessment environment when they do not feel safe enough in case of failure and overly concerned with the consequences.

There is a lack of literature related to pedagogical recommendations for e-assessment with instruments for e-authentication and authorship verification. In the TeSLA project, the process of integrating these instruments starts at the course design stage (Figure 1).

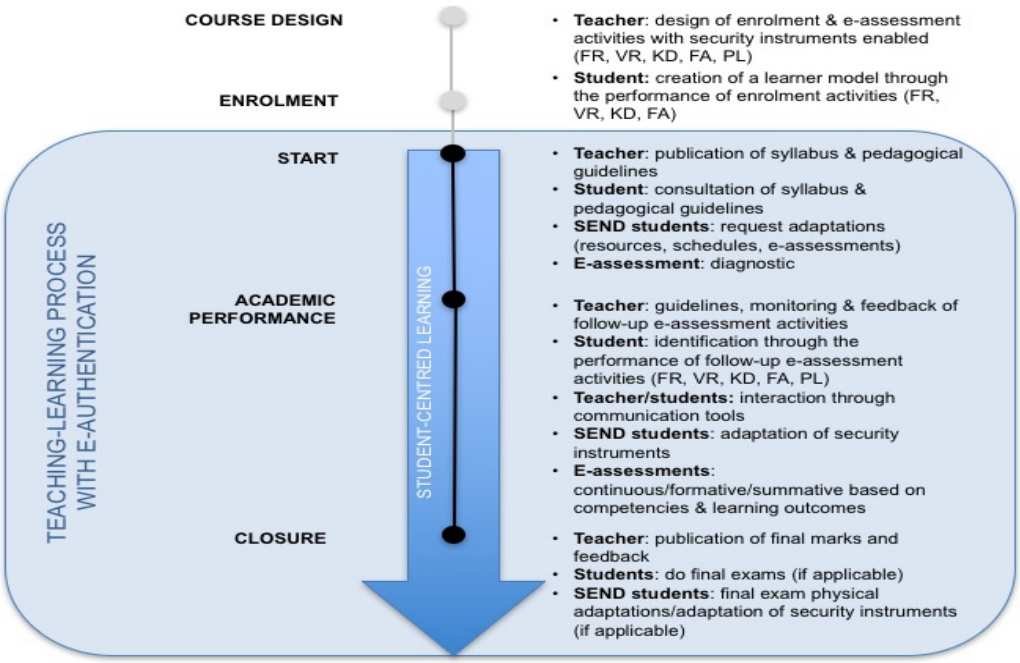

Figure 1. Teaching-learning process with the support of e-authentication and authoring instruments

The teacher redesigns, or creates new e-assessment activities, where the security instruments are enabled. Two types of activities are necessary: enrolment and real. The *enrolment activities* are used to create a learner model (a biometric model) that is later used as a reference for user authentication in subsequent real activities. They are activities with non-grading purpose that serve for user registration. The *real e-assessment activities* aim to authenticate students and validate the authorship of their work and may have grading purpose. The enrolment activities are activated at the beginning of the course and previous to the performance of the real e-assessment activities. Once the enrolment activities are completed, during the academic performance process, students perform several real e-assessment activities.

The most widespread classification of learning activities is Bloom's taxonomy which differentiates between knowledge, comprehension, application, analysis, synthesis and evaluation skills (Bloom et al. 1956). Several authors have redefined these categories by incorporating new activities and tools related to digital resources (Churches, 2008; Conole, 2008; Carrington, 2016; Schrock, 2013). The specific classifications regarding e-assessment activities include questions (e.g. closed, open, multiple-choice, matching, ordering), e-portfolios, essays, online discussions, concept maps, personal response systems, badging, online role playing or scenario-based activities (Stödberg, 2012; Guàrdia, Crisp, & Alsina, 2017; Trumbull & Lash, 2013). A recent study proposes a new classification of e-assessment activities organised into five competences: 1) ability to search for, process and analyse information, 2) ability to apply acquired knowledge, 3) ability to use language to communicate successfully, 4) ability to create learning products in diverse formats, and 5) ability to apply knowledge in real or simulated scenarios (Guerrero-Roldán & Noguera, 2018). Following the approach of classifying the activities based on the abilities they help to develop, in the context of the TeSLA project, e-assessment activities are organized into three categories related to what types of skills are being tested:

1. **Selection**: students select an answer (e.g. a correct answer from a list, a match or an adequate next step in a procedure).

2. **Creation:** students create an answer or product (e.g. an answer to an open question, a report, a table or an image).
3. **Performance:** students perform/enact/demonstrate attainment of learning outcomes (e.g. giving a presentation, taking part in a role-play, game or simulation, carrying out a laboratory practical or an internship).

These activities can be delivered in various formats. For instance, a text may be typed or generated using speech to text software, a performance may be delivered 'real-time' or submitted as a video and/or voice recording.

3. Methodology

The TeSLA system is being designed and refined following a cyclical process of improvement based on the data collected from three large scale pilots. This paper focuses on the experience and data gathered from the second pilot that took place between February and June 2017 within the context of seven universities (including face-to-face, blended and online modes of delivery) in six countries. These universities were: Anadolu University (AU) in Turkey, University of Jyväskylä (JYU) in Finland, Open University of the Netherlands (OUNL), The Open University of United Kingdom (OU-UK), Sofia University (SU) and Technical University of Sofia (TUS) both in Bulgaria and the Open University of Catalunya (UOC). This study aimed to check the efficacy of the TeSLA instruments while gathering feedback from users about their experiences.

To understand the various affordances and issues raised above and to contribute to the refinement of the TeSLA e-authentication and authoring instruments, we investigated teaching staff' views about the TeSLA system with respect to the following research questions:

- (RQ1) What are the pedagogical approaches used for implementing the TeSLA e-authentication and authoring instruments for e-assessment?
- (RQ2) What are the teaching staff opinions about the use of the TeSLA e-authentication and authoring instruments for e-assessment?
- (RQ3) What are the teaching staff recommendations for the use of the TeSLA instruments with students?

3.1 Context and participants

The participants in this study were teaching staff of undergraduate and postgraduate courses from a range of fields of study. The following Table (Table 1) illustrates the characteristics of a total of 113 courses participating in the pilot from the seven pilot institutions.

Table 1. Characteristics of the courses participating in the pilot.

Characteristics	Values	%
Mode of delivery	Blended	48%
	Online and distance	52%
Language of the course	Bulgarian	15%
	Catalan and Spanish	14%
	English	28%
	Finnish	19%
	Turkish	20%
Course level	Continuing Professional Development (CPD)	1%
	Post-graduate	11%
	Undergraduate	71%
	Undergraduate & CPD	16%
	Other or missing	1%
Field of study	Arts and Humanities	10%
	Social and Legal Sciences	66%
	Sciences	6%
	Health Sciences	2%

	Engineering and Architecture	15%
	Other or missing	1%

All TeSLA instruments (FR, VR, KD, FA, PL) were tested in the pilot institutions, depending on their assessment contexts and feasibility of use. The table (Table 2) illustrate the distribution of students who tested each instrument.

Table 2. Distribution of students that tested each instrument per pilot institution.

Instrument	AU	JYU	OUNL	OUUK	SU	TUS	UOC	**Total**
Face Recognition	1443	10	14	0	262	402	503	**2634**
Voice Recognition	175	10	8	0	63	200	437	**893**
Keystroke dynamics	191	87	7	382	61	249	500	**1095**
Forensic Analysis	72	103	32	0	125	47	486	**865**
Plagiarism instrument	70	80	132	266	125	89	455	**951**
Overall number of unique students per institution	1951	280	159	648	505	506	882	**4931**

3.2 The procedures for data collection

Participants were asked to complete the following steps during the course of the TeSLA pilot:

- **Course design:** design and implement an e-assessment with instruments for students. For instance, involved typing or choosing answers in quizzes or online text submissions (FA, KD and PL), performing a presentation (FR, VR), creating artefacts (FR, VR, KD, FA & PL) or uploading documents in assignment (PL, FA).
- **Enrollment:** provide guidelines for students to create a baseline for the instruments used during the real e-assessment activities. This procedure provides initial data for the system to compare against during the e-authentication and authorship checking.
- **Pre-questionnaire:** complete a 20-question questionnaire about their demographics, views about plagiarism and cheating, their opinions about e-authentication and authorship checking instruments, data security, data privacy and trust.
- **Post-questionnaire:** complete a 15-question post-questionnaire about their experience with the *TeSLA* system after using it with students, with similar questions of the pre-questionnaire.
- **Focus group:** attend 40 minutes session online or face-to-face to provide detailed views.

The key roles assumed by teaching staff who acted as the primary contact point of students were to:

- Incorporate the enrolment activities into the course plan.
- (Re)design the real activities to test the TeSLA instruments.
- Ensure enrolment activities were carried out by the overall target of students set for this pilot (a total of 3,500). The target was met and exceeded, since 4,931 students was the final total.
- Ensure assessment activities were carried out and data were captured. A total of 4622 students (not unique) tested biometric instruments (FR, VR, KD) and 1,816 tested the textual analysis instruments (FA and PL).
- Direct technical queries to the appropriate help resources, including technical team.
- Direct other project queries from students to the evaluation coordinator or pilot leader.

One representative from each pilot institution was in regular communication with teaching staff, to support them and gather data about the courses and the pilot progress recorded in an online database.

A total of 108 teaching staff participated as volunteer participants in the TeSLA pilot study. Considering the total sample of participants, there was a reasonable response rate of 84% of respondents (N=78) who answered the pre-pilot questionnaire (Table 3) and 45% of them (N=42) completed the post-pilot questionnaire. This final questionnaire included a question for willingness to participate in the focus group. From these, 35 interviewees participated in the focus group sessions organised by the 7 pilot countries (Table 4).

Table 3. Teaching staff demographics from respondents to pre-pilot questionnaire (N=78).

Items	Values	N	%
Gender	Prefer not to say	3	4%
	Female	45	58%
	Male	30	38%
Age	Prefer not to say	2	3%
	30 or under	0	0%
	From 31 to 40 years old	25	32%
	From 41 to 50 years old	33	42%
	51 years or over	18	23%
Occupation	Course designer	37	47%
	Students' assessor	31	40%
	Course instructor	69	88%
	Other	2	3%

Table 4. Teaching staff participants in focus groups (N=35).

	AU	JYU	OUNL	OUUK	SU	TUS	UOC
Total	4	5	4	4	7	7	4
Female	2	4	2	2	3	5	2
Male	2	1	2	2	4	3	2
Course designer	1	5	4	2	6	8	3
Course Instructor	2	5	4	3	6	8	1
Students Assessor	0	5	4	3	6	8	0
other	1	0	0	0	1	0	0

3.3 Data Analysis

In order to develop a unified approach to planning, implementing and reporting the outcome of the focus group sessions across seven countries, co-authors developed the focus group guidance and a template to support cross-national data analysis of qualitative data from the interviewees and quantitative data from questionnaires' respondents as well.

A deductive approach was implemented for data analysis. The research questions were used to group the data and detect the main findings. Questionnaires' results were analysed based on the number of respondents and presented as a percentage.

The cross-national template was developed based on a common and flexible system of categories grouped into 3 sets that emerged from the data analysis (Figure 2). The three sets were Technical, Organizational and Pedagogical categories, comprised of 8 themes (system interface, TeSLA instruments, real-time feedback, usability, accessibility, security and privacy, fraud detection; and, pedagogy and assessment).

RECOMMENDATIONS

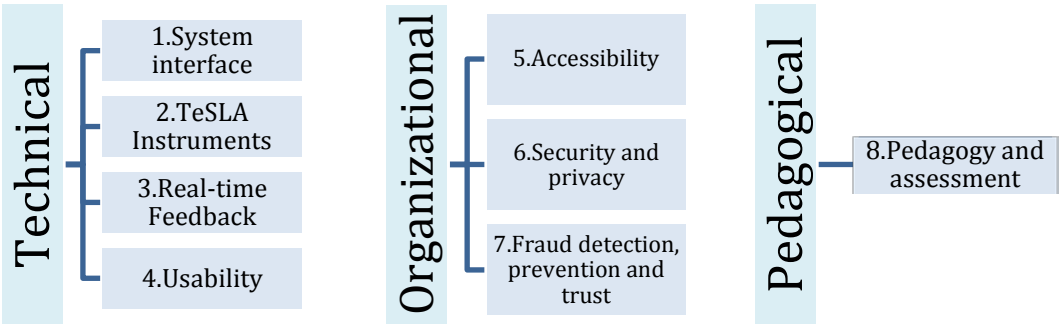

Figure 2. Categories for data analysis of e-assessment with e-authentication instruments

4. Findings

4.1 (RQ1) Pedagogical approaches for teaching staff interested in TeSLA

The underlying TeSLA Educational Assessment Model describes an 'Assessment' as "an assembly of one or more 'Activities' designed to measure 'Learning Outcomes' with the aim to establish (collect evidence of) a person's competences (cognitive and non-cognitive traits) at a particular moment in time". (Janssen, Guerrero-Roldán, Hermans, & Noguera, 2018). The response to an activity ('Activity Response') can be of various kinds (i.e. the learner has to select, create or perform). An Assessor applies "Assessment Criterion" defined in connection with an activity to the Activity Response of a Learner or a group of learners. The response format comprises: mouse click, text, sound, image or programming code. The Assessor determines the Result (e.g. mark, feedback).

Based on the literature and the scenarios where the TeSLA instruments have been integrated within the pilot, Table 5 presents a set of e-assessment activities that can be used for e-assessment.

These activities were grouped according to the Bloom revised taxonomy (Krathwohl, 2002) and indicates the five instruments to support the design of assessment activities using e-authentication. These were grouped in the 3 categories previously explained (Figure 1)

To answer the first research question about pedagogical approaches used for e-assessment with e-authentication, data collected from universities about the e-assessment activities descriptions using the online database were categorised based on TeSLA practical categories used with teaching staff, Bloom's revised taxonomy, online activities and the five TeSLA instruments (Table 5).

TeSLA	Bloom taxonomy	Online activities	FR	VR	KD	FA	PL
Selection	Recall facts, concepts	Complete quiz-based exams	✓				
		Complete questionnaires with multiple choice and students can use voice	✓	✓			
Performance	Understand, explain ideas or meanings	Complete questionnaire with open questions (250 characters)	✓		✓	✓	✓
		Participate in a discussion forum, blog notes, or learning diary	✓		✓	✓	✓
		Participate in a web conference with a discussion chat	✓	✓	✓		
	Apply, use knowledge in new	Give an oral presentation	✓	✓			

	situations or for inquiry-based learning or problem solving	Participate in a game or simulation task (with voice)	✓	✓			
		Take part in a role-play (with voice)	✓	✓			
	Analyse (compare, connect ideas), evaluate (justify decisions)	Carry out a practice in a laboratory (with voice explanation)	✓	✓			
		Execute data analysis using Excel or software (with voice explanation)	✓	✓			
		Solve mathematical problems (using text and/or voice explanation)	✓	✓	✓		
Creation	Create Produce original work	Development of a multimedia presentation or video clip (with voice slides)	✓	✓			
		Elaborate a poster or infographic about a research topic (with voice)	✓	✓			
		Develop programming code	✓		✓		
		Elaborate academic paper (essay) or report about a research theme or final written assignment	✓		✓	✓	✓

Table 5. Potential E-assessment activities in conjunction with face recognition, voice recognition, keystroke dynamics, forensic analysis and plagiarism detection

Altogether a full range of pedagogical activities linked to Bloom's taxonomy could be tested with the TeSLA instruments but not all authentication tools could test all the tasks. Careful selection was required.

Table 6 presents the practical considerations in order to instantiate the pedagogical framework about the respective activities where the TeSLA instruments were tested. This information was gathered through the online database and refers to teaching staff who participated in this study.

Table 6. Practical considerations where the TeSLA instruments were tested (N=108)

Characteristics	Values	%
Assessment purpose	Formative	62%
	Summative	23%
	Diagnostic	4%
	Other or missing	10%
Location	At home	85%
	At university	15%
Monitoring	Supervised	15%
	Unsupervised	85%
Individual or collaborative work	Individual	93%
	Collaborative	6%
	Individual and Collaborative	1%
Response type	Select answer	17%
	Create answer or product	73%
	Perform/enact/demonstrate	10%
Response format	Mouse click	14%
	Text	61%
	Sound (oral input)	8%
	Image (picture, video)	17%
	Programming code	0%

In general, the e-assessment activities where the TeSLA instruments have been tested represent a balanced sample in terms of assessment purposes. In terms of context, e-assessment was used for formative purposes (62%) summative (23%) and diagnostic (4%). The majority of them have been designed to be conducted at home (85%), in an unsupervised way (85%) and

individually (93%). The response type most used has been the creation of an answer or product (73%) in text format (61%).
The common e-assessment scenarios among the institutional partners were: create an answer or product (73%) select an answer (17%) and perform/enact/demonstrate (10%). The type of response format provided by students were text (61%), image (17%), mouse click (14%) and then sound (8%).

4.2 (RQ2) Teaching staff opinions about the use of the TeSLA.

Data from the teaching staff post-questionnaire show that the majority of partner universities staff considered e-authentication relevant and agreed that "their university is working to ensure the quality of the assessment process" (AU, JYU, SU and TUS 100%, UOC 91% and OUUK 75%). They also "trust an assessment system in which all assessment occurs online" (JYU 100%, SU 83%, AU and OUUK 75%, UOC 69% and TUS 50%).
In addition, data from respondents indicated that the main advantages of e-assessment with e-authentication based on educators' views were:

1. "To save time in commuting" (all institutions: 50%-100%).
2. "To prove originality of the students' work" (SU: 83%, OUUK: 75%, JYU: 60%, AU: 50%, TUS: 50%).
3. "To avoid face-to-face assessment" (SU: 67%, UOC: 66%, AU: 50%).
4. "To better adapt assessment to students' needs" (OUUK: 75%, AU: 50%).

Based on the pre-pilot questionnaire data, most of staff members from the universities confirmed that students occasionally cheat in their courses (OUUK: 75%, UOC: 56% , JYU: 56%, OUNL: 50% and SU: 50%). The majority of respondents agreed (more than 90% from all universities) that "It is cheating if a student copy/pastes information from a website in a work developed by the student without citing the original source". However, these respondents mentioned that were "not so sure about students who plagiarise when they work together and submit similar work" (SU: 50%, TUS: 43%, UOC: 26%). They also confirmed that "There are clear and specific rules to follow at their institution to deal with cheating", for example, AU (99%), UOC (93%), JYU (89%), OUUK (75%), TUS (71%), SU (50%), OUNL (50%).
However, a significant number of respondents (more than 50%) found that the key disadvantages of e-assessment were:

- "Work overload in performing the assessment activities" (OUUK: 75%, SU: 67%, UOC: 44%).
- "To spend time in learning to use new technologies" (OUUK: 75%, JYU: 60%, AU: 50%).
- "Time overload in assessing the activities", particularly (AU: 50%).

In addition, data about respondents' views also confirmed a few issues about security and privacy, such as students' resistance in sharing personal data. For example:

- "*Some students were very critical about sharing this kind of personal data"*. JYU
- "*Some students, who used face recognition tool, were asking about who will watch their videos and what the aim of it is*". SU
- "*Some students complained about privacy. One student left the pilot due to the amount and use of personal data collected*". UOC
- "*Some students asked various questions about data privacy and security by email*". OUUK

4.3 (RQ3) Teaching staff recommendations about the use of the TeSLA.

Table 7 presents the summary of thematic data analysis of the interviewees' technical needs, organisational views and pedagogical issues and recommendations. These categories are linked

to the 8 themes (Figure 1) used to identify various indicators that emerged from the data which are synthesized with snapshots.

Table 7. Summary of findings related to pedagogy (themes, indicators and snapshots)

Categories	Themes	Indicators	Snapshots
[I]Technical needs	1.System Interface	Guidance	*More guidance from the system to combine instruments and analyse outcomes*
	2.TeSLA Instruments	Familiarity	*Knowledge about the instruments (including technical requirements) early to plan activities*
	3.Feedback	Audit Report	*Audit Reports that can be accessed quickly after the activity including results about the enrolment completion and the instruments' outcomes*
	4.Usability	New devices	*More flexible options for mobile devices*
[II]Organisational issues	5.Accessibility	Inclusive tasks	*Adapting different instruments and tasks according to their needs for students with Special Educational Needs and Disabilities (SEND)*
		SEND assistance	*Some SEND students had difficulties with the system based on their disability*
	6.Security Privacy	Flexibility of e-assessment	*TeSLA might support the shift from human invigilated exams to system invigilated exams*
		Privacy concerns	*Various students felt comfortable by sharing their data but some of them had concerns about their privacy and data security*
	7.Fraud prevention Trust	Cheating prevention	*An opportunity to limit cheating in the university education*
		Fair assessment and accreditation	*Convenience and "fair assessment and accreditation of students based on their merits"*
		Reliable system	*Reliable system will increase the confidence of the institution*
[III]Pedagogical aspects	8.Assessment Pedagogy	Course design changes	*Change in course design required to use TeSLA effectively*
		New types of e-assessment	*Opportunities of "new kinds of assessments"*
		Variety and regularity	*More open-ended questions, and variety of types of assessment needed*

All partners mentioned that the TeSLA system had improved, and the instruments were well received by the students.

In terms of technical needs, most of interviewees considered TeSLA easy-to-use and user-friendly system. However, they would like to obtain more **guidance** from the system to combine instruments and analyse outcomes in order to use the instruments more effectively.

> "*Teachers need to get to know the instruments early enough to be able to plan useful and meaningful activities"* (JYU). It might be more "effective when at least two instruments are combined – voice and face recognition or keystroke dynamics and face recognition" *(SU).*

The **familiarity** with instrument and more knowledge about the technical requirements will help teaching staff to support their students.

"There were students who worked with older versions of Office apps (2003) and used Internet Explorer browser, and there were many issues with them" (SU).

"In some *courses we ask students to attach charts and images, I'm not sure if the authorship can be checked in such cases" (UOC).*

Interviewees mentioned that they would like also **reports** that can be accessed quickly after the activity is completed, however, feedback should be simple with information to help them make decisions. They would like to be notified when:

"Are several faces detected in the camera frame?" (TUS).

"Cases where the same person performs differently in the enrolment and in other activities. For example, is the keystroke rhythm different? Is the writing style different?" (UOC).

"*when the system does not recognise a student? (OUUK).*

Interviewees also mentioned about **mobile devices**. They won't recommend taking an assessment using mobile phones because the screen is very small. However, if TeSLA can work in mobile devices they think that this would be very useful for students, particularly because

"*Students use their voice, camera and fingerprint authentication frequently on their mobile phone*" (OUUK).

In terms of organisational views, some interviewees presented positive comments related to the system that enabled **inclusive** e-assessment **tasks** for *special educational needs and disabilities* students (SEND).

"I felt a little bit intimidated showing my face and been recorded. However, in my case [it's a SEND student] this system will be very helpful for adapting the assessment to my needs" (UOC).

"*Students can use other programs and browsers/tabs on their computer while completing the exam, their actions during the assessment are not observed*" (SU).

Whereas others also shared a few concerns related to accessibility. For example, e-assessment with e-authentication will require technical **assistance** and more alternatives for SEND as described below.

"*Low fine motor students had problems with keystroke dynamics" (OUUK)* and "*Students with dyslexia who stammer were not comfortable with voice recognition" (SU).*

Interviewees also commented about security and privacy. TeSLA enables **flexibility** of e-assessment "*A person can shift comfortably from the human-managed exams to the system-managed exams*" (AU). They mentioned that "*most of the students did not point privacy issues as they participated in the pilot on a voluntary basis***"** (UOC). However, some educators mentioned that "*There were some students who did not want to share their information*" (AU). They also expressed that "*Students are nowadays more aware of the* ***privacy and security issues*** *than earlier, and that they can and will question these matters*" (JYU).

"Our students found positive to be informed about Data Protection including consent form, but some of them presented various questions, such as: what data is sent when TeSLA is active? How is the data sent? What protocol is used? Is the data transmission secure? (Is the data sent encrypted using a reasonably secure key?) what is visible to the Open University? Will they be forced to use this regardless of their data privacy and security concerns?" (OUUK).

Their comments related to fraud, prevention and trust, revealed their views in terms of **cheating prevention** they consider that "*e-authentication will increase the trustworthiness of e-learning however fraud would still be possible*" (SU), and **fair assessment and accreditation** "*teachers considered that the system will make students feel more secure for those students that do not cheat*" (UOC). Interviewees perceived TeSLA as "***reliable*** *system that fits to*

contemporary living and recent trends in higher education." (SU), which "*will increase the confidence of the institution*" (TUS). Teachers see that *"there is a lot of possibilities with the use of TeSLA, especially if it provides reliable results"* (OUNL).

In terms of pedagogical issues, interviewees mentioned that e-authentication requires some **changes** about existent course design, for example, "*more open-ended questions OUNL"* Interviewees considered that TeSLA system will increase the opportunities of "***new kinds of assessments***" (JYU). For that, it will be necessary **variety and regularity,** that means, "*variety of types of assessment*" (AU) and "regular assessment *that creates extra chances to demonstrate what has been learned and done during the course" (OUNL).*

5. Discussion and final Remarks

The teaching staff used diverse pedagogical approaches which consisted of a range of scenarios and a variety of types of e-assessment (Mellar, 2016; Crisp, 2014; 2010), which matched the authentication tools chosen (Noguera et al, 2017). All instruments opened up new types of both formative and summative assessments (Trumbull & Lash, 2013; Whitelock, 2011). Nevertheless, the response type and response format constituted the basis for the selection of instruments. Depending on the response type of e-assessment activity (Janssen et al. 2018), some instruments appeared to be more suitable than others. The revised Bloom's taxonomy (Bloom et al., 1956) has assisted with the description and communication of adapted pedagogical activities for e-assessment with e-authentication.

The approach adopted by all the partners when using the TeSLA instruments was a student centred one (ESG, 2015; Baneres et al., 2016). The assessments were designed to allow the students to reveal their skills and understanding of the different knowledge domains to the best of their abilities. The teachers also wanted to increase the students' trust in the various authentication tools and the system as a whole. This is because the consent forms complied with EU regulations (EC, 2012; EMHE, 2012) and were communicated as simply as possible so that students could understand that their personal data was protected and any information from their TeSLA usage would be applied within their own University's Policy & Procedures if cheating was detected.

Partners described a positive acceptance of TeSLA instruments across different course teams, instructors and students. They also mentioned a few issues that might increase the trust in the system and instruments. Pilot coordinators play an important role to communicate needs and technical issues to the technology developers and keep course teams and students – including SEND students – well informed and supported on security and privacy as well as on fraud detection (QAA, 2016), prevention and trust (Okada et al., 2018; Mellar et. al., 2018; Park 2004). For that seven recommendations are suggested to support teaching staff with e-assessment with e-authentication and authorship checking in terms of:

Technical needs:

- (1) **Technical FAQ** that provides information about the system will be useful for teaching staff to avoid or deal with problems faced by them or their students.
- (2) Prompt **audit report** about the results of each instrument with guidelines for the university staff will be helpful for them to check and interpret results and ensure the quality of the e-assessment.

Organisational issues:

- (3) **Data security and privacy awareness** for teaching staff and students will be useful through more information about the e-authentication and authorship verification instruments to promote trust in the system.
- (4) Universities must develop and share **e-authentication and authorship verification policies** for verifying and dealing with fraud. This should include legal and ethical

recommendations to deal with problems and measures to prevent academic malpractices and for quality assurance.

- (5) Local guidelines such as a **manual about the instruments** with instructions should include information on data protection and privacy; and fraud detection and prevention.

Pedagogical aspects:

- (6) Pedagogical teams must discuss and share **best practices of e-assessment** that can be combined with TeSLA instruments.
- (7) Universities should offer **course team support** for academic staff to plan useful activities and e-assessment tasks with TeSLA system.

The e-assessment activities were designed to fit the TeSLA instruments, but like any pilot technical difficulties arose and issues such as e-authentication reliability and interface improvement for SEND students, can be dealt with for the next round of testing. More importantly work and prompt reporting of authentication issues is required. Good academic practice in (online) teaching should recognise academic malpractice such as cheating, plagiarism and impersonation, which has become more common; so that, it should be addressed by academic staff (Pell, 2018) with technology such as the TeSLA instruments.

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