



Teacher education is a deeply pedagogical process rooted in values, ethics, and the social purpose of schooling. Globally, it sits at the core of educational quality and fairness, as research in comparative and international education demonstrates: the training of teachers directly influences students' learning chances, social inclusion, and the democratic aims of schools. Teachers are not simply transmitters of curricula, but active professionals whose convictions, reflective skills, and ability to manage the complexities of classroom life give shape and substance to the educational experience itself.

The pedagogical dimension of teacher education frames teaching as a relational, context-aware, and ethically grounded profession rather than just a set of procedural skills. From a research perspective, this demands robust research methodologies that can critically examine the complex realities of schools and inform evidence-based policies. Equally important is the connection between theory and practice, which helps to bridge the persistent gap between universities and schools.

The contributions gathered in this volume reflect the richness and diversity of experiences showcased during the ATEE Spring Conference 2024, held at the University of Bergamo from May 29 to June 1, 2024. The volume presents 70 selected papers out of more than 300 presented by researchers representing over 40 countries.

This broad spectrum of studies highlights promising directions that can inspire renewed inquiry and concrete proposals aimed at improving contemporary educational systems.

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Teacher education research in Europe: trends, challenges, practices and perspectives

May 29th – June 1st, 2024
S. Agostino, Bergamo



Edited by Nicole Bianquin and Francesco Magni





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BOOK OF PROCEEDINGS

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Let me introduce open education... Facilitating prospective teachers' understanding of open education through an ai-based tool

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Abstract

Open Educational Resources (OERs) are key to promoting access and inclusion. Despite the EU recognizing their importance for educational innovation, OER adoption remains limited. This study explores ENCORE, a tool for undergraduate and prospective teachers to foster open education by enhancing pedagogical knowledge and values. Combining AI-driven tools to retrieve relevant OERs, ENCORE supports course design addressing challenges like digitalization, climate change, and post-COVID economic recovery. Two project-based workshops on ENCORE (N=64) showed significant pre-post gains in OER knowledge and practices ($p < .001$). Moreover, the UTAUT scale findings highlight performance expectation and behavioral intention as key factors, confirming ENCORE's validity for teacher training to embrace an open educational perspective.

Keywords: open education; AI-driven tools; initial teachers' training; UTAUT; OER Knowledge.

1. Introduction

The increasingly dynamic, open, digital, and AI-mediated reality has over time radically altered the professional footprint, especially of educators (Tosato & Raffaghelli, 2011; Díez-Gutiérrez & Díaz-Nafría, 2018; Ranieri, 2019).

Today there is a growing abundance of resources also accelerated by generative artificial intelligence (GenAI), which has dramatically expanded the range of possibilities increasingly “at the fingertips” of students and educators (Williamson et al., 2020). The ongoing evolution has heightened the need for both adaptive and forward-looking approaches, which include the integration of AI-based tools (Tlili et al., 2023). While GenAI technologies unlock new opportunities, they also call for a critical examination of their implications on both human and educational levels. In this context, educators are urged to revisit their practices and core priorities in order to design interventions that are technologically innovative, environmentally sustainable, and socially resilient (REF). In parallel, the evolving digital landscape reinforces the relevance of openness as a guiding principle. We are immersed in an “open” reality (“The Open Definition,” 2024), characterized by the freedom to access, use, modify and share knowledge without restriction. This is an important consideration especially when discussing scientific processes in which knowledge is produced through data collection, analysis, publication, critique and reuse (Molloy, 2011). The theme of openness especially of education, in terms of a knowledge-sharing process based on advances in educational technologies, was foreseen as early as a decade ago as an opportunity to make better use of existing educational resources, to develop more inclusive educational models, and to facilitate lifelong learning. In the ensuing decades, government attention on open education has remained steadfast and focused as crucial to modernizing educational provision, reducing barriers to accessing quality education, and bridging the gap between nonformal and formal education (European Commission, 9th January 2025).

Central for the concept of open education are the OER, or Open Educational Resources. OERs are educational materials made freely available online under Creative Commons (CC) licenses, enabling users to retain, reuse, revise, remix, and redistribute these resources (Wiley & Hilton, 2018). This concept, established during UNESCO's 2002 Forum on Open Courseware, aims to democratize access to knowledge and empower learners globally (UNESCO, 2002, 2011). In recent years, the rise of archives of learning objects has provided teachers with a vast wealth of information and the ability to personalize interactions with students, without losing sight of the demands of an ever-changing technological landscape (Inamorato Dos Santos et al., 2016). Initially seen as tools for broader accessibility, OERs go beyond materials by evolving to embody the philosophy of Open Education. They move from resource sharing to the integration of open educational practices (OEPs) that modernize and democratize learning environments (Ossiannilsson et al., 2020). However, this transition to OEPs remains a process that requires careful consideration and reflection (Ossiannilsson, 2020).

1.1 ENCORE Promoting AI-human Collaboration in Education

Despite these challenges, the role of teachers remains crucial for the quality of education and student learning (Darling-Hammond et al., 2005, 2017). The need to improve the quality of teacher training, both initial and in-service, is internationally recognized as a priority in educational policies (OECD, 2005, 2019) and European strategies (European Council, 2009, 2014, 2017, 2020).

In this context, teachers' skills must be continuously updated, particularly in a rapidly changing context. This is especially relevant in terms of accessing available materials, selecting and adopting high-quality resources. From this perspective, the ENCORE (ENriching Circular use of OeR for Education) Project emerges (<https://project-encore.eu/>). This Project was funded by the European Union and launched in 2022 by the University of Pisa as Project Coordinator. ENCORE undertakes to offer itself as a support for finding high-quality Open Educational Resources (OERs), classified according to the ESCO taxonomy (European Skills, Competences, Qualifications, and Occupations), providing clear references for educational planning.

ENCORE aligns with three key competency frameworks to address the challenges of digitalization, the green transition, and an inclusive society:

- Digital Competencies (DigComp): Fostering the skills needed to thrive in a technologically advanced society, addressing emerging themes such as AI, virtual reality, and sustainability;
- Entrepreneurial Competencies (EntreComp): Promoting entrepreneurial value creation and inclusive learning through formal and informal contexts;
- Green Competencies (GreenComp): Integrating sustainability education to develop systemic and ethical thinkers, in line with the EU's climate neutrality goals.

Through this combination, the ENCORE project aims to guide students, prospective educators, educators, teachers and trainers in designing courses/paths that connect learning objectives with the skills needed to tackle global challenges such as digitalization, climate change, and post-pandemic economic recovery (Raffaghelli et al., 2023).

The ENCORE system envisions being embedded into educators' practices and institutional life as a tool to be experimented with, commented on, and critiqued through cycles of reflection and meaning-making. This approach resonates with the concept of "design for learning" (Conole, 2013; Raffaghelli, 2014), which starts from ill-defined solutions and fosters the exploration and situated adoption of technologies.

The approach arises from the need for a situated and negotiated adoption of technologies, focusing on solving problems detected by the users themselves rather than imposed from outside.

2. Methods

2.1 Research Questions

The study aims to investigate whether the intervention with ENCORE changed in any way 1) the level of knowledge and awareness about OERs and 2) whether, by interacting with a real technology-mediated educational situation, changes were perceived at the level of technology acceptance and perceived effectiveness.

These objectives were translated into the following research questions (RQs):

RQ1. To what extent did the level of knowledge of OERs increase following an ENCORE-based course?

RQ2. To what extent can you describe an improvement in perceived acceptance and effectiveness of the intervention with ENCORE?

2.2 Research Design

The project adopted a Design-Based Research (DBR) approach (Wang & Hannafin, 2005), implemented in two iterative cycles to collect data and refine the ENCORE approach based on the feedback obtained. The first cycle consisted of 11 preliminary sessions to explore ENCORE and design scenarios. The second cycle involved the implementation of 8 internal pilot projects, which allowed testing and improving the ENCORE platform in authentic educational contexts. Overall, the two phases engaged a total of 457 participants. The approach adopted was that of a case study, in which the activity and experience with technologies were relevant, in this case with the ENCORE platform. To address RQ1 – the impact of exposure to the ENCORE approach on participants' knowledge and use of OERs – two questionnaires were administered before and after each event: "How Open I Am" (ex-ante) and "How Open Can I Be" (ex-post). These instruments (Appendix 1), based on the self-assessment descriptors of DigCompEdu (Redecker, 2017) and extended using the Open Digital Framework (Inamorato Dos Santos, 2016), explored participants' awareness of OERs, licensing, open practices, and Open Science (OS) principles.

To investigate the impact of exposure on professional learning and educators' and students' acceptance of the ENCORE system, the "Your Opinion of the Session" survey was designed (Appendix 2). It was inspired by the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh et al., 2003; Kurelovic, 2020; Raffaghelli et al., 2022) and adapted from the OER Acceptance Study (Kurelovic, 2020; Raffaghelli et al., 2022). This model is widely used to analyze human behavior regarding technology acceptance, usage intention, and actual usage. Below, are the five main dimensions that determine user behavior:

- Performance Expectancy: The extent to which an individual believes that using the system will enhance him or her job performance.
- Effort Expectancy: The perceived ease of using the system.
- Social Influence: The extent to which an individual perceives that those close to him or her think he or she should use the new system.
- Facilitating Conditions: The extent to which an individual believes that organizational and technical support exists to facilitate the use of the system.
- Behavioral Intention: The intent to use the system in the future.

The model is particularly relevant in educational settings, where technology adoption depends not only on their perceived effectiveness but also on educators' ability to integrate them into complex teaching practices.

Based on these data, two moments of data analysis were prepared. Regarding the investigation of OERs, pre-post test results were subjected to descriptive analysis and t-test to investigate:

- Knowledge of OER;
- Using OER;
- Adoption of OER and OE by;
- Knowledge of OS;
- University support for OS;
- and Contributing to OS.

Instead, the data collected with the UTAUT were subjected to descriptive analysis, ANOVA repeated measures and linear regression analyses to investigate the effectiveness of the intervention on the precise dimensions investigated:

- Performance Expectancy (PE);
- Expected Effort (EE);
- Social Influence (SI);
- Facilitating Conditions (FC);
- Behavioural Intentions (BI).

For clarity, all information on the codebook, procedures and tools adopted is available in the open data shared on Zenodo (Raffaghelli et al., 2024).

2.3 Participants

The focus of this actual contribution is located in one of the second loop meetings conducted in December 2023 with 64 student educators in initial training (secondary education), from the University of Padua.

3. Results

3.1 OER Knowledge

RQ1. To what extent did the level of knowledge of OERs increase following an ENCORE-based course? To assess the reliability of the scale in measuring the constructs of interest and to verify that the items included in each variable were consistent with one another and provided reliable results, Cronbach's α and McDonald's Omega (ω) coefficients were calculated. The analyses showed generally moderate values, with some differences between the pre-test and post-test. In the pre-test, α values ranged from 0.52 to 0.76, indicating low to moderate internal consistency. In the post-test, α values were similar, with some scales slightly worsening (e.g., $\alpha = 0.22$ for the "Adoption of OER and OE by teachers" dimension), while others remained stable or marginally improved.

By combining descriptive analysis data (Table 1), the boxplots in Figure 1 and the results of the Wilcoxon signed rank test with continuity correction, some key points emerged, which will be reported based on the analyzed dimensions.

Dimension	N.	Descriptives_Pre			Descriptives_Post		
		Mean	Median	Std. Dev	Mean	Median	Std. Dev
Knowledge of OER	64	0.92	0.916	0.27	1.25	1.18	0.19
Using OER	64	0.80	0.79	0.28	1.06	1.10	0.23
Adoption of OER and OE by teachers	64	0.98	1.05	0.26	1.05	1.05	0.21
Knowledge of Open Science	64	0.93	0.92	0.29	1.19	1.18	0.22
University support for OS	64	1.10	1.18	0.28	1.21	1.18	0.29
Contributing to OS	64	0.96	0.92	0.24	1.10	1.05	0.24

Table 1 - Descriptive Analysis of OER Knowledge Test

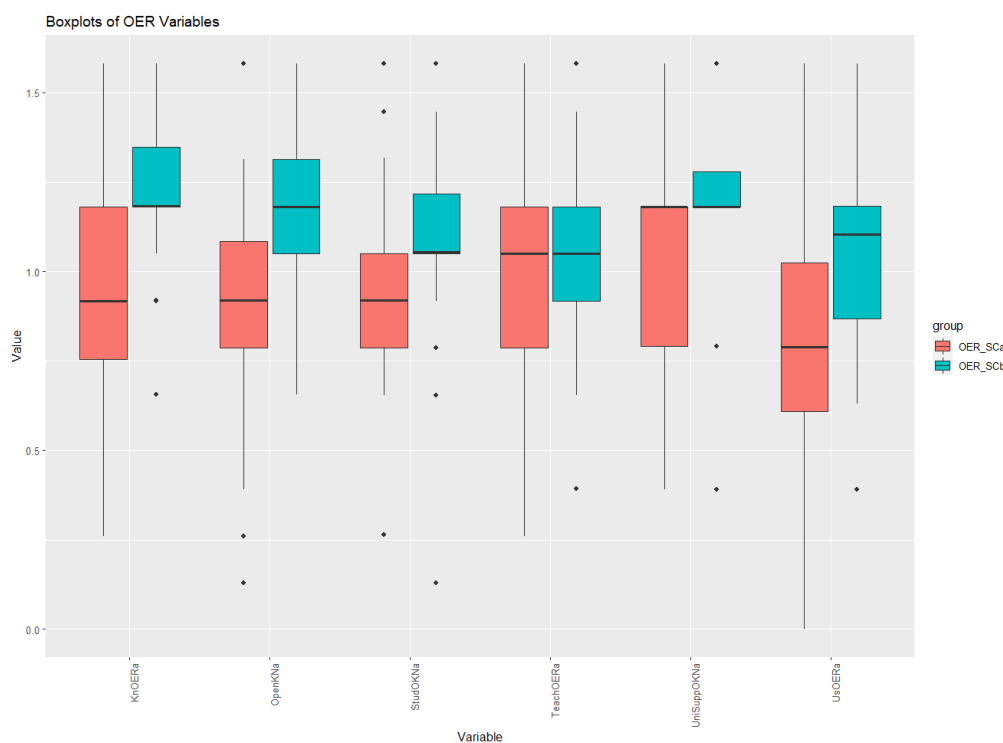


Figure 1: Boxplot about OER Knowledge Pre and Post Test.

Regarding the "Knowledge of OER" dimension, the test is highly significant ($p < 0.001$) with a very strong effect ($r = 0.7796$), suggesting a significant difference between pre- and post-measurements in OER knowledge. Similarly, for "Using OER," the test is highly significant ($p < 0.001$) with a strong effect ($r = 0.8086$), indicating a significant change in the use of OER between pre- and post-measurements.

Regarding "Adoption of OER and OE," although the effect is moderate ($r = 0.2355$), the p-value is slightly above the significance threshold of 0.05 ($p = 0.05955$).

For "Knowledge of Open Science," significant improvements were observed ($V = 163.5$, $p < .001$) with a strong effect ($r = 0.7021$). Regarding "University Support for Open Science," the result for this dimension is significant ($p < 0.05$), though the effect is weaker ($r = 0.2584$).

Finally, in the "Contributing to Open Science" dimension, the result is highly significant ($p < 0.001$) with a moderate effect ($r = 0.4438$). Overall, these results suggest a positive impact of the program/training on participants' knowledge and use of OER and the principles of Open Science.

3.2 UTAUT results

RQ2. To what extent can you describe an improvement in perceived acceptance and effectiveness of the intervention with ENCORE?

Even in this case, to assess the reliability of the scale, Cronbach's α and McDonald's Omega (ω) coefficients were calculated. The reliability analysis results, expressed through the Cronbach's α and McDonald's ω coefficients, showed: good internal consistency for PE ($\alpha = 0.76$; $\omega = 0.76$); very high reliability for EE ($\alpha = 0.85$; $\omega = 0.86$); good reliability also for SI ($\alpha = 0.79$; $\omega = 0.79$); and excellent reliability for BI ($\alpha = 0.91$; $\omega = 0.91$). The only value where a problem with internal consistency was found was FI ($\alpha = 0.04$; $\omega = 0.51$).

Proceeding with the data collected through the UTAUT questionnaire (Table 2) and the boxplots in Figure 2, which evaluate the different dimensions of the scale, interesting results have emerged.

Variable	Item	N.	Mean	Std. Dev	Median
UTAUT Test					
PE	1-4	56	3.85	0.56	3.75
EE	5-8	56	3.08	0.84	3.25
SI	9-12	56	2.26	0.80	3.25
FC	13-16	56	3.08	0.59	3.00
BI	17-20	56	3.77	0.90	3.75

Table 2 - Descriptive Analysis of UTAUT Test

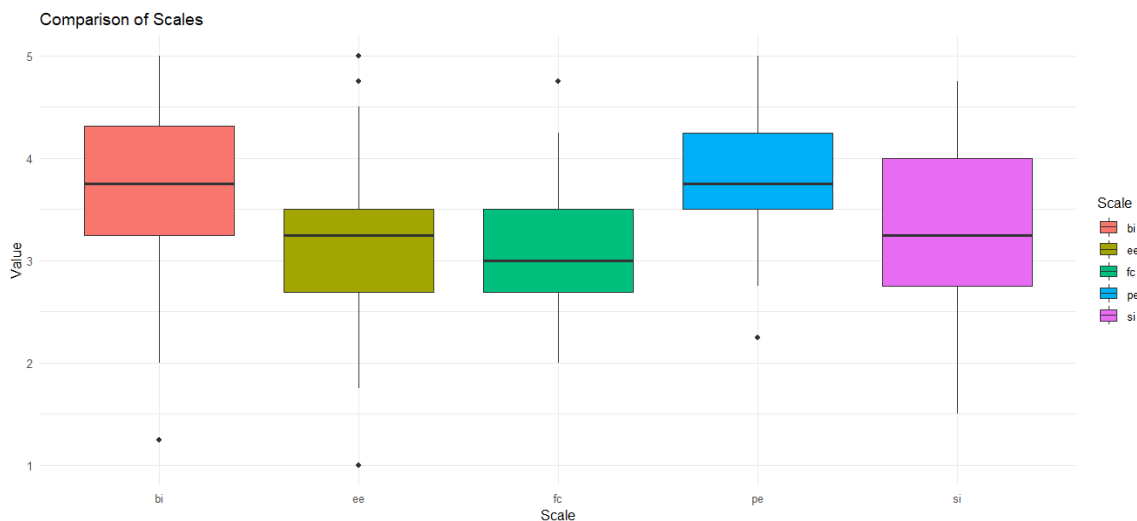


Figure 2: Boxplot about UTAUT Scales comparison.

From the initial data, it emerged that: about PE, that refers to the degree to which users believe that using ENCORE will enhance their learning experience with OER, respondents perceive ENCORE as highly useful for their learning ($M = 3.85$). The relatively low standard deviation (0.56) suggests that responses were fairly consistent across the sample. About EE, which measures the perceived ease of use of ENCORE, respondents moderately agree that ENCORE is easy to use ($M = 3.08$) but the higher standard deviation (0.84) suggests more variation in the responses.

La dimensione delle SI, which reflects how important others (e.g., peers, professors) affect the individual's decision to use ENCORE, a mean score of 13 indicates a moderately high perception that significant others influence the use of ENCORE. The standard deviation of 0.80 suggests that while

there is general agreement on the importance of social influences, there are differences in how much students feel influenced by others in their academic environment. About FC, which assesses whether the necessary resources and support are available to use ENCORE effectively, students are moderately confident that ENCORE can be used with the available resources and support ($M=3.08$). However, the relatively low median score ($Me=3.00$) compared to PE and BI may indicate some limitations in the perceived availability of support or resources for ENCORE usage, which could be an area to focus on for future improvements.

Finally, about BI, which reflects the student's future intent to use ENCORE, a strong intention to continue using the system was detected ($M=3.77$). The higher standard deviation (0.90) implies that while most students intend to use ENCORE in the future, some may be less certain. The median score ($Me=3.75$) suggests that the majority of students have positive intentions regarding ENCORE's future use.

A repeated measures ANOVA was conducted to examine differences among the UTAUT model variables in relation to students' perceptions. The analysis revealed a significant effect of the variables ($F=19.6$, $p<.001$). Mauchly's test of sphericity was not satisfied ($W=0.673$, $p=0.012$), and therefore, the Greenhouse-Geisser correction was applied.

Post-hoc results indicated that PE and BI were rated significantly higher than EE, SI, and FC. Specifically, PE stood out with higher mean scores compared to EE (mean difference = 3.107 , $p<.001$) and SI (mean difference = 2.375 , $p<.001$). Similarly, BI scored significantly higher than EE, SI, and FC. Subsequently, a linear regression model was applied to explore how the predictive dimensions (PE, EE, SI, and FC) influenced BI, that is, the intentional behavior towards usage. The analysis of the variables revealed, in particular, that SI is the strongest and most significant predictor ($p<0.001$), suggesting that the perception of social influence is strongly associated with the intention to use the technology. Secondly, EE, although having a positive effect, is marginally significant ($p<0.1$), indicating a potentially important relationship that does not reach conventional significance levels. The other variables, PE ($p=0.132$) and FX ($p=0.667$), do not have a significant impact on behavioral intentions. The model as a whole is significant, with an F-statistic of 15.23 ($p<0.001$), and explains a moderate percentage of the variability in BI ($R^2=0.5442$). This indicates a good degree of prediction, although there is still some unexplained variability by these factors.

4. Discussion and Conclusion

This study sought to evaluate the impact of the ENCORE intervention on educators' knowledge of Open Educational Resources (OERs) and their acceptance and perceived effectiveness of the platform. The results of the analyses provide valuable initial insights into how exposure to the ENCORE approach can influence both the understanding of open educational practices and the acceptance of technology-mediated tools in education. The following sections will discuss the implications of these findings in more detail.

The findings from the analysis of the subscales "OER knowledge," "Using OER," and "Understanding and contribution to Open Knowledge" indicate statistically significant results, with cut-off levels at $<.001$ ($df=63$, $t=9.43$, 9.83 , and 7.22 , respectively). Interestingly, lower levels of experience were associated with higher effect sizes, suggesting that less experienced participants may show more pronounced results. However, it is crucial to acknowledge that these findings might vary when considering more experienced educators, as the data may reflect different interactions with OER and AI tools.

About the UTAUT model application, overall, the results suggest that students generally have a positive perception of ENCORE across most of the UTAUT dimensions, particularly in terms of Performance Expectancy and Behavioral Intentions, which are both high. This indicates that students believe ENCORE enhances their learning and are likely to use it in the future. However, the variability in Effort Expectancy and Facilitating Conditions indicates potential areas for improvement. Specifically, the ease of use (EE) could be improved, as some students may find it challenging to use ENCORE. Similarly, Facilitating Conditions may require further attention to ensure that all students feel they have adequate support and resources for using the system effectively.

The application of the UTAUT model further highlighted that, for participants, the use of ENCORE in adopting an open educational perspective is impactful, with 54% of the variance in Behavioral Intention significantly predicted by the model. Notably, the results show that the Social Influence factor plays a significant role in shaping behavioral intentions, while the expected effort appears to have a minimal effect. Social Influence in this context is primarily driven by the importance of the project and the novelty of gaining access to these open educational resources, as indicated by qualitative feedback from participants.

Future research will focus on analyzing the differences in responses between senior educators and exploring the extent to which AI might function as a “dopaminergic” factor, potentially diminishing its impact as exposure to AI technologies increases. This aligns with the disconfirmation effect (Venkatesh et al., 2011), previously studied in AI-powered tools in higher education (Raffaghelli et al., 2022), which suggests that increased engagement and familiarity with AI leads to a reduction in frustration over initial expectations.

Looking ahead, further investigation is necessary to explore how the integration of OER and AI-powered tools can enhance teachers’ professional learning and facilitate greater technology uptake in educational settings. This research will be vital in shaping strategies for more effective and sustainable technology adoption within the teaching profession.

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Appendix

Appendix 1 – OER Knowledge questionnaire

Core dimension	Variable	Item
Knowledge of OER	Identify open licences	1. I can identify the license of an educational resource.
	Tagging OER	2. I can tag OER properly to increase the possibilities of others to re-use/find them.
	OER knowledge	3. I know what an Open Educational Resource (OER) is.
Using OER	OER sharing	4. I have shared and created OERs adapted from others.
	Referencing OER	5. I appropriately reference the OER I use (whether I adapt the resource or not).
	Supporting Institutional Strategies on OER	6. I support my institution in the implementation of OER as an open education practice.
	Use open licences	7. I openly license the OERs I produced.
	Personalisation Process	11. I use OER to study through a personalised approach of the learning process.
Adoption of OER and OE by teachers	Apply OER	8. I know that my teachers have used Open Educational Resources for my learning.
	OER in Teaching	9. I have seen the principles of open education in practice by teachers, e.g. using and sharing OER, using MOOCs and free and open online courses as support material or reference.
	Accessible materials	10. Besides applying the principles of OER in their teaching, I have seen my teachers to take into account the access and accessibility of the teaching materials that I produce, in order to cater for those learners with special needs.
	Different OERs	12. Generally in my experience, the teachers adopt different OER in my teaching and support the institution to be more open to the learners.
Knowledge of Open Science	OS concept	13. I am familiar with the concept of Open Science.
	OS basic concepts	14. I understand basic concepts of open science and have consulted research shared openly.
	Open data	16. I have seen open data and I can explain what it is.
University support for OS	Open Access Journals	15. The university where I study supports the teachers/researchers to publish openly, so we (students) can have access to the materials.

Contributing to OS	Open Science Community	17. I am an active contributor to open research projects and I am involved in communities that contribute to citizen science.
	Institution's policies	18. I support my institution in their effort to promote open research, by engaging in my teachers' research projects or through the association of my thesis/project work to research activity.
	Open research promotion	19. I believe open research and collaboration is extremely relevant, whenever appropriate and feasible.

Appendix 2 - "Your Opinion on the Session" test (inspired by UTAUT model)

Some general questions!	
Below, questions are separated by different aspect, investigating some general aspects of your reflections and perceptions about your experience with the ENCORE platform.	
1	Your Age
2	Gender
3	Degree Course
4	Degree Course Name
5	Course Year
6	Which was the topic/activity in this session that you liked the most? Please indicate it below.
7	What advantages can the use of ENCORE bring a) to teachers and b) to students?
8	What disadvantages can the use of ENCORE bring a) to teachers and b) to students?
9	What features of the system do you most appreciate from a training-learning perspective and why?
10	Overall, do you think the ENCORE system could be interesting for a student? Please indicate your level of agreement using a value from 1 (Not interesting at all) to 5 (Extremely interesting).

Some specific questions!	
Below, let's explore some specific reflections and perceptions about your experience with the ENCORE platform. We introduced ENCORE as a relevant support to adopt OER. In evaluating your engagement with ENCORE, please always consider its utility in relation to the future use of OER.	
Please indicate your level of agreement with the following statements, using a value from 1 to 5, where:	
1 = Full disagreement;	
2 = Disagreement;	
3 = Neither agreement nor disagreement;	
4 = Agreement;	
5 = Full agreement	

Questions	Items	Variable
11	PE1: I find ENCORE useful in my learning about OERs.	Performance

12	PE2: Using ENCORE could enable me to accomplish training activities with OER more quickly.	Expectancy
13	PE3: Using ENCORE increases my learning productivity with OER.	
14	PE4: If I use OER supported by ENCORE, I will increase my chances of getting a better rendering of my work in the courses.	
15	EE1: My interaction with ENCORE is clear and understandable.	Effort Expectancy
16	EE2: I am skilled at using ENCORE.	
17	EE3: Learning to use ENCORE is easy for me.	
18	EE4: I find it easy to get ENCORE to do what I want it to do.	
19	SI1: People who are important to me think that I should use OER and ENCORE.	Social Influences
20	SI2: People who influence my behaviour think that using OER and ENCORE can be a learning opportunity for me.	
21	SI3: Professors and staff at my institution are helpful in the use of ENCORE.	
22	SI4: In general, my university supported the use of OER and using ENCORE could be considered.	
23	FC1: I have the resources necessary to use ENCORE.	Facilitating Conditions
24	FC2: I have the knowledge necessary to use ENCORE.	
25	FC3: ENCORE is compatible with other systems I use.	
26	FC4: A specific person (or group) is available for assistance with ENCORE difficulties.	
27	IU1: I intend to use ENCORE in the future.	Behavioural Intentions
28	IU2: I predict I would use ENCORE in the future.	
29	IU3: I plan to use ENCORE in the future.	
30	IU4: I would recommend ENCORE to my peers.	
31	Please share any thought about this session and the future of technologies in learning and teaching!	