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D 2.2

Topical and methodological map of standardisation education

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Lead authors	Vladislav Fomin (VU) Kęstutis Mosakas (VU) Oksana Kuzmuk (VU)
Contributors	Rimvydas Laužikas (VU) Hugo Alexer Parada Gelvez (UPM) Jose M. del Alamo (UPM) Sury Bravo (UPM) David Rodríguez Torrado (UPM) Rudi Bekkers (TU/e) Paul Wiegmann (TU/e) Nizar Abdelkafi (POLIMI) Stephanie Bijlmakers (TiU) Irene Kamara (TiU) Panos Delimatsis (TiU) Knut Blind (FHG) and partners contributing to T2.2
Contributors to data collection	All contributing to T2.2 partners
Peer reviewers	Knut Blind (FhG) Elisabeth Staudegger (UG) Hristina Veljanova (UG)

	Barbara Reiter (UG) David Bierbauer (UG)
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Executive summary

This report presents the results of Task 2.2, the aim of which was to identify and categorise relevant existing content and methods and specify gaps in standardisation education. The effort was led by Vilnius University (VU), contributed to by work of POLIMI, UPM, DCU, TiU, TUD, FHG, TUB, and TU/e.

This report presents an overview of the body of knowledge relevant to education about standardisation – the teaching topics, content and methods – used by the Consortium partners in their teaching about standards and standardisation, as well as by other educators.

The report also provides the overview of relevant policy documents with respect to how the broad concept of “EU interests and values” can and should be interpreted by standardisation educators. Data for this report were collected during March-November 2024 through a number of surveys, interviews, review of relevant web resources worldwide, and as feedback from experts in a number of professional and academic venues, where the Edu4Standards.eu project’s and WP2/T2.2 tasks were presented.

This report establishes a connection between the work reported in Edu4standards.eu Deliverable D2.1 and Deliverable D2.3. Published in October 2024, D2.1 presented what is referred to as the ILO Framework – the hierarchical framework of intended learning outcomes for standardisation in line with EU interests and values. In the present report, the first attempts are made to map the teaching content mastered by the consortium partners against the D2.1-proposed ILO Framework, thus aiming to identify relevant teaching content and methods to be considered as reference materials in education about standardisation in line with EU interests and values, as well as aiming to identify gaps in teaching content and methods in cases where no relevant content could be identified. The Framework Model of the Innovative Teaching Concept of Standardisation (ITCoS), presented in this report is further elaborated in Edu4standards.eu Deliverable D2.3. The Framework Model of ITCoS presented here also establishes the foundation for the design and implementation of Pilots under WP3 of Edu4standards.eu, as well as can serve as a guiding framework for the development of policy recommendations under the same work package.

This report ends with the conclusions and discussion on the relevance of findings for education, research, and practice.

Introduction

This report – Deliverable D2.2 of Edu4Standards.eu – presents the results of the work conducted under T2.2. T2.2 is one of three tasks executed under WP2 (“Design teaching concepts of standardisation”), each culminating in producing a deliverable: Task T2.1 produces Deliverable D2.1, Task T2.2 – Deliverable D2.2, Task 2.3 – Deliverable 2.3.

The three tasks, and the three deliverables jointly contribute to the aim of WP2 to *design an innovative teaching concept of standardisation (ITCoS)*. The work on ITCoS is carried out under the lead of lecturers and researchers of EU universities, who already integrate standardisation-related content in their lectures, in co-operation with industry and standard setting organisations:

“The designed ITCoS will cover the standardisation under IEC, ISO and ITU lead; update students on the highly decentralised, global standardisation processes (fora and consortia); and address the technical, economical, legal, and societal facets of standardisation (multidisciplinary orientation). The ITCoS aims to bridge industrial and societal facets as well as integrate the aspects of responsible, human-centric standardisation and the EU core values into standards-development processes. This ITCoS should foster the development of green and digital skills and underline their respective support through standardisation.” [Edu4Standards.eu GA]

To deliver on expectations set in the Grant Agreement (GA), consortium partners-contributors to T2.2 engaged in a systematic effort aimed at identifying content relevant for education about standardisation used by lecturers in Europe and worldwide; conducted interviews with European and international university educators with experience in the area of standardisation education; conducted interviews with representatives of National Standards Organisations / Bodies (NSOs / NSBs); and surveyed university websites for content and methods relevant for education about standardisation in line with EU interests and values.

T2.2 builds on D2.1. published in October 2024. D2.1 presented what is referred to as “the ILO Framework – the hierarchical framework of intended learning outcomes for standardisation in line with EU interests and values”. Under T2.2, first attempts were made to map the teaching content mastered by the consortium partners against the D2.1-proposed ILO Framework, thus aiming to identify relevant teaching content and methods to be considered as reference materials in education about standardisation in line with EU interests and values, as well as aiming to identify gaps in teaching content and methods in cases where no relevant content could be identified.

The analysis of versatile data collected under T2.2 and regular discussions and sense-making efforts over the results of the ongoing work led to conceptualisation of a four-level hierarchical framework model of curricula development

and implementation (Framework Model of ITCoS) as one of the elements of the ITCoS to be developed under WP2. The Framework Model of ITCoS, among other, maps the different intellectual products of Edu4Standards.eu project – those already developed under WP2 as well as these to be developed under WP3. Finally, the Framework Model of ITCoS establishes the foundation for developing, implementing, and evaluating teaching Pilots, as well as for developing policy recommendations under WP3.

1. Setting the background: the policy outlook on standardisation in line with EU interests and values

1.1. EU's new strategic vision: Aligning standardisation with EU interests and values

In recent years, there has been an important shift in the EU's strategic vision on standardisation. While the traditional role of standardisation has been to provide various technical solutions, ensuring safety, quality, compatibility, and efficiency across a multitude of different domains, the recent EU policy documents call for the integration of aspects that have generally not been part of the European standardisation agenda. In the strategic policy document *An EU strategy on standardisation: Setting global standards in support of a resilient, green and digital EU single market*, which outlines the European Commission's recent initiative for a standardisation framework to enhance EU's global competitiveness, resilience, and sustainability, this new vision is presented as follows: *"The special status of the European standardisation organisations comes with responsibilities. More than ever, standards do not only have to deal with technical components, but also incorporate core EU democratic values and interests, as well as green and social principles"* (European Commission, 2022, p. 4). This perspective is reiterated and further substantiated in various other parts of this strategy document, repeatedly stressing the importance of standardisation in advancing EU interests, such as the resilience of the European single market, sustainable development, digital transformation, fostering innovation, and global competitiveness (European Commission, 2022, pp. 1, 5–6, 7), as well as promoting the EU's core values (European Commission, 2022, pp. 1, 2, 5–6, 10), such as respect for human dignity and rights, freedom, democracy, equality, and the rule of law (see D2.1 of this project). While many of the 2022 EU standardisation strategy's identified initiatives can be seen as the traditional, promoting the role of standardisation as enabler of consensus-based market competitiveness, global trade, and the supporter of sustainable development, similarly e.g., to the US Standardisation Strategy (ANSI, 2020), the pronounced turn towards EU core values introduces a call for standardisation professionals and educators to apprehend the implications of new policy direction for practice.

Moreover, as outlined in Appendix PA-1, which reports on value concepts as represented in European strategic and regulatory guidance documents, the Commission's urge for a more holistic approach towards standardisation is echoed in other related documents as well. For example, *The 2024 annual Union work programme for European Standardisation* (European Commission, 2024a) proposes actions that contribute to EU interests such as sustainability, the resilience of the European industry and internal market, and the digital and green transitions; as well as values such as safety, privacy, autonomy, trust, and respect for fundamental rights in the context of digital standardisation and AI (see Appendix PA-1, sec. 8). The *Artificial Intelligence Act* (EU Regulation 2024/1689) repeatedly stresses the need to consider concerns related to health, safety, and fundamental rights (e.g., the rights

to liberty, security, privacy, and information), while also explicitly referring to the EU Charter of Fundamental Rights (Appendix PA-1, sec. 3; see also the related Standardisation Request M/593 (European Commission, 2021a), which highlights the importance of developing harmonised standards and standardisation deliverables to support compliance with these requirements (e.g., in areas like risk management, transparency, and accountability)). Additionally, the Act highlights the importance of standards in strengthening the EU's global influence, managing high-risk AI systems, and ensuring their compliance with requirements (Appendix PA-2, sec. 1). Whereas the communication document *ICT standardisation priorities for the Digital Single Market* (European Commission, 2016) calls for numerous values to be considered in the development and deployment of standards, including openness, impartiality, consensus, respect for privacy (e.g., private data protection), safety, security, trust and transparency (e.g., in the context of data management), as well as fairness and non-discrimination (e.g., in the context of Intellectual Property Rights (IPR) and licensing terms) (Appendix PA-1, sec. 7). It also makes the following notable statement concerning fundamental rights:

*“The actions to address the [new] challenges [in the development of ICT standards] needs [sic] to ensure a proper balancing in view of their compliance with fundamental rights, as standardisation may have implications in this area. For instance, the actions need to ensure full respect of the rights to private life and personal data protection, and should also take into account other **fundamental rights**, including freedom to provide business and right to property.”* (European Commission, 2016, pp. 3–4; emphasis in the original)

Moreover, as highlighted in Appendix PA-3, increased attention in policy documents is now paid to green and digital skills and the concept of gender responsiveness. Green skills, crucial for advancing the EU's environmental goals, include expertise in sustainable technologies and eco-friendly processes. Digital skills have to do with safe and effective utilization of modern digital technologies, including digital devices, communication applications, AI, and information networks. Green and digital skills are complementary in fostering the so-called “twin transition” (European Commission, 2021b, p. 15), which seeks to achieve a sustainable, climate-neutral economy while simultaneously leveraging digital technologies to boost economic growth and resilience. Gender responsiveness, rooted in the EU's core value of equality, calls for eliminating gender biases and promoting equity. In the context of standardisation, it stresses fair gender representation in standardisation activities and the creation of gender-responsive standards to meet diverse societal needs, as currently most standards are not gender-responsive and fail to meet anthropometric dimensions (i.e., the body shape differences) (European Commission, 2024b). As noted in Appendix PA-3, while strongly emphasized in European policy documents, these priorities still require clearer guidelines and competency models to be effectively incorporated into standardisation curricula.

In summary, the EU's need to enhance its global competitiveness, economic resilience, and open strategic autonomy (Cagnin et al., 2021; Blind, 2025), along with the evolving technological, social, and regulatory landscape more

generally, has compelled the Commission to issue several key development strategy documents, including the European standardisation strategy (European Commission, 2022). In these documents, the Commission stresses the importance of integrating the concepts of fundamental rights, European core values, and interests (e.g., economic, strategic, and security priorities) into standardisation and standards, while also highlighting the twin digital and green transition and various societal facets like gender responsiveness, diversity, inclusion, accessibility, and others.

The Commission's new strategic vision and expectations regarding standardisation follow the more than a decade-long debate on the competitiveness of European standardisation in the global arena. Motivated by the notable success of Asian players in engaging with international and European standardisation organisations (OECD, 2005; Suttmeier et al., 2006; Blind & Von Laer, 2022), and tracing the roots of that success to broad, highly successful educational programmes (Jachia et al., 2020), the question arises of how education about standardisation in Europe can be leveraged to boost competitiveness to the desired levels (De Vries & Egyedi, 2007; European Commission, 2016). As the question has not received practical answers in Europe – not even in the context of what can be referred to as the “traditional” technological view of standardisation – the new human-centric and EU-interests-and-values-oriented policy imperatives for standardisation raise the educational transformation challenge bar even higher. Specifically, there is a need to adapt and adopt the EU policy visions into educational curricula across Europe.

1.2. The current state of standardisation education in Europe

To evaluate the new challenges presented by the shift in EU policy and to gain a clearer understanding of the depth of the problem, we administered a few surveys with some of the consortium partners, consisting of a small number of highly regarded European standardisation educators (see secs. 3.2, 3.3, 3.4), conducted interviews with standardisation educators and professionals (sec. 3.6), and carried out a web search to collect data on gender responsiveness and green and digital skills in standardisation curricula worldwide (sec 3.7).

In general, the surveys suggest that at present the European higher education experts in the field of research and education about standardisation still largely adhere to a more traditional conception of standardisation, focusing predominantly on various technological domains (e.g., digital technologies, ICT, electronics, machinery, etc.), management, economics, and law, with limited attention being paid to the topics that align with the EU's new vision of responsible standardisation. This finding is in line with broader global trends in education about standardisation, as noted by Catalani et al. (2022), who highlight the ongoing need for National Standards Bodies (NSBs) to address gaps in education by raising awareness about societal challenges, inclusivity, sustainability, and gender responsiveness through targeted educational initiatives (see also Blind and Drechsler, 2017; Blind, 2019). For instance, in our survey, out of nine respondents, all representing different European universities that teach

standardisation, none explicitly indicated that they cover gender issues in standardisation. Seven educators responded negatively, while the remaining two only provided suggestions or material recommendations (see sec 3.3). The situation is comparable when it comes to teaching green and digital skills, with only one university covering digital skills in the context of standardisation and one planning to teach standards that specifically serve sustainable development goals (SDGs) in the future (sec. 3.3).

In contrast, six out of nine respondents indicated that they do, at least to some extent, address related societal facets (for example, the impact of technologies on society), although the survey responses do not make it very clear what the exact depth and breadth of these facets are in their lectures on standardisation (sec. 3.3). With respect to European interests, only one university reported covering them. Two universities either gave a negative response or did not answer the question, while the remaining six indicated that they do not address European interests “directly,” “explicitly,” or “specifically” in their teaching (sec 3.3). While the teaching domains and contents vary among the respondents, the overall responses suggest that the current educational landscape of European standardisation does not yet align with the EU’s vision. At present, most of the surveyed educators do not address green and digital skills or gender issues and no single educator addresses all of the relevant aspects.

This conclusion is further supported by our web search (sec. 3.7) on various standardisation-related study programmes (e.g., engineering and technology, design and technology, business studies, risk assessment and management, supply chains, quality management, and more) as presented on the websites of 67 EU universities and 41 US universities. The goal of the survey was to determine the extent to which gender equality, green and digital skills, and ethical issues are covered in the curricula. The search for the keyword “gender equality” on the EU and US universities’ web sites did not return any results (i.e., there was no mentioning of “gender equality”). The presentation of some study programmes in the EU and US universities included sustainability and ethical issues. At the same time, some of study courses descriptions only mentioned the development of soft and hard skills in rather general terms, not mentioning digital or green skills respectively. A stronger focus on ethics in US universities was particularly evident in programmes related to business, medicine, biomedical engineering, occupational safety engineering. Green skills are aligned with sustainability programs in both US and EU higher educational institutions, for example, Standardisation and Sustainability course at TUB is focusing on sustainability and SDGs.

The observed gap between the policy-desired and actual orientation of education about standardisation presents a multitude of new challenges in implementing the policy-desired vision of the “novel approach” to standardisation education and practices in Europe, the essence of which is “to be in line with EU values and interests”. On the one hand, the policy documents effectively convey the EU’s strategic outlook on standardisation, stressing the necessity to broaden its scope and, in essence, to transform it. On the other hand, the statements in the documents that urge to integrate the European values, interests, and societal facets into standardisation – for example, the claim that “proper balancing” must be ensured for ICT standards to comply with fundamental rights (European Commission,

2016, p. 3) – are simply too vague to provide substantive guidance to educators on how these new aspects can be meaningfully incorporated into standardisation curricula to equip new generations of professionals with the necessary skills and competences. Moreover, some of the concepts involved (e.g., digital skills, gender responsiveness, values, etc.) may be seen as broad, context-dependent, and vaguely defined in the policy documents – an issue that inevitably leads to further complexities when the multi-faceted and interdisciplinary nature of standardisation is considered.

In essence, the new EU standardisation policy invites us to rethink the role of standards and the traditional role of standardisation experts. If the traditional conceptualisation of standard was that of a document, a technical specification to be adhered to by manufacturers (ISO, 2004, p. 12), the new invited conceptualisation can be interpreted as more of a tool for economic activity of business entities and citizens that reconciles the business incentives with the societal demands. The shift of focus in standardisation policy from manufacturers to citizens is important and will inevitably spark academic research and discussion. This inclusion of citizens in the conceptualisation of standards is warranted by the direct invitation for value-sensitive standards and standardisation processes (European Commission, 2022) to directly address and incorporate the EU interests and values, as well as by existing frameworks that facilitate the involvement of organisations representing consumer and societal interests (e.g., EU Regulation 1025/2012, Annex III).

The EU's efforts to cultivate specific knowledge of the general public and raise specific competencies and skills of labour market (European Commission, 2021b, p. 20) are not a new phenomenon. Historically, successful policy implementations have relied on the introduction of standardised tools and reference frameworks such as DigComp, SDGs, and language skill assessments, to clearly define and/or evaluate the relevant knowledge and competency levels. However, in the context of “responsible standardisation” (Jakobs, 2020; Wickson & Forsberg, 2015; Fomin, 2023), we currently observe a gap: there is a strong policy push, yet an actionable tool for the policy implementation is missing. Given the blur conceptualisation of the principles underpinning the policy (e.g., the concept of “human-centricity”), the absence of policy-desired concepts in the teaching portfolios of European experts on education about standardisation, and a vague understanding on what contributes to establishing support for human-centricity, EU interests and values, etc. in standardisation or in education about standardisation, the development of actionable tools for the European educational domain is required.

In order to address this gap, the Edu4Standards.eu proposed proposed the ILO framework (presented in D2.1), which can be developed into a tool to support the policy-desired transition towards standardisation which at the same time contributes to boosting EU competitiveness and safeguard EU interests and values. By building on this provisional framework, abstract value concepts can be translated into more specific competencies, which would in turn make them actionable and relevant for higher education institutions.

Ultimately, the success of the new EU Standardisation Policy will be determined by the answer to the question whether or not the Innovative Teaching Concept of Standardisation (ITCoS) will make a desired impact in the EU Higher Education (HE) landscape and in the EU labour market. For the impact to be made, the policy-inspired innovative approach to education about standardisation (edu4s) must align with the regulatory policy demands, the labour market demands, (see e.g., Blind and Drechsler, 2017) and the landscape of EU research and innovation in the sense that ITCoS helps address the knowledge and skills gaps and demands. Based on this background understanding, this report presents an overview of the existing expertise in the domain of education about standardisation and attempts to identify gaps which can and should be closed with the novel approach to education about standardisation.

In the following sections we present the results of the study aimed to identify the strengths and gaps of the current educational landscape in the broad domain of education about standardisation. This analysis, complemented by the overview of the general landscape of the EU HE landscape, resulted in the elaboration of the curricula development and implementation framework model – Framework Model of ITCoS – which can be seen as an analytic tool for guiding the design, implementation, and evaluation of the Edu4Standards.eu teaching pilots, as well as for the development of actionable (policy) recommendations for the introduction and impact-maximisation of the Innovative Teaching Concept of Standardisation.

2. The methods used

The aim of the research work under Task T2.2 “Identify and categorise relevant existing content and methods, and specify gaps in standardisation” was undertaken by eight consortium partners under the lead of Vilnius University. The aim of the work, accordingly, was to identify and map the relevant for education about standardisation teaching content and methods. Particular boundary conditions were set by the aims of WP2 to design/conceptualise the Innovative Teaching Concept of Standardisation (ITCoS) which builds on the existing best practice in education for standardisation while at the same time incorporates societal aspects, human-centricity, European core values, green and digital skills, and the aspects of gender-responsive standardisation.

Given the aims of the research, exploratory study was undertaken. Primary and secondary data were collected (see Table 2-1, Figure 2-1).

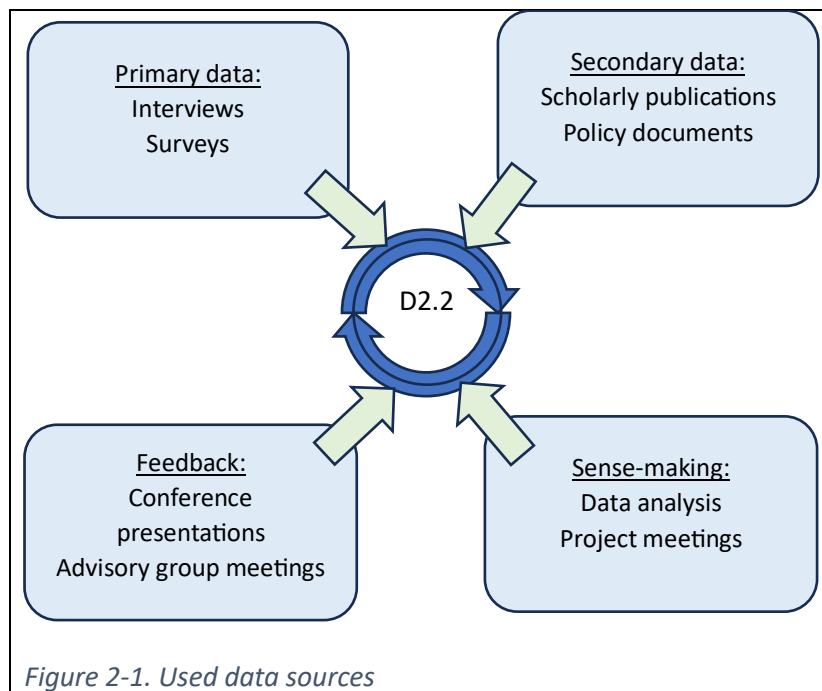


Table 2-1. Primary and secondary data collected

Primary data	Secondary data
Interviews	EU policy documents, Horizon Europe calls
Surveys of consortium partners	University web sites
Expert observations	Scholarly publications
Feedback from the organized project and expert meetings/workshops	Collection of teaching materials from CEN, ETSI, DIN, ISO, other

One source of the primary data was interviews with standardisation experts and professionals – educators, representatives of NSOs and industry experts. In total, 11 interviews with 12 experts were conducted (see Table 2-2 and Table 2-3). The interviews followed the semi-structured interviewing method. The interview questionnaire (see Appendix I-1) was carefully crafted to include a good balance of general and specific questions about the education about standardisation. The questionnaire included a general section and several stakeholder-specific sections tailored to the specific roles of interviewees: industry experts, educators, NSO representatives. The interviews lasted from 45 to 73 min, 60 min on average, and were recorded and transcribed. Interview responses were stored in MS Excel sheets for subsequent access and analysis.

Table 2-2. Metadata for interviews

Focus	Interviews to identify relevant topics, teaching methods, and content of standardisation education, as well as best practices related to topics, learning environment, and teaching methods within different venues of professional engagement with professors and lecturers, practitioners, researchers
Date launched	June 4th
Date answers due	September 30th
# of responses	10
Report on the data	T22_INTERVIEWS_compiled_responses_20241022

Table 2-3. Conducted interviews

Interviewee type ¹	Country of the origin	Conducted by	Duration
Practitioner	Ireland	Dublin City University	N/A
Lecturer	Ireland	Dublin City University	N/A
Lecturer	Ireland	Dublin City University	N/A
Practitioner	Italy	Milan Polytechnic University	73 minutes
Lecturer/Practitioner	Italy	Milan Polytechnic University	73 minutes
Lecturer/Researcher	The Netherlands	Tilburg University	40 minutes
Practitioner	The Netherlands	TU Delft	60 minutes
Lecturer	Germany	Technical University of Berlin	53 minutes
Practitioner	Germany	Technical University of Berlin	51 minutes
Lecturer/Practitioner	Spain	Polytechnic University of Madrid	N/A
Lecturer/Researcher	Lithuania	Vilnius University	55 minutes
Practitioner	Lithuania	Vilnius University	40 minutes

¹ The names can be provided on request and agreement with the interviewees.

Another source of the primary data was surveys conducted with Edu4Standards.eu consortium partners. Three surveys were conducted (see Table 3-2, Table 3-4, and Table 3-8 for survey metadata) during March 7 – June 13, 2024. The surveys aimed to obtain information on (1) the teaching topics, materials, methods used by project partners; (2) whether or not and which specific skills and values are addressed in their teaching; and (3) which specific teaching materials and which specific EU interests and values are planned to be addressed in the Edu4Standards.eu planned Pilots. The collected survey responses were stored in MS Excel sheets for subsequent access and analysis.

Expert observation and received feedback from numerous academic and industrial/policy meetings were consolidated. The list of the most important meetings is presented in Table 2-4. In these meetings, project partners were presenting the ongoing project ideas and results, seeking receiving feedback.

Table 2-4. The list of meetings at which the project partners were presenting the ongoing ideas and results in order to obtain feedback

Type of event	Event name, presentation type	Date, place
Conference		
	STS Graz, presentation	May 2024, Graz
	EURAS, panel discussion	June 2024, Delft
	DIN conference, panel discussion, workshop	September 2024, Berlin
Dissemination event	High Level Forum (HLF)	June 2024, Delft
PMB meeting		Monthly, during January-December, 2024
EAG meetings		13.3.2024 15.5.2024 17.7.2024 18.9.2024 13.11.2024
Edu4Standards workshops		
	ILO Framework development workshop in conjunction with HFDT network	September 6, UG, Graz
	WP2-WP3 integration meeting	November 14–15, UPM, Madrid
	ILO Framework operationalisation meeting with HFDT network	November 29, UG, Graz

Besides the meetings and venues enlisted in Table 2-4 above, T2.2 plans and findings were discussed on a weekly basis in two series of bi-weekly online meetings: WP2 task leaders' meeting, attended by representatives of at least three consortium members; and the meetings of the seven consortium partners contributing to T2.2.

3. Results of the study

3.1. Literature review on education about standardisation teaching methodology

The literature review was conducted by Hugo Alexer Parada Gelvez, Jose M. del Alamo, Sury Bravo, and David Rodríguez Torrado of UPM. Detailed findings of the literature review are presented in Appendix LR-1.

3.1.1. Methodology of the literature review

The Web of Science (www.webofscience.com) scientific repository was used to search for scientific, peer-reviewed publications on standardisation teaching. As detailed in Table 3-1, the search string was elaborated over six iterations.

In each iteration, the search string was adjusted to retain the relevant papers while maintaining a manageable total number of results for inspection. To that end, ten relevant papers were initially identified for the topic to be used as our validation set. The goal was set to reduce the number of papers for manual analysis while keeping at least 80% of papers in our validation set.

Additional constraints were set: only allow texts written in English, and their publication date must be not earlier than 2013.

Based on this iterative process, SS6 was selected as the starting point for the selection process. The literature search has commenced, supported by the CADIMA tool (<https://www.cadima.info/>).

The initial search, after removal of duplicate records, produced 1,419 records. A manual filtering process was applied to this set, starting with the screening of titles, followed by the screening of titles and abstracts, and finalizing with full-text review. Title-level screening excluded 1,037 records, leaving 382 for further review. After the abstract-level screening, 346 records were excluded, resulting in 36 records for full-text review. Of these 36 full-text articles, 29 were excluded as they did not provide any best practices or reusable elements for standardisation teaching, leaving only seven articles for inclusion.

Table 3-1. Search string elaboration steps

Iteration	Search String	Number of papers
SS1	standard* W/3 (educ* OR teach* OR train*)	40,000
SS2	((standardization OR standardisation or normalization) NEAR/3 (educ* OR teach* OR train* OR course*))	68
SS3	(“standardiz*” or “standardis*” or normalization) NEAR/3 (educ* OR teach* OR train* OR course* OR pedagogy* or curricul* or “higher education”)	8,959
SS4	(“standardiz*” or “standardis*” or normalization) NEAR/2 (educ* OR teach* OR train* OR course* OR pedagogy* or curricul* or “higher education”)	6,852
SS5	(“standardiz*” or “standardis*” or normalization) NEAR/3 (educ* OR teach* OR train* OR course* OR curricul*)	8,676
SS6	(“standardiz*” or “standardis*” or normalization) NEAR/3 (educ* OR teach* OR train* OR course* OR curricul*) NOT (standardized OR standardised)	1,429

To increase the number of relevant papers for the systematic literature review, backward and forward snowballing was applied to these seven articles, identifying 165 additional records. After the abstract-level screening, 159 records were excluded, resulting in six new full-text articles for review. Snowballing was repeated for these six articles, identifying 75 additional records. After screening, 68 records were excluded, resulting in seven new articles for inclusion.

Having completed manipulations as described above, produced a set of 20 articles. After removing one duplicate, 19 papers were selected as the final set. The results of this analysis are summarized in the following report.

3.1.2. Analysis of the literature review findings

As presented in the selected articles, the state of standardisation education highlights both advancements and significant challenges. Some initiatives have successfully integrated standards into engineering curricula; however, they still face several obstacles. One of the most critical issues identified in the literature is the lack of awareness and accessibility of standards. Specifically, in an educational context, both faculty and students perceive standards as complex or irrelevant to their field of study. In some cases, standards are seen as prescriptive and restrictive. Consequently, educational institutions face challenges in engaging students in programs that include topics related to standardisation.

To address these challenges, several initiatives have been proposed, ranging from promoting academic activities that increase awareness and accessibility of standards, incorporating standards into early curricula, using innovative

teaching methods, providing accessible teaching materials, training educators, and creating incentives for curriculum integration.

To increase awareness and accessibility of standards, the Think Industry New Generation (TING) project focuses on promoting standards and awareness of industry practices among young students (ages 12–17). As reported by Fernandes and Rocha (2015), this approach effectively enhances students' understanding of standardisation and its importance for product quality and safety by using simulation games, technology labs, and distance learning tools to engage young learners and motivate them to consider technical careers.

The most challenging initiatives involve incorporating standards into curricula. These initiatives face obstacles such as faculty's limited knowledge of standards, restricted access to suitable teaching materials and resources, and overloaded formal curricula. Several studies propose approaches to include standards education in curricula. To address the lack of teaching materials, Bøgh (2015) presents a textbook aimed at providing higher education students with a basic understanding of standardisation and making the subject more accessible through case studies, multiple-choice questions, and discussion points.

El-Bawab and Effenberger (2017) discuss the Project ISTEE, which integrates standards education into telecommunications engineering curricula through a combination of conventional lectures and interactive, research-based workshops. These workshops enable students to simulate real-world standardisation meetings, enhancing their skills in negotiation and problem-solving. Despite improving students' understanding of complex standards topics, logistical challenges persist, particularly regarding the involvement of industry experts.

Budinoff et al. (2023) developed a set of online learning modules that use interactive methods such as videos, quizzes, and self-paced activities to enhance students' competency in technical standards. They recommend distributing content across the semester and incorporating open-ended design projects to promote practical applications of standards.

McPherson et al. (2019) discuss the integration of technical standards into the Engineering Technology curriculum at Purdue University to meet ABET accreditation requirements and align with industry needs. They propose a scaffolded learning approach that progresses from introductory to advanced levels, utilizing miniature case studies, hands-on projects, and industry-based assignments. These works underscore the importance of employing innovative methods to engage students in standardisation education.

Nakanishi et al. (2015) collect and analyse course syllabuses from Japanese universities to encourage more institutions to include standardisation topics and expand joint educational initiatives. Krechmer (2015) emphasizes the need to integrate the theory of standards into academic curricula to enhance students' understanding of their technical and economic impacts, recommending the inclusion of dedicated courses to underscore their importance.

He also highlights training teachers and professors of technical courses as a fundamental step in incorporating standardisation into educational programs.

Nakanishi and Matsuyuki (2015) demonstrate various approaches to integrating global standardisation education across institutions, presenting different models that other universities could adopt. Whitney et al. (2014) illustrates how standardisation is incorporated into technical courses by leveraging content from standards related to technical topics, with a strong emphasis on hands-on applications. Roy et al. (2019) proposes a standards-based framework for incorporating industry-relevant standards into specialized education. Nakanishi (2013) suggests a curriculum for graduate students that combines technical standards with management and negotiation training to meet the demands of global industries. Li et al. (2018) and Li et al. (2020) propose a multi-phase integration model for standards in engineering education, allowing continuous course improvement. These works highlight the challenging task of integrating standards into curricula alongside technical topics to ensure successful outcomes.

These initiatives have achieved success in a few institutions, as evidenced in the literature. However, achieving broader changes in the education sector regarding the teaching of standards requires collaboration and involvement from industry, government, universities, and standardisation organizations. Some studies focus on this by proposing frameworks and benchmarks to address these challenges. For instance, De Vries (2013) discusses implementing standardisation education at the national level, emphasizing the need for coordinated, cross-sector collaboration among industry, academia, government, and standardisation bodies. He demonstrates how top-down policy initiatives combined with bottom-up school engagement can effectively incorporate standardisation into education systems, as seen in South Korea, Indonesia, and the Netherlands. He also emphasizes the importance of dedicated resources and stakeholders as crucial elements for successful implementation.

The IEICE Standardization (2013) conducted a questionnaire survey on standardisation education in Japan, gathering responses from 100 enterprises and 63 universities. The results indicate distinct interests between enterprises and universities. The survey found that while most universities offer courses on technology management (82%) and intellectual property rights (100%), only 45% include global standardisation. Enterprises emphasized practical skills such as technology management and human networking, whereas universities prioritized specific technological knowledge. This highlights the importance of reaching agreements to create balanced educational programs that equip professionals with the necessary skills.

Khan et al. (2013) conducted a faculty survey exploring the use of standards in engineering education across the United States. The study reveals that while some engineering programs integrate standards into senior design projects and courses on technology management and intellectual property rights (IPR), there is a gap in dedicated courses on global standards. Similarly to McPherson et al. (2019), they recommend increasing collaboration

between industry and academia, providing affordable access to standards, and integrating interactive learning activities to enhance students' abilities to apply standards in real-world scenarios.

It is evident that the commitment of industries, governments, universities, and standardisation organizations is essential to promoting education that meets the European regulatory framework described by Orviska et al. (2013), thereby enabling competitiveness and active participation in the global market.

3.1.3. Conclusions on the literature review

The detailed summary of the literature review findings on the current state of standardisation education is presented in Appendix LR-1, in Table 13-1. It contains such relevant for education concepts and variables as teaching methods, teaching content, intended learning outcomes (ILOs), levels of education. The table also summarises on the challenges reported for implementing education about standardisation.

Overall, several key challenges and advancements as identified through the systematic literature review can be highlighted.

Several initiatives have successfully integrated standards into educational programs, particularly in engineering, supported by interactive and practice-based teaching methods to engage students. However, challenges such as a lack of awareness, resistance due to perceived complexity, insufficient knowledge of standardisation among educators, and limited institutional support persist. Additionally, few standardisation programs exist as standalone subjects in master's degrees. Blind (2019) particularly highlights this issue, emphasizing that the lack of dedicated academic research on standardisation weakens its theoretical foundation and limits the development of systematic educational approaches.

To encourage higher education institutions to adopt standardisation education, we propose the following actions:

1. Promote research initiatives on standardisation:

- Engage private sectors in fostering research projects on standardisation.
- Provide institutional support for research on standardisation and involve standards development organisations.
- Promote the visibility and importance of standardisation as a subject for research and teaching.
- Encourage interdisciplinary academic endeavours, aligning educational efforts with industry needs, innovation goals, and societal challenges.

- Build strong theoretical foundations and analytical tools to make the topic more accessible and relevant to academic curricula.

2. Increase awareness and access to educational resources:

- Develop and adapt standardisation materials for use across various disciplines.
- Create incentives for integrating standardisation into curricula, such as grants or awards.
- Provide targeted training for educators to improve their understanding and teaching of standardisation.

3. Apply innovative teaching methods:

- Utilize simulation-based learning, project-based and collaborative learning, case study competitions, and expert-led tutoring to enhance student engagement and comprehension.

4. Reinforce cross-sector collaboration:

- Involve industry stakeholders in curriculum design to ensure relevance and applicability.
- Establish long-term funding mechanisms to support educational and research initiatives on standardisation.
- Secure policy support from government institutions to align educational programs with national and regional strategic goals.

Finally, it can also be concluded that there is no specific concept for teaching standardisation – the conclusion which provides an additional justification for Edu4Standards.eu project’s aim to develop an Innovative Teaching Concept of Standardisation (ITCoS). Standardisation is not a stand-alone discipline, it is taught as part of other disciplines, such as engineering, strategy, innovation, international management, law, (applied) philosophy, political sciences, and economics. This situation implies a great fragmentation of the body of knowledge relevant to education about standardisation, and calls for standardising if not the body of knowledge itself then the competence framework and/or intended learning outcomes (ILOs) which can provide policy support and cater for education about standardisation aimed at boosting EU competitiveness while safeguarding the EU interests and values.

3.2. Survey #1

Under Task 2.2, three surveys were conducted with the following aims:

- 1) To identify the teaching topics, materials, methods used by project partners;
- 2) To find out whether or not and which specific skills and values are addressed in the teaching about standardisation by the consortium partners;
- 3) The same as 1) and 2) above, but specifically in the context of the Edu4Standards.eu planned Teaching Pilots.

Edu4Standards.eu Survey #1 (see Table 3-2 for survey metadata) was conducted among the consortium members during March 7-23. The aim of the survey was to obtain knowledge on 1) the project consortium partners' involvement in education about standardisation and 2) whether the consortium partners active in education about standardisation have formal or informal collaboration with their respective National Standards Organisations (NSOs).

The survey questions are provided in Appendix S1-1. In total, Survey #1 received 11 responses, with 9 responses coming from Edu4Standards.eu consortium partners and 2 from NSO of one of the consortium countries. The summary of responses is presented in Table 3-3 below.

Table 3-2. Survey #1 metadata

Data collection task	Task 2.2, Survey #1
Focus	Involvement in education about standardisation, teaching discipline and topics, venues, used teaching materials
Questions asked	See Appendix S1-1
Date launched	March 7
Date answers due	March 16
# of responses	11
Respondents	9 universities, 2 NSOs
Report on the data	T22_Questionnaire_1_compiled_responses_20240411
Source data	The data are available on request from VU

Table 3-3. Survey #1. Teaching disciplines and topics

Discipline/Topic*	Respondent										
	TUD	UPM	DCU	POLI MI	TIU	TUB	TU/E	VU	OVE	UG	
COMPUTER SCIENCE Information security and privacy; Internet & web standards; Standards and AI			P/O				T/P				
MANAGEMENT The basics of standardisation; Standardisation and innovation; Standardisation & IPRs				T/P		T/O	T/P	P/O			
TECHNOLOGY MANAGEMENT Standards battles, design dominance, and platform competition	P										
LAW Standardisation processes at the national, European and international level; Due process, competition, data protection, IP policy, Liability related to standards use and development; Standards and public procurement					O		T/P		P	O	
INDUSTRIAL ENGINEERING						T/O	T/P				
ICT/TELECOM NETWORKS; Comm. Protocols; Software engineering		P/S									
ELECTRICAL ENG-NG									P		

Responses to Question “Do you teach on standardisation? What discipline?”

O: own content; **T:** textbook; **P:** scientific publications; **S:** standards; **U:** unspecified

Source: T22_ Questionnaire_1_compiled_responses_20240411

3.2.1. Summary of the findings of Survey #1

The questionnaire included questions on relevant topics, teaching methods, and content of standardisation education, as well as best practices related to topics, learning environment and teaching methods within different venues of professional engagement: pre-normative standardisation, formal and consortia standards development, policy development and safeguarding of EU core values.

Eleven responses were systematised and categorised. Eleven partners participated in the survey, conducted by the VU Team.

According to the survey results, the lecturers involved in education about standardisation do not always/at all know/understand how the EU-desired values, as well as the Gender Equality and Green Deal Strategy and DigComp can be meaningfully (and to what extent) incorporated in their teaching.

The following conclusions have been made on the standardisation education, including best practices in delivering education.

3.3. Survey #2

Edu4Standards.eu Survey #2 (see Table 3-4 for survey metadata) was conducted among the consortium members during March 7-23. The aim of the survey was to obtain knowledge on the inclusion/presence of policy-highlighted topics in the teaching of consortium partners. These policy-highlighted topics included in Survey #2 were the following:

1. European interests
2. Gender responsiveness
3. Societal facets
4. Green skills
5. Digital skills

In total, Survey #2 received 11 responses, with 9 responses coming from Edu4Standards.eu consortium partners and 2 from Austrian SDOs (invited by UG). The summary of responses is presented in Table 3-5 through Table 3-7 below.

Table 3-4. Survey #2 Metadata

Focus of Survey #2	European interests; Gender responsiveness; Societal facets; Teaching Domains; Green and Digital skills
Date launched	March 7
Date answers due	March 23
Number of responses	11, of which 9 are universities
Report on the data	Preliminary_report_T2.2_KM_v2 (summary of the survey on pp. 7–9); Report_on_survey_2_materials_KM_1008 (Column H)
Data source	The data are available on request from VU

Table 3-5. Survey #2. Teaching topics map

Respondent	TUD	UPM	DCU	POLIMI	TIU	TUB	TU/E	VU	OVE	UG	AT NSO
Teaching domain**											
DIGITAL (3)	✓	✓	✓								
ICT (3)	✓			✓				✓			
ELECTRONICS (2)	✓	✓									
NRG-RENEWABLES (2)	✓										
HEALTH (1)			✓								
PRODUCT SAFETY (1)					✓						
ENVIRONMENT (1)					✓						
DATA PROTECTION (1)					✓						
SEMICONDUCTORS (1)					✓						
BIOECONOMY (1)						✓					
MGMT S STNDRDS (1)						✓		✓			
IEC AND CENELEC (1)									✓		
SMART ENG-NG (1)											✓
CROSS-DOMAIN (2)							✓			✓	

*Based on responses to Question 7 in column H (7. Does your teaching include domain-/industry specific standardisation? If yes, which industries? (1. Aerospace & Defence, 2. Agri-food, 3. Construction, 4. Cultural and Creative Industries, 5. Digital, 6. Electronics, 7. Energy Intensive Industries, 8. Energy-Renewables, 9. Health, 10. Mobility-Transport-Automotive, 11. Proximity, Social Economy and Civil Security, 12. Retail, 13. Textiles, 14. Tourism)).

**The list of topics provided in the survey question comes from SWD(2021) 351, Annual Single Market Report 2021
 Source: Report_on_survey_2_materials_KM_1008 (Column H)

Table 3-6. Survey #2. "Survey focus topics addressed in teaching" map

Respondent	TUD	UPM	DCU	POLIMI	TIU	TUB	TU/E	VU	OVE	UG	AT NSO
Specific topics*											
EU INTERESTS (2)			M	M	✓	M	M	M		✓	M
GNDR-RSPNSVNSS (4)		✓			M	✓				✓	✓
SOCIETAL FACETS (8)	✓	✓	✓	✓	✓		✓	✓		✓	M
GREEN SKILLS (2)		✓		M				M			✓
DIGITAL SKILLS (2)		✓									✓

*Based on responses to Questions 2, 3, 4, 5, 6, 8, and 9).

✓ – The topic is addressed in teaching

M – respondent has (or may have) teaching materials on the topic (or a related topic), but does not address the topic explicitly

Source: Report_on_survey_2_materials_KM_1008 (Columns C, D, E, F, G, I, J)

Table 3-7. Survey #2. "Defining EU Interests" map*

Respondent	TUD	UPM	DCU	POLIMI	TIU	TUB	TU/E	VU	OVE	UG	AT NSO
EU Interests											
EU VALUES (8)	✓	✓		✓	✓	✓	✓	✓		✓	
SINGLE MARKET (3)		✓						✓		✓	
COMPETITIVENESS (3)		✓		✓		✓					
INNOVATION (2)		✓				✓					
EU REGULATION (5)			✓	✓	✓				✓	✓	
DIGITAL STRATEGY (4)			✓		✓			✓		✓	
SME ENTERPRISES (1)			✓								
INTEROPERABILITY (2)			✓	✓							
SECURITY (4)			✓	✓	✓			✓			
QUALITY (2)			✓	✓							
ECON. INTERESTS (4)			✓		✓	✓		✓			
STRAT. INTERESTS (3)	✓				✓					✓	
PUBLIC INTEREST (2)					✓					✓	
GT/ SUSTAINABILITY (4)					✓	✓	✓	✓			
CORPR. INTERESTS (2)					✓				✓		
STRAT. AUTONOMY (2)					✓			✓			
REGIONAL DEV-NT (1)								✓			

*Based on responses to Question 1 in column B (1. How do you define "European interests" in standardisation?).

Source: Report_on_survey_2_materials_KM_1008 (Column B)

3.3.1. Summary of the findings of Survey #2 and implications for identifying gaps

1. European interests

The survey shows that the partners most strongly associate EU interests in standardisation with promoting EU values (8), supporting EU regulation (5), economic interests (4), sustainability / green transition (4), security (4), and promoting EU digital strategy (4). The aspects of fostering EU single market (3), strategic interests (3), and competitiveness (3) were mentioned by three partners, whereas innovation (2), interoperability (2), quality (2), corporate interests (2), public interest, (2), and strategic autonomy (2) were each mentioned by two partners.

The responses to the question of addressing EU interests in teaching indicate a potential gap, with only two universities (TU/e, UG) giving a positive response and numerous others (5) claiming that their teaching does not address the issue of EU interests explicitly. While some of the universities indicate connecting their teaching content to EU interests in a less direct manner, it is not clear whether this is sufficient for the purposes of promoting EU

interests via standardisation / education about standardisation. The examples of teaching materials presented by the respondents – apart from EU policy documents mentioned by multiple respondents – have only been few. This indicates that the Consortium partners do not possess teaching material and examples, which can be used to demonstrate in clear and straightforward way how to incorporate EU values and interests into standards as part of the set of requirements. However, some respondents indicated that they teach and have materials on topics that are relevant to EU interests even if not directly focused on them, including the case of China boosting its global competitiveness through education on standardisation (POLIMI), the legal value of standards and how standards are used to support EU policies and legislations (TiU, UG, and DCU), sustainable development goals (TUB), and the link between standards and innovation (TU/e). POLIMI also uses a textbook developed with the support of ETSI, which is a European Standardisation Organisation.

2. Gender responsiveness

With respect to gender responsiveness, the survey results indicate a likely gap, given that 6 out of 9 universities state that they do not address the topic of gender explicitly although one of them have teaching materials on the topic. In total, three respondents provided examples of materials or teaching methods on the topic of gender: TUB provided academic articles, TiU referred to the UNECE Declaration for Gender Responsive Standards and Standards Development as well as sources from ISO and CEN, whereas UPM has a course "Women in Science and Technology" for the Telecommunications Engineering degree, which contains numerous materials on the subject. Moreover, out of two respondents from Austrian NSBs, one (ATNSO) claims to address gender responsiveness in teaching.

3. Societal facets

Out of 9 universities, 1 (TUB) does not address societal facets, 1 (POLIMI) does not address them in detail, 1 (VU) only addresses them in general terms, whereas the remaining 6 seem to address them at least to some extent. It is noteworthy, however, that the responses from the universities are rather diverse, with the exception of UPM, UG, and DCU focusing on the ethical and societal impact of technologies. This could either indicate a lack of uniform approach to societal facets in the context of standardisation education (e.g., which of them are relevant) or that the universities cover them in a more context-specific manner. Overall, it remains somewhat unclear to what extent the universities address the societal aspects and to what extent these aspects should be addressed to be in line with the European Commission's vision of standardisation education. The examples of materials provided focus on the topics of product safety, data protection, and the environment (TiU), societal value and risks in the context of regulation and technologies (DCU), the shift from legal provisions to norms, including the ethical consequences (UG), the impact of standards on society and the economics of standards as a social science (TU/e), societal issues in the context of ICT standardisation (UPM), and accessibility (POLIMI).

4. Teaching domains

Digital (3), ICT (3), and electronics (2) are the most common specific domains, but in general the teaching domains appear to be quite diverse.

5. Green skills

7 out of 9 universities state that they do not address green skills, whereas one university (TU/e) has plans to address them in the future by teaching standards that specifically serve SDGs. Some of the teaching materials/methods presented include ISO standards on the environment such as ISO 14000 (POLIMI), references to the importance of ESG (TiU), materials on SDGs (TUB, TU/e), and examples on standards for energy saving (VU). At present, however, there is a likely knowledge gap here, given that green skills are not addressed by most of the universities.

6. Digital skills

7 out of 9 universities state that they do not address digital skills, with only one university – UPM – claiming that they address a broad range of digital skills that are important for standardisation (e.g., within the UPM Telecommunications School Course). The survey results suggest a likely knowledge gap with respect to digital skills relevant for standardisation.

3.4. Survey #3

Edu4Standards.eu Survey #3 (see Table 3-8 for survey metadata) was conducted among the consortium partners responsible for the teaching pilots. The aim of the survey was to obtain knowledge on whether the consortium partners responsible for the pilots intend to address policy-highlighted topics in their pilots: green and digital skills, gender responsiveness, EU interests, core EU values. Two questions were asked:

1. Do the patrons of the pilots have specific teaching materials or/and methods for the topics of Green skills, Digital skills, Gender-responsive standardisation, EU interests?
2. Do the patrons of the pilots have specific teaching materials or/and methods corresponding to the ILOs defined under T2.1 (in the ILO Framework)?

All 5 pilot patrons responded to Survey #3 (see Table 3-8). The summary of responses is presented in Table 3-8 below.

Table 3-8. Metadata for Survey #3

Focus	Topics / materials of Pilots to cover: Green / Digital skills. Gender, EU Interests, Values Definition of HLI
Date launched	June 5
Date answers due	June 13
# of responses	5
Report on the data	No separate report document

Table 3-9. Survey #3 responses summary on specific teaching materials and methods to be used in the pilots and to address ILOs in particular

Respondent	TUB	UB	TU/E	UG	POLIMI
Materials and/or methods*					
On green skills		C	M(P)	M(P)	M(T)
On digital skills		Mt		M(P)	
On gender-responsive standardisation	M(A)			M(P), Mt	
On EU interests	M(A)			P	
Materials and/or methods corresponding to ILOs	M on gender and SDGs	C and M on sociology, human resource management, psychology, and information systems and technology		M	

*Q: Do the patrons of the pilots have specific teaching materials or/and methods for the topics of Green skills, Digital skills, Gender-responsive standardisation, EU interests? Do they have specific teaching materials or/and methods corresponding to the ILOs defined under T2.1?

M – respondent indicates having teaching materials on the topic (A – academic articles, P – policy or law-making documents, T – textbooks)

Mt – respondent indicates applying or being aware of a particular teaching method relevant to the topic

C – respondent indicates a course on the topic taught at their institution

3.4.1. Summary of the findings of Survey #3

Table 3-9 presents a summary of survey responses on current teaching materials and methods for topics like green skills, digital skills, gender-responsive standardisation, and EU interests in the pilots, as well as methods and materials used to address ILOs in particular. The methods and materials indicated by the pilot leaders include

academic articles on gender issues and sustainability (TUB), separate university courses on the topics of green and digital skills and gender-responsive standardisation (UB), EU policy and law-making documents (TU/e, UG), as well as a combination of own textbook and new materials to be identified within the project (POLIMI, UG).

As for the teaching resources available to address the intended learning outcomes (ILOs) identified in the Edu4Standards.eu ILO Framework in D2.1, the pilot leaders mention EU documents (TU/e, UG), materials on gender issues and sustainability (TUB, UG), university courses on ethics, sociology, human resource management, psychology, and information systems that include topics and teaching materials related to ILOs (UB), or note a lack of previously developed materials explicitly focused on values (POLIMI). In general, however, the focus of the responses on generic textbooks, scholarly articles, and EU policy documents suggests a lack of dedicated teaching materials to address the new priority topics.

Additionally, there is likely a gap concerning the teaching methods with respect to the policy-desired topics. Regarding digital skills, UB reports using a generic approach of carrying out standardisation exercises in classrooms equipped with computers, where students search websites and databases. However, the survey respondents did not indicate any additional methods relevant to these topics. Consequently, the specific teaching methodologies, including formalized best practices for the new topics, remain an open question.

3.5. The mapping exercise: mapping the content of the project Pilots to the ILO Framework

The mapping exercise was an essential step towards developing ITCoS Model, given that the policy analysis conclusions (see Appendix PA-1 and Appendix PA3) revealed that the policy documents require academia to tackle main European strategies – transition to green and digital Europe with gender equality in education and research, the Edu4Standards.eu survey results revealed that lecturers involved in education about standardisation do not always (or at all) understand how the green and digital skills, gender responsiveness issues and the support for EU interests (and actually the understanding what the EU interests are) and values can be meaningfully (and to what extent) incorporated in their teaching.

Against this background of the lack of understanding among the experienced educators about how education about standardisation can support EU values and interests, Edu4Standards.eu project Pilots' leaders were asked to map their Pilots courses' materials against the Edu4Standards.eu ILO Framework. The purpose of this exercise was threefold:

- 1) to identify gaps in how the Pilots’ planned education about standardisation is addressing EU interests and values,
- 2) to validate the ILO Framework developed under D2.1,
- 3) to gain understanding about the mapping task and share the experience for future elaboration of ITCoS (and the related methodological guides).

The project-planned 7 Pilots represent the following educational levels and disciplines (see Table 3-10).

Table 3-10. The project-planned pilots: educational levels and disciplines

Educational level	Discipline or venue	Responsible Edu4standards.eu partner
BSc	Economics and Management	UB
MSc	Technology Management	TUD
MSc	Management	TUD
“Teach the teachers”	Extracurricular – summer school	UG
BSc & MSc mixed	Extracurricular – course	POLIMI
LLL: Lifelong learning	Engineering and other disciplines	FhG
In-company	Hi-tec, semiconductor industry	TU/e

The mapping exercise specified the tasks the Pilot leaders had to accomplish:

1. Choose the educational level from the ILOs framework (scale from 0 to 7);
2. Choose the Intended learning outcomes that the Pilot addresses;
3. Report the topic(s) that the Pilot will address;
4. Identify materials the Pilot will use to teach on the topic(s);
5. Identify the teaching method(s) to be used.

Table 3-11 below presents the results of the first two from the tasks listed above.

Table 3-11. Summary of the mapping exercise

Skill	European values					European interests and challenges			
	Human Dignity	Freedom	Democracy	Equality	Rule of Law	Green	Digital	Gender equality	Energy transition
Level 5: Short-cycle tertiary education									
S5.1		1			2	3	3	2	3
S5.2		1	2	2	2	4	3	2	3
S5.3						1	1		1
S5.4				1			1		
S5.5					2	2	2		2
S5.8					1	1	1	1	1
S5.6				1	1	1	1	2	1
Level 6: Bachelor's level									
S6.1	1	1	1	2	1	1	1	2	
S6.2:	1	1	1	1	1				
S6.4:		1	1	1					
S6.6:	1	1	2	2	2	2	2	2	2
Level 7: Master's level									
S7.2						1	1		1
S7.3				1		1	1	1	1
S7.6						1	1	1	1
S7.7:		1		1	2	4	5		4
S7.8:			1		2		1		
S7.10					1	2	2		2
Level 8: Doctoral level									
S8.1			1			1	1		1
S8.8				1	1	1	1	1	1
Total:									
	3	7	9	13	18	26	28	14	24

The summary presented in Table 3-11 allows identifying to what degree certain skills in support of EU interests and values are targeted by the lecturers, who are the recognised experts of education about standardisation in Europe (for the meanings of the codes see Table 3-12 below).

Based on the results of the mapping exercise (Table 3-11), few observations can be made. Green and digital skills are targeted twice as often as gender responsiveness and equality skills. Transversally, the challenge of gender equality is addressed twice less often than any of the other three challenges that were offered for the mapping exercise.

The EU value of human dignity is the least covered target in the course materials of the planned Pilots. This may come as a surprise, as future standardisation experts must be trained not only to respect other participants in the standardisation process but also to understand how human dignity can be integrated as part of formal requirements within standards. This entails going beyond interpersonal qualities like friendliness or compassion in standardisation processes to ensure that standards themselves account for human dignity alongside technical requirements. For example, a product's design and implementation must consider its impact on individuals' autonomy, equality, and well-being as integral elements of the standard.

Interestingly, the degree to which the five core values are targeted is changing with a steady increment from the lowest value of 3 for human dignity to the highest level of 18 for the rule of law: human dignity (3) – freedom (7) – democracy (9) – equality (13) – rule of law (18). The “rule of law” received almost 50% more references than the second largest value “equality”

Another interesting observation is that while equality as EU value is the second most targeted, the challenge of addressing gender equality is the least targeted.

The final observation can be made that, overall, there was an even distribution of skills across educational levels. The doctoral level stands apart, but it was not represented in the Pilots as a doctoral-level course. Rather, the Pilot leaders rated some of the skills as pertaining to the doctoral (Level 8 in the ILO Framework) level of education.

With regard to the intended use of teaching materials, the most traditional forms were represented:

- Edited book on standardisation (collection of scholarly publications)
- Scientific publications
- ETSI textbook
- ETSI Slide set
- ISO standards
- ISO Reports
- EU policy documents
- EU legal documents

With regard to the intended teaching methods, the following variety of methods and learning activities was reported:

- Lecturing
- Active learning
- Business case studies

- Interactive teaching
- Teaching games
- Analysis of scientific articles
- Teaching with case
- Students' reflection

Overall, the Pilots' leaders found the exercise useful but challenging. This fact led to the discussion on the need to develop additional methodological guidance for educators to explain the purpose and the content of the Edu4Standards.eu ILO Framework, and provide guidance for the mapping exercise. Following the exercise and the reflection on it, the first attempt at developing a guidance document was made, the guidance document is presented in Appendix MXG-1.

Table 3-12. Examples of relevant to standardisation skills, as defined in the Edu4Standards.eu ILO Framework

S5.1: assess the need for standards in line with EU values and interests.
S5.2: assess the need for getting involved in standardisation.
S5.4: explain the steps needed to identify and use standards relevant to a specific topic of interest.
S5.5: analyse the interactions between standards and the regulatory framework.
S5.6: outline the professional activities of a standardisation expert during committee meetings, between organisation meetings, inside his/her own organisation, further activities as a national delegate.
S5.8: implement standards in product or process development.
S6.1: be actively involved in standardisation processes (participant).
S6.2: illustrate interactions between standards and regulatory framework
S6.4: analyse value conflicts in a standardisation use case
S6.6: promote green/digital/gender aspects in standardisation through active participation in various initiatives.
S7.2: strategically influence the agenda in standardisation processes.
S7.3: understand the key determinants of successful standardisation in line with EU values and interests.
S7.6: lead standardisation committees.
S7.7: depict interdependencies between standardisation and innovation
S7.8: depict the relation between standardisation and IPR (relevance of patents, tension between patents and standards).
S7.10: understand standardisation in the context of the national quality infrastructure and the macroeconomic environment
S8.1: participate in discourse on standards and standardisation in line with EU values and interests at the most advanced level.
S8.8: lead complex projects on standardisation within one's field and at the interface between fields taking into account actively EU values and interest.

3.6. Interviews

Edu4Standards.eu consortium partners were conducting interviews (see Table 3-13 for survey metadata) with standardisation educators and professionals. In total, 12 interviews were conducted during the period from June 4 to December 5, 2024 (see Table 2-3 above). The aim of the interviews was to identify relevant topics, teaching methods, and content of standardisation education, as well as best practices related to topics, learning environment, and teaching methods within different venues of professional engagement with professors and lecturers, practitioners, researchers.

Table 3-13. Metadata for interviews

Focus	Interviews to <i>identify relevant topics, teaching methods, and content of standardisation education, as well as best practices related to topics, learning environment, and teaching methods within different venues of professional engagement with professors and lecturers, practitioners, researchers</i>
Date launched	June 4th
Date answers due	September 30th
# of responses	12
Report on the data	T22_INTERVIEWS_compiled_responses_20241022
Data source	The data are available on request from VU

Table 3-14. Interviews summary on teaching methodology, content, topics, and best practices related to topics

Respondent	University teacher	University teacher	University teacher	University teacher	Practitioner	NSB	NSB	NSB	NSB	NSB
Teaching disciplines*	University teacher	University teacher	University teacher	University teacher	Practitioner	NSB	NSB	NSB	NSB	NSB
Standards	SDO		SDO, O						SDO	
Standardisation	O	EP, SDO		SDO, O		U				SDO, O
LAW			SDO							
Economics, market regulation			L							
Safety					SDO, O, EP					
ICT domain: Telecommunications Engineering degree		SDO		U				U	SDO	
Management (of Technology)							SDO, L			
Sustainability					SDO, O, EP		SDO, EP			

*Q: teaching methods, relevant topics, the content of standardisation education

O: own content; P: scientific publications; U: unspecified, SDO: the materials of standardisation organisations, standards, DR: dedicated repositories – the materials of the educational projects HSBooster and StandICT, L: legal documents.

Source: T22_INTERVIEWS_compiled_responses_20241022

Table 3-15. Learning activities and methods used worldwide and by the interviewed parties

ISCED LEVEL	LEVELS 0-4	LEVEL 5	LEVEL 6	LEVEL 7	LEVEL 8
Teaching activities					
Practice-based learning: participation in standards development activities		✓	✓	✓	✓
Practice-based learning: visits of students to NSB offices		✓	✓	✓	✓
Practice-based learning: participation in internship projects within standards institutes		✓	✓	✓	✓
Practice-based learning: participation in industrial projects		✓	✓	✓	✓
Weekly practicum which allows students to learn in a hands-on environment the techniques that are communicated through the standards		✓	✓	✓	✓
Practice-informed learning: guest lectures given by NSB staff, experts		✓	✓	✓	✓
Research-based learning: participation in and conducting research projects		✓	✓	✓	✓
Experimentation: experiments and preparation of laboratory reports					
Design and prototyping: design, test, and analysis of functional prototype (product development, engineering). Addresses referencing and using standards		✓	✓	✓	✓
NSB facilitation of contacts between academics and committee member experts (who can provide guest lectures and materials)		✓	✓	✓	✓
Provision of technical expertise by universities for studies carried out or commissioned by NSBs		✓	✓	✓	✓
Gamification (including serious games)		✓	✓	✓	✓
Analysis of real-world case studies taken from the local context		✓	✓	✓	✓
Collaborative approaches (cooperation with external partners)		✓	✓	✓	✓
Classroom discussions, reflecting on articles and student-centred approaches		✓	✓	✓	✓
Workshops		✓	✓	✓	✓
Analytical and computer methods for designing, performing, and analysing experiments		✓	✓	✓	✓
Other: organization of conferences/workshops to support or stimulate education about standardisation		✓	✓	✓	✓

3.6.1. Summary of the findings of the interviews

The survey conducted by partners aimed to collect data on teaching methods, content, topics, and best practices related to standardisation. The interview guide was developed by Nizar Abdelkafi, POLIMI, after discussions and taking into account recommendations of the partners in the task. The guideline contains questions targeted at different types of respondents: teachers, practitioners who also teach, standardisation development organisations, researchers, as far as some of the respondents have multiple work obligations.

There are different approaches to the definition and classification of teaching methods. In most cases, teaching methods represent a number of learning activities, some of them can be overlapping. One of the examples of the classification can be the following: digital teaching, online teaching, blended learning, flipped classroom, hybrid teaching, self-directed learning, problem-oriented learning/problem-based learning, research-based learning and teaching, project-oriented learning, cooperative/collaborative learning, interdisciplinary learning, service learning, challenge-based learning, gamification, education for sustainable development, competence-oriented teaching. As far as each teaching method includes a variety of learning activities, most of the respondents provided more precise answers to the question on teaching methods and mentioned learning activities they use to teach standardisation.

1. Teaching methods and learning activities

The respondents mentioned the following learning activities: training, online lectures, guest lectures, workshops, slides, a book report on a presentation, group work, research work, study groups, co-teaching to engage for training, workshops, case studies, role-play, games, podcasts, learning by doing, webinars, meetings, online activities, storytelling, discussions, some recorded modules, guest lectures, standardisation days, project days, specific standards trainings, MOOC, report, leaflets, writing own books.

One of the respondents said she engaged participants through emotional and passionate speeches and discussions. Other respondents admitted making their courses interactive: giving five-minute assignments, serious games or reflecting on the papers in the power point presentations format.

Some respondents admitted students considering standardisation unattractive to students compared to the specific topics related to their degree/field of studies. Thus, there is a need to upgrade awareness of the importance of standardisation in line with EU values and interests among higher education institutions professionals and students, according to the answers of the interviewed.

2. Best practices

Collecting the examples of best practices of teaching standardisation resulted into the following list of activities mentioned by the respondents:

- putting standards databases into the libraries of the universities;
- using templates and guidelines of the respectively functioning agencies;
- networking events;
- collaboration of SDOs and universities;
- engaging students with real-world applications, making the topics more interesting;
- using practical examples and videos to show how standards impact everyday life;

- interactive learning and using games;
- international trainings;
- creating a MOOC course.

Practice-based learning dominated as the method of cooperation of universities with national standardisation bodies (NSBs). Mostly, NSBs conduct only one or two practice-based learning activities while some of the organisations offer a list of them. Guest lectures, podcasts and videos, teaching modules produced by NSBs were also mentioned by respondents as the learning activities provided in cooperation with NSBs.

One more way of cooperation between NSBs and universities is participation of universities in the standardisation bodies committees. Thus, universities practically take part in developing standards.

3. The future vision of standardisation education

Teachers and practitioners admitted that having standardisation as a concept for education is a challenge at their HEIs, as well as finding resources to deliver standardisation-related topics. Some of the respondents admitted that free access to standards would simplify teaching, as well as establishing an online certified course. The majority of the respondents reported the need to popularise standardisation education, to attract more students to the courses, to make education about standardisation a fine-tuned mission, get more people involved in standardisation education. Some respondents mentioned smart standards. According to the respondents, the future of standardisation education would be seen via:

- programs incorporating standardisation education into different courses;
- long-term programs as qualification in standardisation;
- the European-style syllabus curriculum, which could become part of an undergraduate degree or postgraduate post-qualification;
- standardisation as a part of university curricula without the need to impose an additional subject, but as a part of existing educational programs;
- standardisation-based research to boost technologies' development;
- the importance of a strategic vision of building standardisation ecosystem;
- the need to take new legislation into account while planning the strategic development of standardisation;
- making standardisation popular and visible through different media;
- fostering the understanding of standardisation in line with EU values and interests as a matter of citizen engagement.

3.7. Web search

48 websites were visited to collect data on gender, green and digital skills incorporated into standardisation curricula worldwide. These included 7 consortium partner universities in the EU and 41 U.S. universities enlisted on the website of the American National Standards Institute as HEIs, which are cooperating with ANSI and provide freely accessible information on joint educational activities. The aim was to identify whether or not their references to policy-desired skills for education about standardisation can be identified in the description of educational courses by searching of the keywords like “gender equality”, “sustainability”, and “ethics”, “digital” etc. The content of 118 standardisation courses of both European and American higher educational institutions was analysed. Few highlights of the findings can be presented:

- **Ethics:** explicitly mentioned in course descriptions of 8 out of 48 (17%) universities. Addressed in courses related to medical studies, genetics, biology and natural sciences;
- **Green skills:** explicitly mentioned in course descriptions of 7 out of 48 (15%) universities. Addressed in courses related to sustainability;
- **Gender equality:** explicitly mentioned in course descriptions of 4 out of 48 (8%) universities;
- **Digital skills:** explicitly mentioned in course descriptions of 2 out of 48 (4%) universities.

3.7.1. Summary of the findings of the web search

The policy documents² set the strategic orientation for higher education to support the key European development strategies: transition to green and digital Europe, safeguarding EU core values, attaining gender equality in education and research, among others. The web survey findings show that only a small percentage of courses which are related to standardisation cover the policy-demanded topics.

The largest coverage was found for the concept of “ethics”, which can be seen as a key concept in the discussion on human-centricity and societal facets of education about standardisation (as extensively elaborated in D2.1 and in Sec. 1 of this report). This concept, however, is mostly missing from the programs/courses in Management, Economics, or Social, Humanitarian sciences. Green skills is the second most referenced skill set, yet it is referenced in even narrower segment of courses – mostly in the context of sustainability.

² For the comprehensive analysis and the list of the analysed policy documents see Appendix PA-3.

Gender equality and digital skills are the least referenced, found in less than 10% of course descriptions, and are mentioned twice or four times less frequent than the ethics and green skills.

The comprehensive summary of the results of the web survey were aggregated in XLS tables³ containing information on 67 EU and 41 U.S. university courses descriptions.

3.7.2. Summary of the findings on interviews and the web survey

The table (Table 3-15) on teaching standardisation methods was composed based on the interview responses conducted by partners and the web survey of academic/university web sites.

The research was conducted among universities teachers and NSBs representatives who also teach standardisation. Data in the table presents teaching methods and learning activities used by standardisation teachers by the levels of education classified by ISCED (EUROSTAT, 2011).

As already reported in Section 3.5 (“The mapping exercise”), consortium partners use a variety of teaching methods in delivering education about standardisation. The interviews gathered more perspectives on educational approaches, which was again broadened by data from the web survey.

The majority of interview respondents reported using similar teaching methods: lectures, power point presentations, reading scientific publications and reflecting on them, performing team and individual projects, participation in research, listening to podcasts. Some responses referred to watching educational videos. One of the replies included method individually used by the trainer – using actor’s skills to get students involved. Other methods to get students involved included asking them questions, adjusting the content to the local context of the learners, asking for the students’ reflection, providing the content to make students find interconnections between standardisation and the topic taught.

The results of the web survey show a broader scope of approaches to education. To emphasize is the practice when universities are cooperating with NSBs. Such collaboration results in a bigger variety of teaching methods: guest lectures, designing new products using standards, participation in internship projects, visits of students to NSB offices, provision of technical expertise by universities for studies carried out or commissioned by NSBs.

The survey of the US universities websites revealed a broad scope of their collaboration with American National Standards Institute (ANSI), not only in terms of methods, but also in terms of disciplines. Some examples to mention:

³ The data are available on request from VU. File reference: HEI courses_content_methodology_values_OK

new product development (NPD) / product design, project-based approach, case studies, teamwork, experiments and experiment analysis. The disciplines mentioned include pharmaceuticals, medical equipment, astronomical sciences, engineering, ICT, mechanics, etc.

Common for both, European and the US universities is the practice of teaching standardisation as a part of other courses – technology, economics, law, etc. When such approach is chosen, the most popular teaching methods are case studies, scientific publications analysis, classroom discussions. Serious games as a teaching method are used in standardisation courses across the EU. Respondents also mentioned using videos, podcasts, MOOC courses used to increase the involvement of students into the standardisation field.

Stemming from the overview of university courses related to standardisation, it has been concluded that if the discipline is related to sustainability, it is evident that teachers do incorporate green skills into the content. The same situation can be observed within the field of medical studies, genetics, biology and nature sciences. In this case, some ethical considerations are included in the curriculum. Gender equality issues remain unaddressed by the majority of educators.

But the main streamline of the content is that if it goes beyond nature sciences, it does not incorporate developing knowledge on gender equality or digital skills in standardisation education. Thus, the policy documents require academia to tackle main European strategies – transition to green and digital Europe with gender equality in education and research while university teachers struggle to identify the necessary skills and choose/create a working competence model from existing or prospective instruments and tools.

The majority of standardisation courses still do not contain topics to develop green and digital skills, as well as gender equality awareness. Although, there are sources of information on gender responsiveness in standardisation and they were mentioned as teaching materials by the minority of respondents.

3.8. Review of teaching materials

The surveys aimed at identifying teaching materials used by the consortium partners were complemented by additional review of suitable / relevant teaching materials for teaching about standardisation in law studies. Whereas detailed information is provided in Appending TM-1, few reflections can be provided here.

First, the results of the dedicated efforts to collect relevant to education about standardisation materials are in line with the responses collected through the project-initiated surveys: there is a great variety of teaching materials which are or can be used in education about standardisation. The “traditional” portfolio of knowledge sources used

in education are textbooks, scientific publications, published standards. In law, studies, legal texts and policy documents are extensively/widely used.

An important observation can be made that the educators note a non-availability of free access to the texts of published standards. This, however, may be changing in the nearest future due to the ongoing legal / regulatory dispute in the EU. Currently, there are not enough sources focusing clearly on incorporating European interests and values in the standardisation education.

Another important observation is that (serious) games are increasingly used, or receive increasing interest from teachers in the field of standardisation. Here, however, the issue of free access/free games is also noted. Most known games suitable / developed for education about standardisation are offered on a paid basis. In most cases, the content of games is generic with no specific industry information. Some standardisation games are interactive and can be accessed online, while others are board games. The duration and content of the activities varies from a short introduction to the subject to the full day management problem-solving game on setting standards, the examples of which are provided in the Appendix TM-1.

More information on games suitable for education about standardisation is presented in Deliverable D2.3.

3.9. Review of the EU educational landscape

The 2022 “EU Strategy on Standardisation” (The European Commission, 2022) calls for a human-centric approach to standardisation, as well as for EU standards and standardisation to support EU interests and core values, promote gender equality and foster green and digital skills of the general population (see Appendix PA-1). This call can be seen as an apex of the wave of policy efforts aimed at the introduction of responsible innovation and standardisation, the roots of which can be traced to the early 2010. This policy call signals the paradigmatic shift in the role of technology in society and calls for revisiting the role of the society in the standardisation system.

In the context of the new EU strategy for standardisation, and the pretext on the responsible standardisation efforts, the term “responsible” must be understood as that which takes into account the effects that the standards may have on others, on society at large or on the environment and trying to make sure that they do not harm any of these. These invited features of “responsible” and “human-centric” can also be understood as bi-directional concepts – not only the effects of standards on society, but also the effects of diverse societal stakeholders on standards and standardisation.

In this section we bring forth few important implications for education about standardisation based on the historic context in which the call for responsible and, later-on, human-centric standardisation emerged. To start with the historic context, the way the European Commission (2013, p. 3), defines *“Responsible Research and Innovation (RRI) ...[as a]... comprehensive approach of proceeding in research and innovation in ways that allow all stakeholders that are involved in the processes of research and innovation at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of societal needs and moral values and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services”*. Grunwald (2011, p. 28) adds the ethical dimension and observes that *“... Responsible Innovation unavoidably requires a more intense inter- and trans-disciplinary cooperation between engineering, social sciences, and applied ethics”*. Thus, 1) broad stakeholder participation and 2) inter- and trans-disciplinary cooperation can be seen as the core of the “responsible” approach to standardisation. Despite the European Commission’s considerable efforts (see e.g. (Shanley et al., 2022)) in bringing forth (more) responsible and (more) human-centric approaches to standardisation, the progress has so far been disappointing. We argue here that one of the causes of that disappointing outcome to be found in the fact that the two “core criteria” of responsible standardisation - broad stakeholder participation and 2) inter- and trans-disciplinary cooperation – were not and are not matched by the corresponding educational initiatives. Further to that, prior to the 2022 EU Standardisation Strategy, the EU Policy on standardisation has never actually been focused on societal members.

One of the key organizational principles of the higher education system in Europe and globally is its orientation towards the “market demands” for skills. The established understanding about the skills and competences required from standardisation professionals is well presented in a number of EU and international studies, included those sponsored by the European Commission (Blind & Drechsler, 2017; ISO, 2019a, 2019b). The explicitly mentioned support for EU interests and core values, for gender responsive standards, for fostering green and digital skills by and through standardisation – these can be seen as non-technical requirements for standards and standardisation. The knowledge requirements towards “in-companies” (ISO, 2019a) and “in standards-related organisations” (ISO, 2019b) standardisation professionals are not inclusive of these new non-technical dimensions. From the inception of the modern standardisation system more than a century ago and until today, standardisation professionals contribute to the development of new standards by representing their respective employer and thus promote corporate interests (Blind & Mangelsdorf, 2016). The broader societal grasp and the turn to human-centric standardisation requires reconciling this juxtaposition of corporate interests on the one hand and societal concerns on the other. To change the situation, societal stakeholders must be made aware that they stand to suffer from standards that only reflect the technically feasible and/or the economically desirable (from a corporate perspective, as opposed to a societal one) features. This awareness creation, combined with the need for broad societal /

stakeholder representation and the need for inter- and trans-disciplinary cooperation can and should be addressed through education.

Table 3-16. The roles and responsibilities of standardisation professionals

	Title	Example	Role/responsibility
Standards as a core: standardisation professionals	Officer of the standardization body	Principal officers: https://www.iso.org/structure.html	Administration of the Standardisation body and its structural units
	Secretary / manager of the Technical Committee;	Committee Manager: https://www.iso.org/committee/48750.html	Assistance to the Technical Committee, management of a specific standardisation process. Cf. "The role of Committee Manager", p. 6 at https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100415.pdf
	Technical Programme Manager	Technical Programme Manager: https://www.iso.org/committee/48750.html	Reporting to a Technical Team Leader, the Technical Programme Manager delivers results by monitoring the performance of his/her programme.
	Editorial Manager	Editorial Manager: https://www.iso.org/committee/48750.html	Management of editorial development of assigned projects
	Technical committee member/expert	TC member: https://eshop.lsd.it/public#!/committee/info/5998	Professionals (subject matter experts) working in a specific business or public sector (consumers) organisation who are involved in the development of the content of standards. Cf. https://www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/my_iso_job.pdf
Standards as periphery: known roles of standards users and decision-makers	Business or public sector organisation professional	Senior librarian: https://www.lnb.it/en/contacts/information-management-department/data-management-unit Professional at the Department of Restoration on [some] museum: https://www.uffizi.it/en/pages/restoration-department	Applied, professional work in the field of competencies (librarianship, exhibit restoration, engineering, logistics... etc.)
	A professional working in the legislative field/state or municipality administrative body professional	Member of the Committee on Culture at the National Parliament: https://www.lrs.lt/sip/portal.show?p_r=38374&p_k=2&p_kade_id=9&p_pad_id=1072 Director of the Department of Cultural Heritage: https://kpd.lrv.lt/en/about-us/contacts/	Development, revision, and approval of legal documents at the national, municipal or institutional level
	Food certification laboratory worker	Employee (or head) of food and water (quality) control laboratory ISO/IEC 17025: https://www.iso.org/ISO-IEC-17025-testing-and-calibration-laboratories.html	Certification of food, water, stock feed against the national or international requirements for quality, component nomenclature, or nutrients. Sensory analysis: https://www.iso.org/ics/67.240/x/ Food microbiology: https://www.iso.org/ics/07.100.30/x/
Standards as periphery:	Journalist	<i>To be discovered/ described</i>	E.g., creating awareness about standards and standardisation among the general population
	Nurse or health / assisted living specialist	<i>To be discovered/ described</i>	E.g., professional work in the field of nursing and/or assisted living, where knowledge of legal requirements, technology options, and health requirements are inter-related
	Etc.	<i>To be discovered/ described</i>	<i>To be discovered/ described</i>

The new approach to education about standardisation must instil knowledge about the roles standards play not just in the technical domain, but also economically and for society at large (environment, health and safety, etc.). Consider Table 3-16, where the list of the traditional roles of standardisation professionals, as covered by IWA 30-1 and IWA 30-2 (ISO, 2019a; 2019b) is complemented by what can be considered as non-traditional or “shadow” roles – professionals, whose daily work requires knowledge of standards and standardisation, but who are unlikely to participate in “in-company” or in “in standards-related organisations” work.

If the traditional standardisation jobs require education about standardisation where the standards are “the core” of the education (the upper part of Table 3-16), then the “shadow” professions – we can refer to them here as “the new standards professionals” - are more likely to require education where standardisation is “the periphery”.

Eventually, the knowledge of the “new standards professionals” may need to be complemented by more practical knowledge about standards and standardisation - e.g., entities, processes and documents. This knowledge may lead to an (increased) awareness of the importance of standards and standardisation in the different domains, and for the professionals taking a more active part in the development of standards. For this to happen, however, the policy and the new approach to standardisation education must recognize the importance of the creation of awareness about the importance of standards across disciplines and educational levels. To date, however, the human-centric, societal perspective on standardisation was seen by the policy and professionals as a one-way, top-down initiative which did not imply broad participation of societal members (see Table 3-17).

Table 3-17. The efforts of policy and education to promote the idea of responsible standardisation

Focus of the policy action Policy era	The key elements of the policy	Expected effect of the policy	Expected sources of knowledge about standards and responsibility
Prior to the launch of EU RI debate (prior to 2010)	Government (laws to protect citizens)	Adoption and use “safe” standards and technologies by markets	Law and Professional education
Since the launch of EU RI debate (between 2010 and 2023)	SDO and representative organisations (proxies) of societal stakeholders	Engagement of societal stakeholders in standardisation	University and professional technology and engineering education
The 2023 Standardisation strategy	Citizens, societal stakeholders	Awareness of benefits of value-based standardisation	Pre-school and school education, university and professional education not limiting to technology engineering

It is at this background, that we would like to review the EU HE landscape in the following subsections. Education about standardisation can bring the policy-desired paradigm shift in standardisation – making standardisation serve EU interests and safeguard EU core values, as opposed to (or balanced against) corporate interests and values. The framework of intended learning outcomes presented in Deliverable D2.1 (the ILO Framework) proposed a generic hierarchical categorisation of knowledge which the education about standardisation must cater for, for the paradigmatic change in standardisation practice to take place. For one, the ILO Framework brings forth the understanding that the appreciation of personal and societal responsibility must be established early on, prior to entering the higher education. Second, the recognition of the fact that conceptualisation of the “standardisation professional” cannot be limited to “in company” and “in standards-related organisations” work as defined in the well-established competence frameworks (Blind & Drechsler, 2017; ISO, 2019a; 2019b) calls for the development of a discipline- and domain-/industry-specific competences for standardisation professionals. Table 3-16 above makes the first step towards such effort by enlisting few examples of the “new standards professionals”. Identification of knowledge requirements for new / non-traditional domains can be done through a discussion between HEIs, standards organisations, and industry-specific companies, where the “new professionals” fulfil their daily work. Edu4Standards.eu envisioned “Call for Pilots” program can be one of the first practical efforts in filling the knowledge gap on the “shadow” roles and the corresponding knowledge and skills.

Our assertions are supported by recent observations of the High-Level Forum on Standardisation, that *“Societal stakeholders, in particular, highlighted in their responses how their experts and representatives often feel isolated during technical discussions, unable to effectively present their views and interests or influence the consensus position”* (HLF, 2024, p. 20). Education about standardisation can and should promote awareness creation about importance and the role of standards and standardisation in different disciplines, and at different educational levels, as defined by the ILO Framework.

3.9.1. Distribution of education by field and sex

Eurostat data offer a good overview of the state of European HE in terms of disciplines, gender, and levels of education from the demand side of the HE market. It is these three variables, which must be considered given 1) the European policy vision for the development of the EU industries and society in general (as reviewed in Sec. 1 above), and the EU standardisation strategy in particular, and 2) the Edu4standards.eu project’s anticipated impacts, as elaborated in the project’s GA. Hence, it is the relevance of education about standardisation and the targeted impact which can and must be discussed at the backdrop of the European HE landscape.

Eurostat data show that the most popular field of tertiary education are Business administration and law, Engineering, Health and welfare, Arts and humanities, Social sciences and journalism, and Education. These fields to large extent are represented in the project consortium (see Table 3-3, Survey #1 “Disciplines and topics”). These fields can be also mapped as having special importance for the professional domain of standardisation (see Table 3-16 above, Table 3-18 below).

Table 3-18. Educational perspectives on standards and the broad fields of education

Educational perspective on standards and standardisation	The relevance to the broad field of education
Development of standards, new product development	Engineering
Standards market competition, new product development	Business studies, Economics
Uses of standards-based technologies and services	Health and welfare
Adoption of standards, public procurement	Business and administration, law
Safeguarding EU values and interests	Law
Promoting awareness about the importance of standards and standardisation	Journalism

Whether education about standardisation is often considered to pertain mainly to the engineering field, this field is the second largest, and with almost three times greater number of male students. Such situation invites rethinking the importance of the policy call to gender responsive standards and standardisation. Infamous examples of standards which can serve almost exclusively the needs of male population (such as the car airbag standard, chemical hazard protection gear, among other) can be explained by this gender aspect of European engineering education.

Eurostat provides few highlights on the gender aspect in tertiary education (also see Figure 3-1 below):

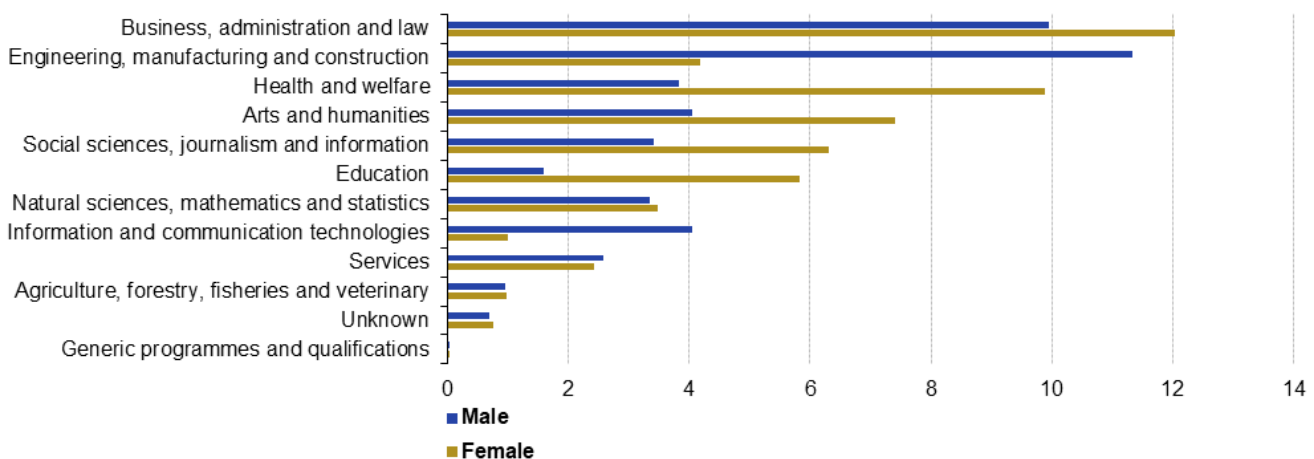
- In 2021, women accounted for 54.2 % of all tertiary students in the EU. The share of women among tertiary students was:
 - 48.4 % for those following short-cycle tertiary courses,
 - 53.7 % for those studying for bachelor's degrees,
 - 57.5 % for those studying for master's degrees, and
 - 48.8 % for those studying for doctoral degrees.

As such, the majority of short-cycle tertiary students and doctoral students were men, while the majority of bachelor's and master's students were women.

Among students studying for master's degrees, women were in the majority in 2021 in all of the EU Member States. Given the statistics, consider the role of women in health and welfare study programs at the backdrop of the importance of standards in health- and life-support technologies and services. Education about standardisation in

this broad field can and perhaps should be delivered by women. For this matter, the broad field of Education has four times more female students. The same can be conjured for the broad field of Social sciences, journalism and information– with three times larger number of female graduates, these future education and media professionals will be the key players to promote the awareness of the importance of standards to the general population. It is exactly in these fields, where there are observed the greatest gender imbalances, and where one can expect bigger impact in promoting the strategic orientation of the new approach to education about standardisation, as captured in the slogan “boosting EU competitiveness while safeguarding EU interests and values”.

Distribution of tertiary education students by broad field and sex, EU, 2021 (%)



Note: ranked on the total (male and female) share of students in each broad field.

Source: Eurostat (online data code: educ_uae_enrt03)

Figure 3-1. Distribution of tertiary education students by broad field and sex.

Source: https://ec.europa.eu/eurostat/databrowser/view/educ_uae_grad02/default/table?lang=en

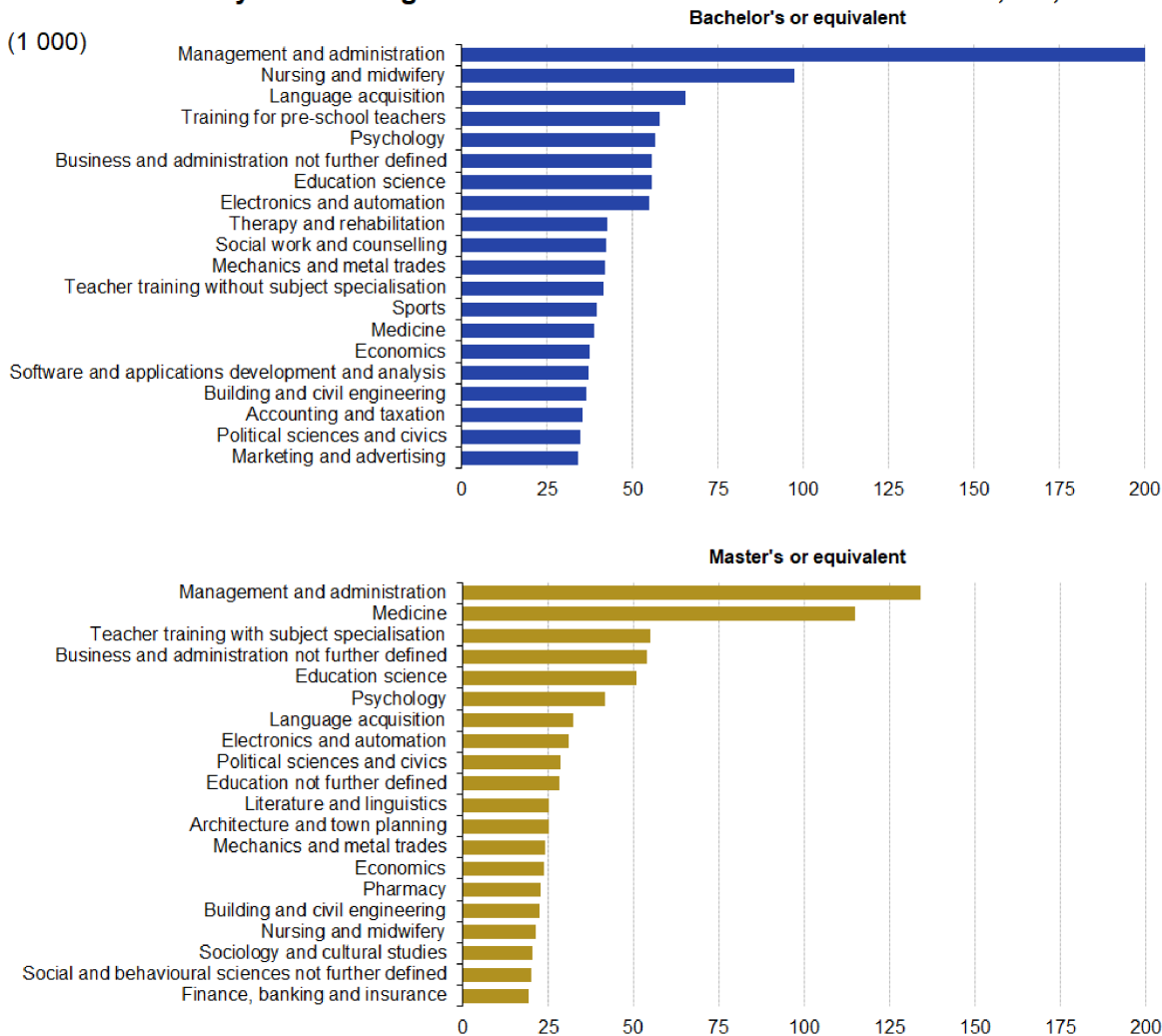
3.9.2. The educational level and the broad disciplines

Additional insights can be gained from examination of differences in the popularity of fields of education between bachelor and master levels of education (see Figure 3-2). Eurostat provides a few highlights which can be of importance in the context of education about standardisation.

- In 2021, 22 % of tertiary education students in the EU were studying business, administration or law.
- In 2021, the most frequently awarded degree in the EU was for management and administration.

- Some 14.8 % of all tertiary graduates were women graduating from business, administration and law, while 10.8 % were men from the same field. Equally, around one-tenth of graduates were men from engineering, manufacturing and construction (10.8 %) and another tenth were women graduating from health and welfare (10.4 %).

Number of tertiary education graduates in each detailed field of education, EU, 2021



Note: the figure shows the top 20 detailed fields of education with the highest numbers of graduates for each type of tertiary degree.

Source: Eurostat (online data code: educ_uoe_grad02)



Figure 3-2. Number of tertiary education graduates in each detailed field of education, BSc and MSc.
 Source: https://ec.europa.eu/eurostat/databrowser/view/educ_uoe_grad02/default/table?lang=en

These highlights, once again, have importance if considered at the backdrop of the educational perspectives on standardisation (see Table 3-18 above and Table 3-19 below):

- Promotion of EU interests and values through education about standardisation in the broad field of Management and administration can have impact when considering such topics as public procurement, national and international technology policies, company strategies for market competition, etc.
- The educational fields where women outnumber men are well positioned to promote the general awareness about the importance of standardisation, the ethics of technology and service standards, the societal aspects of standards and standardisation.

3.9.3. Summary of the findings of the review of the EU HEI landscape

The analysis of the European tertiary education landscape by sex of students and graduates from different fields reveals great differences in gender concentration for engineering, management studies, social sciences, journalism and information as well as for arts and humanities. These differences invite to ask a question on whether a uniform or differentiated didactical approaches have to be developed or at least considered when implementing education about standardisation oriented towards future professionals for a) standard development, b) standards market adoption and competition strategies, c) implementation of standards in products and in organisations, d) promotion of awareness about standards and standardisation, e) education about standards and standardisation in line with EU interests and values.

Additional questions should be considered, when devising strategies for the highest relevance and impact of education about standardisation, also with respect to the “core-periphery” categorisation of standards-relevant professional affiliations (as exemplified in Table 3-16 above):

- Which educational field(s) can/should be considered as having the highest relevance and potential impact for education about standardisation?
- Which educational field(s) are most relevant for promoting human-centric, societal, and gender responsive perspective on technology standards and standardisation?
- Which educational field(s) are better positioned to promote European interests and core values?
- What approaches to education about standardisation are more relevant / most suitable when knowledge about standardisation is the core or the periphery of the educational effort?

To conclude, the task of mapping educational resources available for education about standardisation would be incomplete if considered in isolation from the European landscape of higher education. Standardisation is often taught as part of a course under different title, rarely as a “stand-alone” discipline. The summary of the most popular fields, the distribution of students by gender, and the relevant professional domains is presented in Table 3-19.

Table 3-19. The most popular educational disciplines, BSc and MSc

Most popular according to Eurostat* (the number of graduates each year, thousands)	Educational perspective on standardisation	Subject to great gender imbalance
Management & administration (200 BSc, 140 MSc), Business & administration (55 MSc)	Standards market competition; Selection of standards in new product development; Public procurement	
Nursing & midwifery (100 BSc), Medicine (110 MSc)	Uses of standards-based technologies and services	2,5x more female in the broad field of Health and welfare
Language acquisition (60 BSc)		2x more female in the broad field of Arts and humanities
Psychology (55 BSc, 35 MSc)		
Education science (55 BSc, 50 MSc), Training for pre-school teachers (55 BSc), Teacher training (55 MSc)	Safeguarding EU values and interests; Promoting awareness about the importance of standards	4x more female in the broad field of Engineering, manufacturing and construction
Electronics and automation (55 BSc)	Development of standards; Selection of standards in new product development	3x more male in the broad field of Engineering, manufacturing and construction
Social sciences, journalism and information (the 5 th largest field by the percentage of students, BSc and MSc combined)	Promoting awareness about the importance of standards	2x more female

* Source: https://ec.europa.eu/eurostat/databrowser/view/educ_uae_grad02/default/table?lang=en

The broad fields, which are highlighted in bold in Table 3-19 are these covered in teaching by Edu4standard.eu consortium partners. The fact that there are more fields which are not covered by Edu4standards.eu educators, serves as an additional justification for the planned Call for Pilots. Table 3-19 also invites further elaboration of how to approach standardisation as the core and the periphery topics in education, as well as seeking inter- and cross-disciplinary examples and other educational resources. Finally, Table 3-19 enlists the educational fields which are not considered as the traditional fields from the perspective of standardisation education. Leveraging education about standardisation in these fields, among the already mentioned implications, would require an effort to contextualise the general knowledge components of the ILO Framework developed under D2.1 into discipline- and profession- specific skill sets to make the education about standardisation attractive and meaningful for students (Fomin, 2020).

4. Framework Model of ITCoS

One of the key intellectual outputs expected from WP2 of Edu4Standards.eu project is the development of the Innovative teaching Concept of Standardisation – ITCoS. According to the project’s Grant Agreement (GA), ITCoS is conceptualised very broadly:

The ITCoS will be designed under the lead of teachers of EU HEI, who already integrate standardisation-related content in their lectures, in co-operation with industry and standard setting organisations... The ITCoS aims to bridge industrial and societal facets as well as integrate the aspects of responsible, human-centric standardisation and the EU core values into standards-development processes. This ITCoS should foster the development of green and digital skills and underline their respective support through standardisation.

Further, Edu4Standards.eu GA defines ITCoS as a composite of *a generic educational instrument and its implementation guide*. In line with the conceptualisation of ITCoS as established by GA, three tasks under WP2 jointly contribute to the development of ITCoS aimed at reinvigorating education about standardisation under the slogan “boosting EU competitiveness in line with EU values and interests”, each with a distinctive intellectual product. ITCoS development work started under T2.1 with the formulation of intended learning outcomes (ILOs) which – for the first time in the practice of European education about standardisation – were explicitly developed to meaningfully embed EU interests and values.

This D2.2 presents a curricula development and implementation framework model – the Framework Model of ITCoS – which establishes the framework for the advancement of education about standardisation in accordance with the established practices of the educational domain and in support of Edu4Standards.eu project goals.

ITCoS development work started under T2.1 with the formulation of intended learning outcomes (ILOs) which – for the first time in the practice of European education about standardisation – were explicitly developed to meaningfully embed EU interests and values.

T2.3 contributes to the conceptualisation of ITCoS as a generic teaching concept use guide for standardisation education, which starts from the identification of industry needs for knowledge and skills, and matches them with relevant skills defined in the D2.1-presented ILO Framework. Next, D2.3 suggests an ITCoS Tool for identifying and sharing relevant educational resources (content, methods) for education about standardisation.

The Framework Model of ITCoS presented here takes a broad(er) perspective on the HE in Europe. The Model treats HE as a multi-stakeholder environment established by policy makers, HEI management, lecturers, and technical and administrative staff. The Model is aimed to explicate that the reinvigoration or advancement of education about

standardisation is not likely though in-class or in-company teaching practice alone. Advancement of a novel approach in HE requires engaging different instruments at all levels of the hierarchical Framework Model of ITCoS – policy, relevance and impact, program integration, and, finally, didactical, technical, and administrative support for teaching (see Figure 4-1).

The Framework Model of ITCoS as presented here is the result of many discussions and sense-making exercises among the consortium partners during the first 11 months of the project, up to the moment when this report (D2.2) had to be finalized for the internal review (see Table 2-4 for the lineage of the sense-making effort and Figure 2-1 for the graphical presentation of the analytical and the data collection efforts). The presentation of the Framework Model of ITCoS starts with quoting the relevant “requirements” towards ITCoS from the GA, and ends with the discussion on how the Framework Model of ITCoS can guide the advancement of the education about standardisation, starting from the Model’s operationalisation during the next stages of the project, especially in respect to the teaching pilots and drafting policy recommendations.

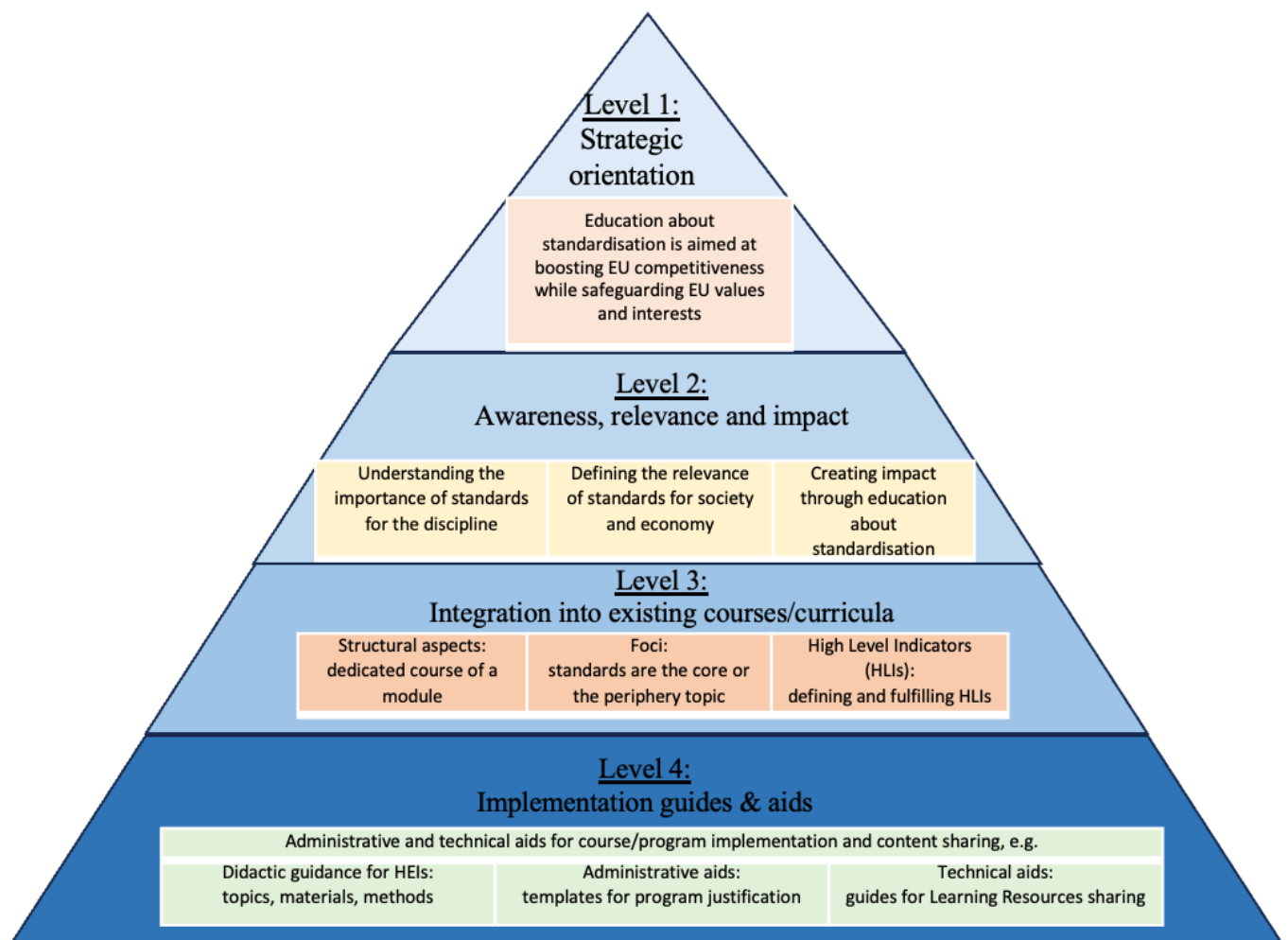


Figure 4-1. Framework Model of ITCoS: four-level framework for the advancement of education about standardisation

Level 1: Strategic orientation // the guiding principles of ITCoS

Fostering EU competitiveness through standardisation and standards in line with European values and interests.

The ultimate aim of the effort to invigorating education about standardisation in Europe is to enhance EU competitiveness by developing among professionals and laymen a deep understanding of standardisation and standards that align with EU core values such as human dignity, democracy, gender equality, and the rule of law and protect EU interests, including the development of green and digital skills.

The Level-1 of the Framework Model of ITCoS defines the top-level hierarchical goal to deliver education about standardisation (edu4s) which:

- teaches/explains to students how standards and standardisation can promote the interests of private and public organisations in/and the region where they live;
- ensure a commitment to fairness and respect and support for ethical and societal norms;
- enable students to understand the dual responsibility of advancing (private) business goals while committing to EU values and interests.

The Level-1 objective is the guiding principle of ITCoS, which influences all lower levels of the Innovative Teaching Concept. It serves as a strategic orientation for curriculum design and implementation. Edu4standards.eu project contributes with two intellectual products to Level-1:

- ILO Framework – the hierarchical model of intended learning outcomes for education about standardisation based on EU interests and values (presented in D2.1);
- The policy analysis – disambiguating policy requirements and expectations towards education about standardisation in line with EU interests and values (presented as part of D2.2).

Level-1 is where the thrust of Edu4standards.eu deliverable D2.1 is to be found. The ILO Framework, according to GA, establishes the top-level of the hierarchical model of the innovative teaching concept of standardisation.

Level 2: Awareness, relevance and impact // Identifying the demand for discipline- and industry-related skill. Identifying specific skills and knowledge for impact-maximisation.

At this level, the Framework Model of ITCoS helps the relevant stakeholders position their education about standardisation within the diverse landscapes of European higher education and job market, addresses the diversity of disciplines, topics, and integration approaches of human-centric standardisation into education to ensure relevance and impact of educational programs

The Level-2 objective is to create and promote awareness about and maximise the impact of education about standardisation in line with the strategic orientation defined at the Level-1.

At Level-2, the Framework Model of ITCoS addresses the diversity of disciplines, topics, and integration approaches of education about human-centric standardisation and standards. This ensures broad applicability and relevance across educational programs:

- Diversity of disciplines: The knowledge attributes defined in the ILO Framework (Level-1) must be reviewed and the relevant to the specific discipline attributes chosen. This allows developing *specific* skill sets for various fields/disciplines (Engineering, Management, Law, Economics, Health or Social Sciences and Humanities) based on the same set of *generic* knowledge attributes presented/defined in the ILO Framework;
- relevance to the economy: the skill sets to be addressed/embedded in educational curricula are traditionally developed to satisfy job marked demands of a particular sector/domain of economy. A practical example of how ILO Framework can be used to identify skills required for a particular economy sector is presented in D2.3;
- creating impact of education about standardisation in line with EU interests and values: besides the discipline-specific knowledge and industry-specific skills, impact maximisation effort must take into account the following:
 - the need for the development of generic skills identified in the policy documents, such as green and digital skills, among other;
 - eradication of inequalities, such as gender-related ones;
 - EU HE landscape in terms of gender preferences and discipline preferences.

Level-2 is where the thrust of D2.2 is to be found. The overview of the practice of education about human-centric standardisation by the EU expert standardisation educators, the analysis of the EU standardisation strategy and key industrial strategies, and the overview of the EU HE landscape establish a solid foundation for positioning the extant and new educational efforts in alignment with the policy-set directions, market demands, and the realities of the educational system.

Level 3: integration into existing programs or courses // Support for operational curricula implementation tasks.

This level supports lecturers (or company trainers) and program chairs in integrating standardisation-related curricula into existing programs or courses, or creating new programs or courses.

At Level-3, such questions are addressed as the volume of teaching in ECTS, whether standards and standardisation are to be the primary focus of the intended teaching or to be used only for knowledge widening and/or awareness creation.

High level indicators (HLI) help the lecturer establish targets for the teaching effort. These can relate to e.g., the volume of the teaching in ECTS, the level of the knowledge to be attained (e.g., as defined in the ILO Framework), the number of students to be reached, the students' gender-related targets, or other HLIs relevant to the specific venue and educational program.

Level-3 tasks and decisions are typically made in consultation with program chairs (or deans) to maximize the coherence/integration aspect of standards-related teaching content with the broader educational context at the program or department level. Typical questions to be addressed:

- diversity of expertise levels: education about standardisation in line with EU interests and values, as defined in the ILO Framework, can address standards and standardisation at different levels, from the basic level of awareness creation to the advanced level of professional or scholarly expertise;
- different integration approaches: as education about human-centric standardisation must be promoted to different disciplines and educational (and expertise) levels, the knowledge about standards and standardisation can be presented as:
 - Core subject: standardisation as the primary focus of a course, offering in-depth exploration;
 - “Peripheric” subject: embedding standardisation within existing courses with a different focus;
- different targets to be met: high-level indicators have to be defined in line with the broader educational and organisational contexts.

Level-3 is where the activities of Edu4standards.eu WP3 Pilots can be positioned. Implementation of the Pilots require embedding then in the broader institutional context, defining HLIs and evaluating the effort accordingly. Through implementation of the Pilots, the suggested elements of Level-3 of the Framework Model of ITCoS will be disambiguated, resulting in formulation of guidelines and tools for the integration of education about standardisation in extant institutional educational programs.

Level 4: Support // Implementation guides and aids

This level focuses on the practical implementation of education about standardisation in line with EU interests and values. Content, methods, and tools are chosen in accordance with the Level-3 made decisions.

The Level-4 objective is to offer operational and technical aids and guides for implementation of education about human-centric standardisation.

Content, teaching methods, and technical tools are chosen in accordance with the choices/decisions made at Level-3.

The key components of Level-4 are:

- Didactical aids: identification and cataloguing of suitable content, delivery and evaluation methods, feedback collection;
- administrative aids: job market figures, policy highlights, market and educational gaps to be used as motivation / justification for students and/or public (e.g., in course description);
- technical aids: recommendation of tools and methods to facilitate the sharing of teaching content, its integration in institutional learning management systems.

Level-4 is where the thrust of Edu4standards.eu Deliverable D2.3 is to be found. The ITCoS conceptualisation found in D2.3 and the associated comprehensive catalogue of teaching topics and materials serve as a practical example of a didactic guide for implementation of education about standardisation. Similarly to Level-3, Level-4 will also be contributed / disambiguated by the implementation of Pilots. The efforts to share the best practice and the content of the whole modules and/or programs will contribute to disambiguation of questions related to technical and administrative aids and guides suitable/desired for supporting the implementation of teaching practice.

The conceptual Framework Model of ITCoS as presented in Figure 4-1, will serve as an overarching guide in the efforts to promote curricula development and implementation for education about standardisation in line with EU interests and values. Implementation of the Pilots under WP3 will contribute with practical knowledge on different levels and elements of the Framework Model. Initial suggestions for specific elements of the Framework Model of ITCoS are presented in Table 4-1.

Table 4-1. Aims, actions, and tools for the curricula development and implementation of education about standardisation, according to the Framework Model of ITCoS.

Level	Level-specific aims of the Framework Model of ITCoS	Examples of tools and actions to support the level-specific aims of the Framework Model of ITCoS		
1. Strategic orientation	<i>The EU policy-level strategic orientation for education about standardisation</i>			
	Positioning <i>edu4s</i> * to boost EU competitiveness while safeguarding EU values and interests	EU-level recognition of the <i>Edu4s</i> ILO framework		
2. Awareness, relevance and impact	<i>The institutional-level implementation strategy for high impact</i>			
	Addressing the disciplinary diversity	Identification of disciplines where traditionally <i>edu4s</i> is delivered	Identification of disciplines where <i>edu4s</i> is currently not but should be delivered	Identifications of suitable topics / examples to be used for <i>edu4s</i> within the identified disciplines
	Addressing the topical diversity	Identification of topics for which traditionally <i>edu4s</i> is delivered. Addressing the 'core-periphery' design questions	Identification of topics which currently are not but should be covered in <i>edu4s</i>	X-mapping disciplines and topics: Standards development; Standards implementation; The use of standards-based products and services; Awareness about standards
	Addressing gender-discipline-level diversity	Identification of gender-related patterns and disparities with regard to disciplines and levels of education	X-mapping disciplines, genders, levels of education, and possible/suitable topics in <i>edu4s</i>	
3. Integration	<i>The institutional-level implementation guides and aids</i>			
	Importance of standards for the discipline	Discipline-specific adaptation of the ILO Framework (D2.1)	Pilot descriptions submitted in response to the "Call for Pilots" (WP3)	
	The relevance of standards for society and economy	Disambiguation of policy-set targets for industrial development and education in the context of <i>edu4s</i>	Policy analysis report (D2.2), Industry requirements elicitation example (D2.3)	
	High Level Indicators for the teaching effort	Specific targets for <i>edu4s</i> for a program, course, or a module	WP3, T3.1	
4. Implementation guides & aids	<i>The institutional-level implementation guides and aids</i>			
	Didactic guidance for HEIs (topics, materials, methods)	Identification and cataloguing of suitable content	Addressing the core-periphery design questions	Identification of suitable content to establish complementarities between the 'core' and 'periphery' learning objectives
	Administrative guidance (course description and program needs justification templates)	Standards- / standardisation-related job market demand statistics;	policy overview for standards- / standardisation-related EU strategies / needs	identification of gaps in educational landscape
	Technical recommendations for Learning Object (LO) development and sharing	Suggest the use of SCORM ⁴ standard: Sharable Content Object Reference Model for easy import-export to popular LMS (Moodle and Canvas)	Suggest <i>edu4s</i> -ILO-specific XML vocabulary for LO description	

* *edu4s*: Education about standardisation

⁴ Uses of SCORM - Sharable Content Object Reference Model (<https://scorm.com/scorm-explained/one-minute-scorm-overview/>)

4.1. The final remarks on the Framework Model of ITCoS

The proposed conceptualisation of the Framework Model of ITCoS as a four-level model is the result of a sense-making of Edu4satndards.eu project development goals and the reflection on the actual project development work.

The conceptualisation should not be understood as the final product, but as a starting point for further discussion and refinement of what is to be presented at the end of the project as the Innovative Teaching Concept of Standardisation (ITCoS).

This conceptualisation is intended to “connect the dots” established by the nominal (as defined in GA) aims of the project and the actual developments. Specifically, it:

1. Adheres to the GA-defined aim of establishing ILOs as “the top level of the hierarchical curricula development model”
2. Accepts the project consortium agreed-upon strategic orientation of education about standardisation “to boost EU competitiveness while safeguarding EU interests and values”
3. Accommodates the work of the project consortium completed so far:
 - i. D2.1 (at the Level 1, as the ILO Framework)
 - ii. D2.2 (at the Level 2, as assessment and mapping of the educational and policy landscapes)
 - iii. D2.3 (at the Level 2, as a guide to establishing relevance of education about standardisation for a specific industry; as Level 4, as a didactical guidance on relevant to edu4s teaching materials)
4. Directs the future project work by suggesting action areas/items:
 - a. Directs the design, implementation of Edu4Standards.eu Pilots;
 - b. Establishes the scope of the Policy Recommendations to be produced under WP3.

4.2. Example of the use of the Framework Model of ITCoS for the development of curricula for education about standardisation

Edu4Standards.eu Grant Agreement (GA) establishes the need to define Intended Learning Outcomes (ILOs) “as the top level of the hierarchical curricula development model” (GA, sect. 1.2.1, p. 5). In doing so, the GA sets the requirements to allow educators map the relevant for delivering education about standardisation content onto the

ILO Framework-defined ILOs: *“The ILOs defined under T 2.1 will be mapped against the stock of existing standardisation content”* (GA, Part B, p. 27).

Through the project work and deliberations, the consortium partners came to the agreement that education about standardisation can be either the core objective of the teacher, or the secondary focus, where the topic/theme of standardisation is used merely to promote understanding of and/or awareness about standardisation. As an example for the latter, in ethics studies examples from standards development can be used to illustrate the roles of standards in society, the relationship between societal and technological factors to situations where ethical principles must be exercised. This understanding about different foci in education about standardisation is important at the background of the aims of Edu4Standards.eu project to promote education about human-centric standardisation to both established/expert standardisation educators and the those for whom this topic is new (GA, Part B, p. 28).

Edu4Standards.eu project must develop a *generic curricula development guide* for education about standardisation in line with the policy-defined objectives:

“More than ever, standards do not only have to deal with technical components, but also incorporate core EU democratic values and interests, as well as green and social principles” (European Commission, 2022, p. 4).

Accordingly, one of the first task of Edu4Standards.eu project was to decide what establishes “core EU democratic values and interests” and “green and social principles”, which the Commission calls for incorporation in standardisation practice in its new Standardisation Strategy (Figure 4-2).

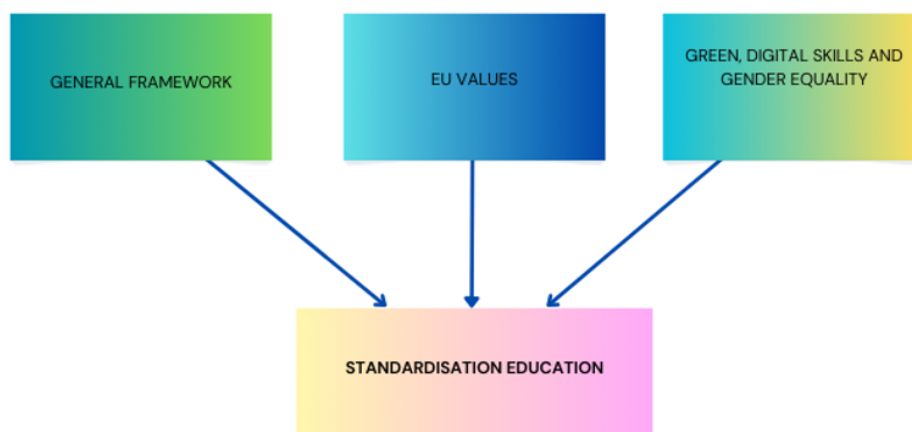


Figure 4-2. Edu4s in line with EU interests and values

Building on the Edu4Standards.eu Grant Agreement (GA), having conducted the EU policy documents analysis, having conducted surveys / opinion pools among the consortium members, the project consortium agreed on the elements which must be included in the Edu4Standards.eu ILO Framework:

- Core EU values: Human Dignity, Freedom, Democracy, Equality, The rule of law.
- EU interests: Green skills, Digital skills, Gender responsiveness

Accordingly, Edu4Standards.eu ILO Framework has been designed to contain two parts. Developed to follow the canons of competence frameworks (CEDEFOP, 2017), the ILO Framework defines the levels of education as one of the dimensions, and the sought-for knowledge and skills to be developed through the education – as the second dimension of the matrix (see Table 4-2.)

The Knowledge & Skills elements of the ILO Framework are further expanded into two sub-sections. Part 1 expands the knowledge and skills to incorporate the EU core values into the context of education about standardisation (see Table 4-2).

Part 2 expands the knowledge and skills to incorporate the EU interests into the context of standardisation, where the Green and Digital Skills and Gender responsiveness are taken as proxies for EU interests, as agreed upon by the consortium partners in line with the GA and the EU policy documents (see Table 4-3).

It must be noted that the given categories of the ILO Framework are not to be understood as final and/or non-amendable. The ILO Framework is a product-in-making, an operationalisation required for the project to proceed towards the defined goals.

Table 4-2. Fragment of Edu4Standards.eu ILO Framework: incorporation of EU core values

Levels	Knowledge	Examples of skills					Responsibility and autonomy
		Human dignity	Freedom	Democracy	Equality	The rule of law	
Level 0 Early childhood education (age 0/3 to 3/6)	The learner is expected: • K01 : form a sense of right and wrong	The learner is able to: • S01 : demonstrate friendliness, kindness, compassion and respect to one another • S02 : reflect on one's and other's feelings in role-playing activities • S03 : understand the importance of having a space where everyone feels valued, safe and respected • S04 : understand the importance of using technology responsibly and respectfully	The learner is able to: • S01 : exercise autonomy by carrying out simple tasks and make choices on one's own • S02 : respect other's autonomy by respecting their choices • S03 : express one's feelings and thoughts and respect other's feelings and thoughts in role-playing activities	The learner is able to: • S01 : contribute to the group or a common goal by fulfilling simple tasks related to the classroom • S02 : participate in co-shaping the rules of the group • S03 : understand the concept of voting and decision-making by voting on decisions concerning the group (ex. what to play)	The learner is able to: • S01 : in an interactive game or activity discuss with the group about cultural diversity, different traditions • S02 : in an interactive game or activity discuss with the group about the importance of inclusion and equal treatment of all group members	The learner is able to: • S01 : take responsibility for one's actions and reflect on that • S02 : discuss the importance of respecting authority • S03 : participate in conflict resolution situations	The learner can engage in simple play and creative activities with guidance and under direct supervision in a structured context.

Table 4-3. Fragment of Edu4Standards.eu ILO Framework: incorporation of Green and Digital skills and Gender responsiveness

Levels	Knowledge	Examples of skills			Responsibility and autonomy
		Green skills	Digital skills	Gender skills	
Level 0	Early childhood education (age 0/3 to 3/6) The learner is expected: • K01: form a sense of right and wrong	The learner is able to: • S01: in an interactive game or activity discuss with the group about the importance of caring for the environment, preserving resources etc. • S02: in an interactive game or activity discuss with the group about ways how to protect and care for the environment (ex. waste separation, recycling) • S03: participate in different activities for protecting the environment (ex. planting trees, reusing old materials, plastic free days etc.)	The learner is able to: • S01: in an interactive game or activity discuss with the group about the benefits and risks of digital technologies (ex. internet safety and online privacy) • S02: in an interactive game or activity discuss with the group about healthy screen time habits • S03: use basic functions of digital tools	The learner is able to: • S01: in an interactive game or activity discuss with the group about the importance of equal treatment of all group members regardless of their gender • S02: in an interactive game or activity discuss with the group about the importance of inclusion and respect of all group members regardless of their gender • S03: participate in different activities without labelling them to a certain gender (ex. girls play only with dolls, boys only with cars)	The learner can engage in simple play and creative activities with guidance and under direct supervision in a structured context.

The codes introduced in the ILO Framework (e.g., K6.1 in Table 4-4 below) can be used as classifiers to map teaching materials which can be used to support the students' learning for acquisition of the specific knowledge (the specific EU interests and/or values).

Table 4-4. Fragment of the Edu4Standards.eu ILO Framework: example of a classifier

Level 6	Bachelor's level	The learner is expected: • K6.1: to have advanced knowledge of standards and standardisation within one's field, involving a critical understanding of theories and principles • K6.2: to have advanced knowledge of values in standards and standardisation within one's field, involving a critical understanding of theories and principles • K6.3: to have advanced knowledge of the legal, ethical, environmental and gender aspects within one's field	The learner is able to: • S6.1: be actively involved in standardisation processes (participant) • S6.2: illustrate the interactions between standards and the regulatory framework • S6.3: carry out deeper analysis of the value relations • S6.4: determine and analyse value conflicts in a standardisation use case • S6.5: propose solutions on simple value conflicts • S6.6: promote green/digital/gender aspects in standardisation through active participation in various initiatives	• The learner can manage and organise their learning process autonomously and independently. They can participate in collaborative projects by carrying out more complex tasks and taking more responsibility for decision-making within the team.
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4.2.1. The ILO Framework and the mapping exercise

At the Level-2 of the Framework Model of ITCoS, the standardisation curricula development task requires obtaining answers to a number of questions related to the positioning of the curricula within the discipline-, economy-, and society-relevant requirements/expectations. At this level of the Framework Model, the first mapping against the ILO Framework-defined knowledge and skills elements is taking place. With regard to this task of mapping, the curricula developer is facing a number of questions and/or challenges:

- Is the intended education about standardisation address standardisation as the primary theme/topic (i.e., the core), or is the topic of standardisation used merely for providing examples and building awareness about the important of standards and standardisation and/or how EU interests and values can be supported/safeguarded by standards and standardisation (i.e., the periphery)?
- Should the curricula developer start the curricula development efforts by mapping his/her teaching content according to the Edu4Standards.eu ILO Framework, or use the ILO Framework to find suitable materials for his/her teaching?

These guiding questions can be further elaborated according to the intentions of the lecturer, as defined in Table 4-5. Examples of professional jobs, roles, and responsibilities, for which knowledge on standards and standardisation can be roughly categorized as the core and the periphery was introduced in Table 3-16 above.

Table 4-5. ILO-content mapping action sets

	<i>In delivering my course, standardisation is the ...</i>	
	<i>Core</i>	<i>Periphery</i>
<i>I intend to use ILO Framework to locate relevant teaching materials</i>	<p>Action 1</p> <p>Which standardisation teaching materials can be used to demonstrate the importance of (specific/chosen) EU interests and values?</p>	<p>Action 2</p> <p>Which standardisation education materials can be helpful in creating awareness about standardisation in my teaching aimed to promote (certain) EU interests and/or EU core values?</p>
<i>I intend to understand which ILOs of the ILO Framework can be supported by my teaching (materials)</i>	<p>Action 3</p> <p>How my teaching about standardisation can demonstrate the importance of (specific/chosen) EU interests and values?</p>	<p>Action 4</p> <p>How my teaching aimed to promotion/protection of (specific) EU interests and/or EU core values can contribute to the development of knowledge base of standardisation education?</p>

Under WP3, more specific questionnaires can be developed for different disciplines and/or levels of education to further facilitate the mapping of standardisation-relevant teaching materials which can support education in line with EU interests and values in general and are addressing specific policy-desired skills in particular: skills fostering green and digital transition, skills fostering gender equality responsiveness, etc. The guiding questions should be developed in the way that by answering them a lecturer can arrive at understanding whether or not his/her intended teaching material can support a specific ILO from the Edu4S ILO Framework. The first attempt to operationalise this action guide will be taken under T3.1 “Pilot design”.

5. Conclusions and further work

This report started with the analysis of policy documents, the results of which were the conclusions that the European policy documents relevant for education about standardisation call for educational system to be oriented towards and comply with the European social model of participation (European Commission, 1994), human-centricity, the twin green and digital transition, strategies for the industrial development and global competitiveness, etc., yet they do not provide guidelines on how to incorporate these policy-desired aspects into curriculum of higher educational institutions.

The Edu4Standards.eu Grant Agreement called for “ITCoS development work... [to] focus on the formulation of intended learning outcomes (ILOs) as the top level of the hierarchical curricula development model”. The innovative ILO Framework was developed under T2.1 and presented in D2.1 of Edu4Standards.eu project. The ILO Framework – probably for the first time – attempted to embed the policy-desired knowledge on EU values and interests in contexts relevant to standardisation in a systematic and meaningful for educational system way.

The embedding of principles novel to the traditional education about standardisation into the context of standardisation knowledge, as presented in the ILO Framework, was done only on a conceptual level. For ITCoS to be established as a *functional* and *generic* “educational instrument and its implementation guide”, the extant vast yet fragmented knowledge relevant for education about standardisation has to be mapped according to the classifiers of the ILO Framework (for different knowledge aspects and educational levels). The general knowledge attributes as presented in the ILO Framework have to be adapted to the requirements and expectations of different disciplines, and the corresponding economic and societal demands, as defined in the Framework Model of ITCoS in this report. The first systematic attempt on this challenging task will be done in D2.3 for the chosen industrial specialisation of professional standards developers (workers of SSOs and of in-company standards departments). Further “grounding” of the ILO Framework-defined generic knowledge elements will be attempted under seven Edu4standards.eu WP3 Pilots for different educational levels and venues, as detailed in Table 3-10.

This report establishes the middle ground between D2.1 and D2.3 by providing versatile analysis of the policy and educational landscapes relevant for education about standardisation. The policy analysis undertaken in T2.2 contributed to D2.1. The educational analysis helped identify irregularities, gaps, and challenges which have to be addressed for maximum impact of educational initiatives, as per Level-2 of the Framework Model of ITCoS (see Figure 4-1).

Specifically, this study revealed gaps in the extant knowledge base and practice with regard to supporting digital and green skills, promoting gender responsiveness/equality, safeguarding EU core values and EU interests. The Edu4standard.eu teaching Pilots (WP3) will be the first step towards closing the identified gaps, as well as the first

attempt of practical use of the Framework Model of ITCoS as a “generic instrument and implementation guide” for delivering education about standardisation, which retains the traditional imperative of contributing to EU competitiveness, while also incorporating new to this educational domain imperative of safeguarding/promoting the EU interests and values.

Conclusions of the Task 2.2 are presented below.

5.1. Assessment of the educational landscape

This report has identified (text in brackets refers to the data collection method):

- The policy expectations for education about standardisation in Europe (policy analysis);
- the topics and methods currently used by European teachers engaged in education about standardisation (interviews and surveys);
- the expectations of standardisation professionals towards education about standardisation / towards today’s and tomorrow’s graduates (interviews and surveys);
- the topics and methods used in education about standardisation as found in the program and course descriptions of non-EU universities (web survey);
- the state-of-art in academic research on methods and content for education about standardisation (literature review);
- the preferences for teaching materials given /used by teachers engaged in education about standardisation (surveys and “inventory” studies);
- the most popular fields of education in the EU by level of education and by sex (Eurostat data).

Based on the above findings, with regard to educational landscape, it can be concluded that:

- education about standardisation is very fragmented, it is not conceived nor practices as a stand-alone discipline;
- education about standardisation is often considered to be unpopular topic, especially if taught outside of engineering discipline (conference panel feedback);
- there are no “best practices” or “standards” with regard to materials and methods for education about standardisation;
- in delivering education about standardisation, a great variety of teaching methods and materials is used:
 - among the many topics and delivery methods, no core method or topic can be singled out. The same is valid for the teaching materials – there were no “standard” or “reference” teaching materials identified even when the same topics were considered;

- there are often-cited / often-used textbooks for teaching the basics of standards and standardisation;
 - more advanced levels of education about standardisation are delivered mostly by using scientific publications as the main source of teaching materials;
 - serious games receive increased attention of educators, but their availability and awareness about them among educators are limited at the moment;
- there is no lack of knowledge or materials relevant for education about standardisation reported by experts.
- However,
- there is a high degree of fragmentation of knowledge and best practice within and across disciplines;
 - examples of best practice can be found – including that of collaboration between educators and standardisation professionals / bodies – but they are not broadly known/followed;
 - the choice of methods and content for delivering education about standardisation highly depends on the lecturer – no education impact assessment efforts/results were identified.

Based on the findings of this study, and given the aims of Edu4standards.eu project, for the novel approach to education about standardisation to have high relevance and impact, the following action points can be formulated:

- the Framework Model of ITCoS should be used by different stakeholders of the education domain when aiming to respond to the policy call for boosting EU competitiveness while particularly considering / addressing European interests and values;
- The Framework Model of ITCoS is developed as a generic tool and instrumental guide to help different stakeholders develop new or revise existing curricula for education about standardisation. Specifically, The Framework Model of ITCoS can assist the educators in:
 - establishing the relevance of educational initiatives against the policy- and economy- set requirements and targets;
 - identify topics and disciplines where education about standardisation can have high(er) impact;
 - identify topics, which currently are not, but should be covered by education about standardisation;

Finally, the structure and the content of the presented Framework Model of ITCoS must be updated in the next stages of the project – design and implementation of Pilots under WP3 – based on the feedback received from the implementation of the Pilots.

5.2. Contribution to scholarly knowledge

This report offers a number of important contributions to the advancement of scholarly knowledge in several academic domains. Specifically:

- Contribution to educational domain:
 - This study presents three comprehensive policy reviews (Appendix PA-1, PA-2, and PA-3) to identify key European policy and strategy elements relevant to education in general and education about standardisation in particular. The disambiguation of the policy documents as found in the policy reports of this study establish foundation for the development of new and revision of existing programs and courses;
 - The review of EU HE landscape, although superficial, provides the initial understanding about disparities in educational disciplines and sexes of students. This knowledge combined with the knowledge of the policy priorities and the knowledge of where is the concentration of students (and of what gender) and what is the content of education about standardisation, allows devising strategies for maximising relevance and impact of education about standardisation in the future:
 - planning of new / revision of existing programs in the context of the EU policy call for education about standardisation to be 1) gender-responsive, 2) human-centric, 3) foster the development of green and digital skills, 4) support EU core values and interests.
 - work on this report resulted in the development and submission of a number of academic publications, thus contributing to the further promotion of the topic of education about standardisation, helping create awareness on the issue and challenges of education about standardisation, offer roadmaps and solutions.

5.3. Practical aspects of the report

Results of this report (D2.2) contribute to the development of the Innovative Teaching Concept of Standardisation (ITCoS) with the presentation of the Framework Model of ITCoS – a four-level hierarchical model for curricula development and implementation (Figure 4-1).

The data collected under T2.2 and systematised in this report will be used for the practical evaluation of the Framework Model of ITCoS in the seven planned Edu4Standards.eu pilots under WP3 (see Table 3-10).

The analysis of the lecturers' experience and the feedback received from the learners, educators, and project partners will be used for subsequent refinement of the data collected under T2.2 and the Framework Model of ITCoS.

Finally, the work carried out under Edu4standards.eu WP2, and under Task 2.2 specifically, resulted in the consolidation of network of stakeholders/actors active in the domain of education about standardisation, and the consolidation of knowledge about educational resources and approaches relevant to education about standardisation.

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Appendices

7. Appendix S1-1. Edu4Standards.eu Survey #1 questionnaire

Edu4Standards.eu, Task 2.2 “Identify and categorise relevant existing content and methods, and specify gaps in standardisation education”

Survey #1

Addressed to: all Edu4Standards.eu consortium partners

Survey distribution and data collection method: email

Responsible for the survey: Vilnius University

1. Do you teach on standards/standardisation?

If answered “Yes” to question 1:

- What discipline?
- What topic(s)?
- What methods are used?
- What is the content?
 - Self-developed or developed by colleague(s), not in a form of a textbook
 - Based on academic publications (research-based)
 - Based on personal knowledge and/or experience
 - Based on a textbook or textbooks
 - Written by self or a colleague (at the same institution)
 - Adopted
 - Provide the URL to access the teaching modules / content
- What is the institution where the teaching takes place?
 - University (specify)
 - Applied sciences university (specify)
 - A company (specify, if possible)
 - Other (specify)

If answered “No” to question 1:

- Are you aware of any educational program, course, or module taught by others at your or other institution?
 - If yes, provide URL and short description of the program, course, or module and the institution where the teaching takes place, to help T2.2 researchers to locate the venue.
- 2. Do you either collaborate or otherwise have contacts with National Standards Body (NSO) in your task of delivering education on standards/standardisation? Choose one of the following:
 - Yes, I collaborate with NSO in delivering education

- No, I do not collaborate, but I know who at our NSO is responsible for educational programs/tasks
 - No, neither do I collaborate, nor do I know who is in charge for educational programs at NSO
3. Irrespective of your answer to 2. above, can you contribute to T2.2 by inquiring NSO on teaching content, venues, and best practice in delivering education about standardisation or by facilitating a contact between NSO and T2.2 researchers?
- No, I can't
 - Yes, I can inquire myself
 - Yes, I can provide a contact to VU team for them to make the inquiry/interview on their own
4. Given the aims of T2.2, how would you like to contribute to its implementation, other than by answering this questionnaire?

8. Appendix s2-x. Edu4Standards.eu Survey #2 questionnaire

Edu4Standards.eu, Task 2.2 “Identify and categorise relevant existing content and methods, and specify gaps in standardisation education”

Survey #2

Addressed to: all Edu4Standards.eu consortium partners

Survey distribution and data collection method: email

Responsible for the survey: Vilnius University

European interests

1. How Do you define “European interests” in standardisation? (Here and elsewhere, pls provide references and/or URL whenever possible).
2. How do you address European interests in your teaching (material, module, measurements like ECTS or others, exam)?
3. Can you give any examples of teaching materials which convey the idea of “European interests”?

Gender

4. How do you address the topic of standards and gender, including gender-responsive standards?

Societal facets

5. How do you address societal facets in your teaching?
6. How do you bridge technical and societal facets?

Specific domains

7. Does your teaching include domain-/industry specific standardisation? If yes, which industries? (you may refer to the 10 ecosystems of the industrial strategy: 1.Aerospace & Defence, 2.Agri-food, 3.Construction, 4.Cultural and Creative Industries, 5.Digital, 6.Electronics, 7.Energy Intensive Industries, 8.Energy-Renewables, 9.Health, 10.Mobility-Transport-Automotive, 11.Proximity, Social Economy and Civil Security, 12.Retail, 13.Textiles, 14.Tourism)

Green skills

8. How do you address green skills relevant for standardisation?

Digital skills

9. How do you address digital skills relevant for standardisation?

Pls provide your contact details:

9. Appendix I-1. Edu4Standards.eu interview guide for Task 2.2 “Identify and categorise relevant existing content and methods, and specify gaps in standardisation education”.

Interview Guide

Edu4Standards.eu, Task 2.2 “Identify and categorise relevant existing content and methods, and specify gaps in standardisation education”.

The guide developed by Nizar Abdelkafi, POLIMI, <Nizar.abdelkafi@polimi.it>

I. Before the interview:

Interview Technique

- Semi-structured interviews allow the interviewer to collect detailed information in a conversational style. It is more important to have a “flow” in the conversation than to stick to the order of the questions in the original interview guide. Hence, it is allowed to deviate from the original interview guide to have a fluent conversation and to address new topics. Nevertheless, the main topics from the interview guide should be covered according to the knowledge of the interviewees. The interviewer may select questions, depending on the interviewee’s role e.g. lecturer, researcher + practitioner.
- Due to time restrictions not all questions – as included in the interview guide – can be asked. Time management is, therefore, essential.
- Based on previous experience, the interviews’ average duration should be between 45 and 60 Minutes. However, the duration of an interview can strongly vary depending on the availability of the expert. Nevertheless, the duration can also depend on expert availability.
- For the purposes of the analysis, the interviews should preferably be conducted in English. If not possible, main statements should be translated and an extensive interview summary generated.

Target groups

- The interview guide contains a set of questions that are specific to each target group:
 - Professors and lecturers (e.g. engineering, business administration, law)
 - Practitioners (e.g. delegates, manager of delegates, head of standardisation)
 - Researchers (e.g. technical researchers involved in standardisation, standardisation researchers)
 - ...
- Some of the interviewees may cover more than only one role, e.g. a standardisation researcher who also participates in standards development. Consequently, questions from different question blocks can be used. As the interview duration is limited, the interviewer should select questions that appear to be more promising to extract valuable insights.

From the project proposal:

*“T2.2 will identify **relevant topics, teaching methods, and content of standardisation** education, as well as **best practices** related to topics, learning environment and teaching methods within **different venues** of professional engagement: **pre-normative research, formal and consortia standards** development, **policy development** and **safeguarding of EU core values.**”*

Introduction and purpose of the research

Given the aims of T2.2, as stated in the project proposal, the purpose of research under T2.2 is to identify:

- (1) Relevant topics,
- (2) Teaching methods, and
- (3) Content of standardisation education
- (4) Best practices related to topics
- (5) Best practices related to learning environment and teaching methods within different venues of professional engagement:
 - (5.1) pre-normative research,
 - (5.2.) formal standards,
 - (5.3) consortia standardisation,
 - (5.4.) policy development,
 - (5.5.) safeguarding of EU core values.

Briefing the Interview partner

- Give a short overview of the project and its goals to the interviewee without going into much detail.
- For the purposes of analysis, it is beneficial to record the interviews (e.g. with MS Teams). It requires agreement by the interviewed expert (see text and question below). If the expert does not agree to recording, the interview can still be conducted, and the results can be used. Then the interviewer should take notes to document the content and main statements of the interview.

II. During the Interview: Open-ended questions

Interviewer:

For the purpose of scientific analysis, we would like to audio record the interview. We guarantee the complete confidentiality of your statements. The information that you provide will stay confidential and will only be used for the elaboration of this study.

- **Do you agree with the recording?**

1. General questions “The Starters”

- Please describe your responsibilities and tasks in your organization.
- How is your work related to standardisation?
 - Is the use of standards an important part of your professional everyday routines, and in which areas do you use standards?

2. Practitioners (non-teachers)

- How important do you consider standardisation for your organisation? Please explain why.
- Are you responsible for standardisation within your organisation?
- What are the benefits of standardisation for your organisation?
- Please explain why you consider education for standardisation relevant?

Delegates:

- Do you regularly work in standardisation committees?
 - In which standardisation bodies?
 - What does a delegate have to do to be prepared for a standards’ meeting?
 - What are the knowledge, skills and competencies required to successfully work in a standardisation working group?
- Have you had official roles in a standardisation body (chairman, other)
 - Which roles did you have?
 - What are the knowledge, skills, and competencies that you think are required to be successful?
- As you started your work in standardisation, did you feel that you are sufficiently trained/prepared for being a standardisation delegate/official?
 - How much did you have to learn “on the job”?
 - What are the subject areas that you think should be taught?
 - If you had to teach standardisation, what kind of knowledge and skills would you emphasize.

Managers, Head of Standardisation (in companies)

- Who in your organization needs to know about standardisation?
- What kind of knowledge and skills about standardisation do your employees need in their job? Do these differ depending on the roles and years of experience of employees?
- Does knowledge on standardisation improve the employability of graduates?
- How important is it to train standardisation experts in non-technical aspects of standardisation (including legal, economic and social aspects)
- What kind of knowledge and skills should the university convey around standardisation?
- Are interdisciplinary executive courses bringing law and economic aspects considered as valuable? Do these courses offer a comparative advantage to courses offered in a single field?

- Is exposure to European values in a standardisation training appropriate or necessary?

In addition to these questions, some of the questions in section 4 might of relevance to companies as well, more specifically:

- What training programs or initiatives does your company offer in standardisation? Do you offer specialized training for employees with different roles and/or levels of experience (e.g. junior, senior, executive)?
- Can you describe the methodologies or approaches used in your training programs? Did you feel that some methodologies worked better than others?
- How are your training programs structured? Are they on-site, online, workshops, or a combination? (What model worked better?) How long do trainings last?
- What types of resources or materials do you provide to employees?
- What topics or subjects are covered in your standardisation training programs?
- What kind of practical exercises, case studies, or real-world examples are you incorporating into your training programs?
- After attending these training programs, have you identified any areas where the training of these standard professionals could be strengthened.

3. Practitioners (teachers)

In addition to the questions in section 2, please ask the questions in section 5.

4. Standardisation Development Organizations

Training programs and methods

- What training programs or initiatives does your organization offer in standardisation?
- Can you describe the methodologies or approaches used in your training programs?
- How are your training programs structured? Are they classroom-based, online, workshops, or a combination?
- What types of resources or materials do you provide to trainees?

Target Audience:

- Who are the primary audiences for your standardisation training programs?
- Do you offer specialized training for different levels of expertise (e.g., beginners, intermediate, advanced)?
- Are there specific industries or sectors that your training programs target?

Content and Curriculum:

- What topics or subjects are covered in your standardisation training programs?
- How do you ensure that the training content remains up-to-date with the latest technological developments and best practices?

Delivery and Engagement:

- How do you ensure engagement and participation from trainees during the training sessions?

- What kind of practical exercises, case studies, or real-world examples are you incorporating into your training programs?
- What is the typical length of a training? What is the average number of participations?

Evaluation and Assessment:

- How do you assess the effectiveness of your standardisation training programs?
- Are there any metrics or benchmarks that you use to measure the impact of the training? If yes, which ones?
- Do trainees receive any certifications or credentials upon completion of the training?

Collaboration with Universities:

- How does your organization collaborate with universities or academic institutions in the field of standardisation education?
- What are your expectations for standardisation education at the university level?
- Are there any specific skills or knowledge areas that you believe university programs should focus on to better prepare students for careers in standardisation?

Feedback and Improvement:

- How do you gather feedback from trainees to continuously improve your training programs?
- Have there been any recent developments or changes in your training approach based on feedback or industry trends? If yes, which ones?
- Are there any plans to expand or enhance your standardisation training offerings in the future? How?

5. Researchers

Researchers in an engineering field involved in standardisation

- What are your main research areas?
- How is your research related to standardisation?
- What was your initial motivation to participate in standardisation?
- How could students or experts from other fields learn from your experiences in standardisation?
- What are the contents that you wished to learn at the university or elsewhere to do your work related to standardisation?

Standardisation researchers

- What are your main research areas?
- What standardisation topics do you focus on?
- What could students and non-standardisation experts learn from your research?
- What aspects of your research should be integrated into teaching materials on standardisation?
- What knowledge required by researchers in order to do research on standardisation?
- What are the hot topics in research about standardisation and why?

- What “hot topics” should be covered by teaching materials on standardisation?
- What are the major trends in research about standardisation?
 - What trends should be covered by standardisation education?

Lecturers and Professors

How long?

- For how long have you been teaching the course on standardisation?

Why?

- Why are you teaching standardisation? (The main motives for offering the course)
- Why do you think students are attending your course on standardisation?

Who?

- Who are your students? Which level (Master, Bachelor, professionals...)
- What about the student participation? How big are the classes? How active are the students in the classes?
- Are your students usually aware of standards and standardisation?
- Are your students interested in standardisation? Do they like the topic? Why?

What?

- What topics related to standardisation do you teach?
- Which topics would classify as core and which topics would you classify as complementary?
- What is the name of the course, in which you are involved? (on standardisation or another topic?). How many hours of teaching in class and how many hours of teaching are required for self-study at home?
- What are the intended learning outcomes? When would you be satisfied with your students after the learning experience?
- What are the teaching materials that you use?
 - Content (e.g. case studies from the industry, research results)
 - Form (e.g. slides, videos, books, MOOC, business games)
- Which teaching materials work well?

How?

- How do you deliver the course? What is your teaching concept behind? For example, how do you achieve a good balance between theory and practice? What about concepts such as the flipped classroom or others? How effective are they?
- How do you engage students and increase their interest in standardisation?
- How do you assess the students’ learning performance?
- What are the subjects that are hard to capture/understand by students?

6. Future of education on standardisation (for all participants)

- How will standards affect your work within five years?

- What are the trends shaping the future standardisation eco-system?
- What future developments do you expect in the field of education for standardisation?
- What could be the future strategies to ensure a wide diffusion of education on standardisation?
 - What should SDOs and other actors do? (e.g. universities, companies, government)

7. End of the interview

- Would you like to add something?
- Would you accept a short follow-up interview in case we want to deepen some information?
- Do you know somebody else, who might be helpful to our study? Could you recommend someone?
- Are you interested in being informed about the progress of our study?

10. Appendix PA-1. Report: Human-Centricity and the EU Core Values in EU Policy

Documents.

Vilnius University team's internal document. Last substantive update: 2024.06.23

By Kęstutis Mosakas <kestutis.mosakas@knf.vu.lt>

The aims: The goal of this report is to provide an overview of the EU core values and the human-centric approach as represented in EU policy documents.

The structure: The first two sections briefly present the notions of the EU core values and the human-centric approach. The subsequent sections cover the way these notions appear in six different EU policy documents. Two appendixes follow thereafter.

The scope: “Regulation of the European Parliament and of the Council: Laying Down Harmonized Rules on Artificial Intelligence” (also known as the “EU AI Act”—(The European Commission, 2021a)), “Standards and Guidelines for Quality Assurance in the European Higher Education Area” (European Association for Quality Assurance in Higher Education et al., 2015), “An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market” (The European Commission, 2022a), “Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe’s Recovery” (The European Commission, 2021b), “ICT Standardisation Priorities for the Digital Single Market” (The European Commission, 2016), and “The 2024 Annual Union Work Programme for European Standardisation” (The European Commission, 2024).

The findings: The analysed documents vary in their treatment of value concepts, with some only bearing indirect relevance to EU core values and others covering ethical issues relevant to standardisation in a more explicit manner (e.g., the “EU AI Act” and “ICT Standardisation Priorities for the Digital Single Market”). In general, the policy documents encompass a relatively broad range of values including safety, security, privacy, autonomy, transparency, accountability, fairness, and non-discrimination, alongside some explicit references to fundamental rights central to EU policies. Given the growing need for ethics in the EU’s standardisation landscape (as is evident from the document analysis), incorporating ethical knowledge and skills into standardisation education may be essential to prepare the future professionals for addressing the emerging challenges in a way that goes in line with EU values and policies.

The appendixes: Appendix 1 is titled “Value concepts in ‘The Charter of Fundamental Rights of the European Union’” and provides brief definitions and explanations of key value concepts in the EU’s Charter of Fundamental Rights, a document that is commonly referenced in the policy documents analysed. This appendix is also expected to

contribute to glossary building. Appendix 2, “Standardisation concepts in EU policy documents”, examines the language and contexts in which standards are mentioned in the policy documents, seeking to gain additional insights into the expectations of the European Commission regarding the role and significance of European standardisation practices.

1. What are the EU Core Values?

According to the official EU webpage (Directorate-General for Communication, n.d.), the EU is founded on the following values:

1. **Human dignity:** Human dignity is inviolable. It must be respected, protected and constitutes the real basis of fundamental rights.⁵
2. **Freedom:** Freedom of movement gives citizens the right to move and reside freely within the Union. Individual freedoms such as respect for private life, freedom of thought, religion, assembly, expression and information are protected by the EU Charter of Fundamental Rights.
3. **Democracy:** The functioning of the EU is founded on representative democracy. A European citizen automatically enjoys political rights. Every adult EU citizen has the right to stand as a candidate and to vote in elections to the European Parliament. EU citizens have the right to stand as a candidate and to vote in their country of residence, or in their country of origin.
4. **Equality:** Equality is about equal rights for all citizens before the law. The principle of equality between women and men underpins all European policies and is the basis for European integration. It applies in all areas. The principle of equal pay for equal work became part of the Treaty of Rome in 1957.
5. **Rule of law:** The EU is based on the rule of law. Everything the EU does is founded on treaties, voluntarily and democratically agreed by its EU countries. Law and justice are upheld by an independent judiciary. The EU countries gave final jurisdiction to the European Court of Justice—its judgments have to be respected by all.
6. **Human rights:** Human rights are protected by the EU Charter of Fundamental Rights. These cover the right to be free from discrimination on the basis of sex, racial or ethnic origin, religion or belief, disability, age or sexual orientation, the right to the protection of your personal data, and the right to get access to justice.

2. What is the Human-Centric Approach?

⁵ In ethics, there is no universally accepted account of what human dignity consists in—it is a contested notion. However, in the context of EU policymaking, it generally refers to “the inherent worth and value of every individual, regardless of their background, status, or circumstances. It entails the recognition and respect for each person’s autonomy, integrity, and inherent rights. This includes the right to be treated with fairness, equality, and respect, as well as protection from degrading treatment or exploitation” (generated by GPT-3.5 under specific instructions).

The concept of “human-centricity” is closely tied to the values listed above but is also distinct from them. While the core values—such as human rights, democracy, and equality—are typically conceived as central to the EU’s human-centric approach, the notion of human-centricity is more commonly deployed in the context of digital development and policies. In general, the goal of the human-centric approach is to “foster inclusive digital economies and societies in which all citizens—notably women and young people—have equal opportunities to participate in the digital world. The human-centric approach puts people at the heart of the digital transformation—driven by people’s needs, fundamental rights and intersectional challenges to closing digital divides” (*D4D Hub Principles*, 2024).

While in its core the approach is concerned with policies, strategies, and initiatives that foster the fundamental rights and welfare of people, various sources (*Demystifying the People-Centred Approach for the Digital Transformation*, 2023; The European Commission, n.d., 2022b, 2023) seem to converge on several particular values (or groups thereof) that consistently appear in the context of human-centricity in various information sources on the EU policies. One could summarize them in the following way:

1. **Empowerment, social inclusion, and solidarity:** Empowering people by ensuring that they get to fully enjoy the opportunities created by digital transformation, with an emphasis on the needs of elderly people, people living in rural areas, persons with disabilities, marginalized, vulnerable, or disenfranchised people, etc., tackling digital divides.
2. **Safety and security:** Ensuring safe and secure digital products, services, and technologies for everyone, protecting people’s privacy, combating various forms of harmful content (e.g., disinformation and manipulation), including harassment and gender-based violence.
3. **Freedom, trust, and transparency:** Empowering people to make free and informed choices online based on objective and reliable information, promoting trustworthy and transparent AI systems.
4. **Participation and democracy:** Using emerging technologies to stimulate engagement and democratic participation, enabling access to trustworthy, diverse, and multilingual online environment, promoting transparency in online services, taking into consideration our cultural and linguistic diversity.
5. **Sustainability:** Minimizing the negative environmental and societal impact of digital technologies and services and ensuring the availability of information on their impact and energy consumption.

3. Regulation of the European Parliament and of the Council: Laying Down Harmonized Rules on Artificial Intelligence

The document that is called “Regulation of the European Parliament and of the Council: Laying Down Harmonized Rules on Artificial Intelligence” (The European Commission, 2021a)—also known as the “EU AI Act”—is the EU’s first legal framework that puts forward harmonized rules for the development, use, and market regulation of artificial

intelligence (AI). It categorizes AI applications into (1) low or minimal risk, (2) high risk, and (3) unacceptable risk. While the first group of AI applications is left largely unregulated and the third is outright banned, the second—high-risk applications—is subject to specific legal regulations and is the key focus of the act. The overarching goal behind the act proposal seems to be “to ensure that Europeans can benefit from new technologies developed and functioning according to Union values, fundamental rights and principles”⁶ (The European Commission, 2021a subsec. 1.1.).⁷ As such, the act is strongly undergirded by ethical considerations, including EU values and fundamental rights (ibid.).

Although the act proposal undoubtedly has an ethical basis at the fundamental level, ethics as such is not the primary focus of its contents, given that it’s first and foremost a legal document. Therefore, it may be important to distinguish between different ways how ethical considerations manifest in it. Here one could distinguish between parts of the act (e.g., articles or paragraphs) that (1) are more administrative/bureaucratic and only indirectly pertain to ethical commitments (covered in 3.1.), (2) those that explicitly mention general ethical concepts (e.g., “values” or “rights”) (covered in 3.2.), and (3) those that mention more specific ethical concepts (e.g., “right to life” as opposed to “fundamental right”) (covered in 3.3.). Although most parts of the act fall under the first category, some other parts explicitly refer to values and/or rights and therefore fall under the second category. Subsection 3.5., titled “Fundamental Rights,” is one of the few parts that belongs to the third category. The mentioned subsection serves as a reference point for the notion of fundamental rights, which is occasionally mentioned in the act. Below, one can find a set of examples from the act that contain ethical concepts to varying degrees and a brief commentary that is provided for each example.

3.1. Examples of implicit ethical commitments

Example – #1:

Article 48: *EU declaration of conformity*

⁶ In general terms, a value is a good and desirable aspect that ought to be promoted in a particular context. A principle, on the other hand, serves as an expression of a particular value in the form of a fundamental rule that is meant to guide one’s behavior and decision-making. In this particular case, the phrase “values, fundamental rights, and principles” could be construed as a reference to a general set of ideals and doctrines that shape the EU’s objectives and actions.

⁷ More specifically, the Commission (ibid.) state the following objectives:

- Ensure that AI systems placed on the Union market and used are safe and respect existing law on fundamental rights and Union values;
- Ensure legal certainty to facilitate investment and innovation in AI;
- Enhance governance and effective enforcement of existing law on fundamental rights and safety requirements applicable to AI systems;
- Facilitate the development of a single market for lawful, safe and trustworthy AI applications and prevent market fragmentation.

1. The provider shall draw up a written EU declaration of conformity for each AI system and keep it at the disposal of the national competent authorities for 10 years after the AI system has been placed on the market or put into service. The EU declaration of conformity shall identify the AI system for which it has been drawn up. A copy of the EU declaration of conformity shall be given to the relevant national competent authorities upon request.
2. The EU declaration of conformity shall state that the high-risk AI system in question meets the requirements set out in Chapter 2 of this Title. The EU declaration of conformity shall contain the information set out in Annex V and shall be translated into an official Union language or languages required by the Member State(s) in which the high-risk AI system is made available.
3. Where high-risk AI systems are subject to other Union harmonisation legislation which also requires an EU declaration of conformity, a single EU declaration of conformity shall be drawn up in respect of all Union legislations applicable to the high-risk AI system. The declaration shall contain all the information required for identification of the Union harmonisation legislation to which the declaration relates.
4. By drawing up the EU declaration of conformity, the provider shall assume responsibility for compliance with the requirements set out in Chapter 2 of this Title. The provider shall keep the EU declaration of conformity up-to-date as appropriate.
5. The Commission shall be empowered to adopt delegated acts in accordance with Article 73 for the purpose of updating the content of the EU declaration of conformity set out in Annex V in order to introduce elements that become necessary in light of technical progress.

Comments: Article 48 requires that providers draw up a written EU declaration of conformity for each AI system placed on the market or put into service and present additional regulations concerning the mentioned declaration. Most of the articles in the act are similar to this one in the sense that they appear more administrative and bureaucratic rather than ethically significant. However, one could argue that there is still a connection between them and the EU's human-centric values. For example, a case could be made that detailed regulations of this sort with respect to high-risk AI systems ensure transparency regarding the AI systems' compliance with regulatory requirements and promote accountability, oversight, responsibility, and consumer protection all of which are important values in the development and utilization of AI systems.⁸

Example – #2:

⁸ From the standpoint of standardisation, the significance here is that if one demands standards makers to make conformity statements or other public-oriented declarations to allow the consumers of standards to know what the standards are about, that makes the standardisation more "human-centric" in the sense that the process promotes a particular value espoused by the EU.

Article 22: *Duty of information*

Where the high-risk AI system presents a risk within the meaning of Article 65(1) and that risk is known to the provider of the system, that provider shall immediately inform the national competent authorities of the Member States in which it made the system available and, where applicable, the notified body that issued a certificate for the high-risk AI system, in particular of the non-compliance and of any corrective actions taken.

Comments: Similar to the first example, the above part of the act is not explicitly engaged in ethical considerations either. However, the duty of information for providers of high-risk AI systems could still be seen as relevant with respect to EU values in the sense that it pertains to risk management and consumer protection (e.g., disclosing the risks involved), transparency and oversight, as well as enabling corrective actions and quality management. Regulations of this sort add to the overall safety and security of AI systems and foster transparency and accountability in their deployment. Most chapters and articles in the act relate to ethics and European values in a way similar to the two examples presented so far.

3.2. Examples of general ethical concepts

The following examples, while distinct, are listed under the same heading, given their overall respective similarities. The relevant terms are emphasized.

List of examples – #3:

Act proposal, paragraph 5 (excerpt): By laying down those rules, this Regulation supports the objective of the Union of being a global leader in the development of **secure, trustworthy and ethical artificial intelligence**, as stated by the European Council, and **it ensures the protection of ethical principles** [unspecified in the document], as specifically requested by the European Parliament.

Act proposal, paragraph 10: **In order to ensure a level playing field and an effective protection of rights and freedoms of individuals across the Union**, the rules established by this Regulation should apply to providers of AI systems in a **non-discriminatory** manner, irrespective of whether they are established within the Union or in a third country, and to users of AI systems established within the Union.

Act proposal, paragraph 27 (excerpt): High-risk AI systems should only be placed on the Union market or put into service if they comply with certain mandatory requirements... **AI systems identified as high-risk should be limited to those that have a significant harmful impact on the health, safety and fundamental rights** of persons in the Union and such limitation minimises any potential restriction to international trade, if any.

Act proposal, paragraph 43: Requirements should apply to high-risk AI systems as regards the quality of data sets used, technical documentation and record-keeping, transparency and the provision of information to users, human oversight, and robustness, accuracy and cybersecurity. **Those requirements are necessary to effectively mitigate the risks for health, safety and fundamental rights**, as applicable in the light of the intended purpose of the system, and no other less trade restrictive measures are reasonably available, thus avoiding unjustified restrictions to trade.

Article 14 (*Human oversight*), paragraph 2: **Human oversight shall aim at preventing or minimising the risks to health, safety or fundamental rights** that may emerge when a high-risk AI system is used in accordance with its intended purpose or under conditions of reasonably foreseeable misuse, in particular when such risks persist notwithstanding the application of other requirements set out in this Chapter.

Article 41 (*Common specifications*), paragraph 1 (excerpt): Where harmonised standards referred to in Article 40 do not exist or where the Commission considers that the relevant harmonised standards are insufficient **or that there is a need to address specific safety or fundamental right concerns**, the Commission may, by means of implementing acts, adopt common specifications in respect of the requirements set out in Chapter 2 of this Title...

Article 53 (*AI regulatory sandboxes*), paragraph 3: The AI regulatory sandboxes shall not affect the supervisory and corrective powers of the competent authorities. **Any significant risks to health and safety and fundamental rights identified during the development and testing of such systems shall result in immediate mitigation** and, failing that, in the suspension of the development and testing process until such mitigation takes place.

Article 62 (*Reporting of serious incidents and of malfunctioning*), paragraph 1 (excerpt): Providers of high-risk AI systems placed on the Union market **shall report any serious incident or any malfunctioning of those systems which constitutes a breach of obligations under Union law intended to protect fundamental rights** to the market surveillance authorities of the Member States where that incident or breach occurred.

Comments: While many parts of the act are only “indirectly” ethical, there are some that explicitly mention general ethical concepts, such as “fundamental rights” or “Union values.” Several examples of such cases are listed above. Although the strong presence of these concepts in the act indicates a high degree of commitment to fundamental moral values on behalf of the Commission, the concepts themselves are rather abstract and lack specificity. Thus, while their presence is worth noting, it is important to clarify their meaning in the document. This is where Subsection 3.5. of the act becomes particularly relevant. Its significance is explained below.

3.3. Examples of specific ethical concepts

Subsection 3.5. in the act, titled “Fundamental rights,” offers a more specific list of rights that, according to the Commission, may be adversely affected by AI systems (e.g., due to their opacity, complexity, dependency on data,

and autonomy). In general, the mentioned subsection of the act proposal could be seen as a reference point for the general ethical concepts mentioned earlier. In other words, although numerous parts of the act stress the importance of “fundamental rights” without elaborating on their exact content, Subsection 3.5. gives one a more specific idea of what this content may be. Consider the following example:

Example – #4:

Act proposal, Subsection 3.5. *Fundamental rights* (excerpt)

The use of AI with its specific characteristics (e.g. opacity, complexity, dependency on data, autonomous behaviour) can adversely affect a number of fundamental rights enshrined in the EU Charter of Fundamental Rights. This proposal seeks to ensure a high level of protection for those fundamental rights and aims to address various sources of risks through a clearly defined risk-based approach. With a set of requirements for trustworthy AI and proportionate obligations on all value chain participants, the proposal will enhance and promote the protection of the rights protected by the Charter: the right to human dignity (Article 1), respect for private life and protection of personal data (Articles 7 and 8), non-discrimination (Article 21) and equality between women and men (Article 23). It aims to prevent a chilling effect on the rights to freedom of expression (Article 11) and freedom of assembly (Article 12), to ensure protection of the right to an effective remedy and to a fair trial, the rights of defence and the presumption of innocence (Articles 47 and 48), as well as the general principle of good administration. Furthermore, as applicable in certain domains, the proposal will positively affect the rights of a number of special groups, such as the workers’ rights to fair and just working conditions (Article 31), a high level of consumer protection (Article 28), the rights of the child (Article 24) and the integration of persons with disabilities (Article 26). The right to a high level of environmental protection and the improvement of the quality of the environment (Article 37) is also relevant, including in relation to the health and safety of people. The obligations for ex ante testing, risk management and human oversight will also facilitate the respect of other fundamental rights by minimising the risk of erroneous or biased AI-assisted decisions in critical areas such as education and training, employment, important services, law enforcement and the judiciary. In case infringements of fundamental rights still happen, effective redress for affected persons will be made possible by ensuring transparency and traceability of the AI systems coupled with strong ex post controls.

This proposal imposes some restrictions on the freedom to conduct business (Article 16) and the freedom of art and science (Article 13) to ensure compliance with overriding reasons of public interest such as health, safety, consumer protection and the protection of other fundamental rights (“responsible innovation”) when high-risk AI technology is developed and used. Those restrictions are proportionate and limited to the minimum necessary to prevent and mitigate serious safety risks and likely infringements of fundamental rights.

Comments: In general, Subsection 3.5. provides a fairly comprehensive list of specific rights that ought to be taken into account in moral and legal decision making concerning the development and use of AI systems. Additionally, the Commission recognizes the possibility that the protection of fundamental rights may necessitate imposing restrictions on certain freedoms, such as the freedom to conduct business and the freedom of art and science. Specifying the fundamental rights and acknowledging them as “overriding reasons” in relation to certain freedoms underlines the Union’s commitment to promote responsible innovation and protect the interests and welfare of individuals and society in an appropriate manner. Moreover, although the excerpt above does not elaborate on the rights mentioned in detail, it makes a reference to the EU Charter of Fundamental Rights, which contains concise descriptions of what EU considers to be fundamental (human) rights (*Charter of Fundamental Rights of the European Union*, 2012). These rights are in line with the EU’s core values outlined at the beginning of this document.

3.4. Final remarks

Without any doubt, the EU AI Act has strong ethical underpinnings, which are represented in the document in a relatively clear and rigorous manner. The need to consider concerns related to health, safety, and fundamental rights is stressed consistently in different parts of the act, whereas Subsection 3.5. provides a more specific outline of what the fundamental rights in question are and additionally refers to the EU Charter of Fundamental Rights, effectively serving as the ethical backbone of the act. While most chapters and articles in the act do not contain explicit ethical considerations and concepts, they can still be construed as ethically significant and necessary in promoting and safeguarding the values of transparency, accountability, oversight, risk management, consumer protection, right to good administration, and others. These values can be seen as more specific aspects of various fundamental rights such as the rights to liberty, security, privacy, and information. As far as other relevant topics go, the act does not cover digital skills or gender-related issues in detail. Digital skills are not mentioned, whereas gender equality is mentioned once as consistent with the EU Charter of Fundamental Rights (The European Commission, 2021a subsec. 1.2.).

4. Standards and Guidelines for Quality Assurance in the European Higher Education Area

The “Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG)” (European Association for Quality Assurance in Higher Education et al., 2015) is one of the key documents in European higher education. It provides a common quality assurance framework for higher education institutions in the European Higher Education Area (EHEA).

The primary focus of ESG is quality assurance in higher education, which, as emphasized in the document itself, is highly important for social cohesion, economic growth, global competitiveness, and cultural development (p. 4). While all of these aspects have ethical implications, their connection to ethics is not straightforward, and the

contents of the document do not directly pertain to ethics. Nevertheless, some of the values of the Union manifest themselves in ESG in a more indirect manner and could be presented as follows:

- **Transparency, accountability, and responsibility:** according to ESG, all internal stakeholders assume responsibility for fostering quality culture in higher education institutions (p. 8). The document also emphasizes the importance of transparency in the implementation of access policies, admission processes, and criteria (p. 10), as well as in the recruitment and development of the staff (p. 11). Additionally, it stresses the need for reports from external experts and agencies to ensure quality assurance and requires that the reports be published, clear, and accessible (p. 16); also, that the agencies involved have full responsibility for their operations (p. 18) and are accountable to their stakeholders (p. 20).
- **Fairness, non-discrimination, and inclusion:** the document states that quality assurance policies should guard the students and the staff against any kind of intolerance or discrimination (pp. 8, 20). Moreover, according to ESG, student-centred learning and teaching must respect the diversity of students (pp. 9, 11) (e.g., mature, part-time employed, and international students, as well as students with disabilities) and ensure that the student admission, progression, recognition, and certification processes (p. 10)—as well as the recruitment and development of the staff (p. 11)—are fair.
- **Trust and respect:** ESG promote mutual respect between teachers and learners (p. 9) and seek to build trust within European higher education systems and institutions (pp. 4, 5) as well as between institutions, the public, and agencies (p. 18).

In sum, although the primary focus of ESG is the effectiveness and quality of study programs, there are a few parts in the document that indicate commitment to the values endorsed by the Union.

5. An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market

“An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market” (The European Commission, 2022a) is an initiative aimed at creating a robust standardisation framework that enhances EU’s global competitiveness, resilience, and sustainability. It is strategically oriented toward green and digital transitions, interoperability, the position of the EU in the global arena, and the EU single market, stressing the importance of standards and the role of standardisation experts in these areas.

While the document does mention EU values in several parts, it does so only in a rather general and vague manner, using the term “EU values” rather than referring to something more specific. In the main text of the document, values are mentioned in the following general way as presented in the examples below:

1. “Europe’s competitiveness, technological sovereignty, ability to reduce dependencies and protection of EU values, including our social and environmental ambitions, will depend on how successful European actors are in standardisation at international level” (p. 1).
2. “To ensure that the European standardisation system delivers in this respect, measures should be taken to ensure that it promotes EU interests and values” (p. 2).
3. “The EU and its Member States must promote a more strategic approach to international standardisation activities ... in order to ensure the EU’s global competitiveness, security and open strategic autonomy, as well as the ability of the EU to promote its values” (pp. 5–6).
4. “With this strategy, the Commission underpins the EU’s role as a global frontrunner in the development of standards, supporting EU values and providing industries with a competitive edge” (p. 10).

However, it is noteworthy that there are two instances of more specific values in the document as well namely, democratic values:

5. “More than ever, standards do not only have to deal with technical components, but also incorporate core EU democratic values and interests, as well as green and social principles” (p. 4).
6. “Therefore, the Commission is committed to making the European standardisation system more functional and agile, to deliver on the standards that make our industries more competitive, serve the EU’s public interest, promote sustainability, and preserve and reinforce democratic values” (p. 9).

In sum, “The EU Strategy on Standardisation” makes several general mentions of EU values and two of democratic values in particular. While the document is not strongly focused on value questions, it is important to pay attention to the context in which they appear. Virtually all of the examples presented above stress the importance of standardisation in safeguarding and reinforcing core EU values in general and democratic values in particular. This implies that value questions are expected to play a role in the context of the EU’s strategy on standardisation.

6. Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe’s Recovery

“Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe’s Recovery” (The European Commission, 2021b) is a strategic initiative by the EU that was put forward in response to the aftermaths of the COVID-19 crisis, aiming to boost Europe’s recovery, support the twin transitions (green and digital), and secure Europe’s Single Market. Its proposals include measures to strengthen the resilience of Single Market, address dependencies in key sectors and promote autonomy, accelerate the twin transitions, and regulate foreign subsidies, among others.

While the document is strongly focused on means of enhancing Europe’s economic recovery and resilience, it does not explicitly engage with value questions or ethical considerations. There are a few statements that stress the

importance of notions like equality and fairness in the context of European economy such as the following: “The Commission is paying a particular attention to equal rights and opportunities for an inclusive recovery across all sectors” (p. 2). Nevertheless, such statements only appear “in passing” and are not elaborated on. As a result, the document offers little substance with respect to value questions.

7. ICT Standardisation Priorities for the Digital Single Market

“ICT Standardisation Priorities for the Digital Single Market” (The European Commission, 2016) is a communication issued by the European Commission that outlines the standardisation priorities in the context of ICT and EU’s Digital Single Market. It emphasizes the opportunities presented by digital technologies, the importance of framework for innovation, fair competition, and cooperation among businesses, the interconnection between the green and digital transitions, and European values in the context of digital solutions, among other things. The document stresses the importance of harmonized standards within the Union for the deployment of technologies such as cloud computing, Internet of Things (IoT), 5G networks, data infrastructures, eHealth, automated vehicles, and more.

Although this communication document does not mention the EU’s human-centric approach by name, it draws considerably on its main values. For example, it calls for “transparency, openness, impartiality and consensus” (p. 4) in ICT standardisation and repeatedly stresses the importance of respect for privacy (e.g., private data protection) (pp. 3, 6, 7, 9), safety, security, and reliability of digital technologies (pp. 6–12), as well as interoperability (pp. 2, 6–12). The notions of trust (pp. 6–8, 10) and transparency (pp. 4, 6, 10, 14), which are both part of EU’s human-centric approach, are mentioned quite frequently as well (e.g., in the context of data management). Moreover, the Commission emphasizes the importance of fairness and non-discrimination in ICT standardisation (pp. 11, 13)—particularly in the context of Intellectual Property Rights (IPR) and licensing terms—stressing the need for “a fair return on investment for standard essential patent (SEPs) holders and fair access to SEPs for all players—and especially SMEs ...” (p. 13).

Finally, the document draws attention to the importance of fundamental rights for the development of ICT standards and, on page 4, makes an explicit reference to the Charter of Fundamental Rights. Consider the following passage:

The actions to address the [new] challenges [in the development of ICT standards] needs [sic] to ensure a proper balancing in view of their compliance with fundamental rights, as standardisation may have implications in this area. For instance, the actions need to ensure full respect of the rights to private life and personal data protection, and should also take into account other **fundamental rights** [emphasis in the original], including freedom to provide business and right to property. (pp. 3–4)

In sum, the “ICT Standardisation Priorities for the Digital Single Market” communication document embodies the EU’s human-centric approach by drawing on values such as transparency, privacy protection, safety, security, reliability, interoperability, trust, and fairness. It calls for a responsible and value-sensitive approach to ICT standardisation, seeking to address new challenges in a way that complies with fundamental rights.

8. The 2024 Annual Union Work Programme for European Standardisation

“The 2024 Annual Union Work Programme for European Standardisation” (The European Commission, 2024) is a document published by the European Commission that identifies strategic policy priorities and actions for European standardisation. In total, it sets out 72 specific courses of action that would implement the mentioned priorities through the development and revision of standards in the context of European industry resilience, the digital transition, the green transition, and the internal market for services and products.

Since the document is focused on proposing specific actions that contribute to achieving European standardisation goals, it does not engage with ethical issues to a great extent. However, for each of the 72 proposed actions the Commission identifies specific objectives under the heading “Specific objectives and policies for European standards/European standardisation deliverables” (p. 5). In this column of objectives and policies, one can find some references to EU core values in relation to specific areas of standardisation. The areas and their respective values are listed below:

- **Standardisation actions/deliverables supporting the resilience of European industry (pp. 5–6):** this part of the document covers issues such as critical raw materials, additive manufacturing techniques, bio-materials, bio-based, and wood-derived products, as well as advanced materials. With respect to EU values, it repeatedly stresses the importance of sustainability in relation to production and manufacturing and mentions safety with respect to advanced materials.
- **Standardisation actions/deliverables supporting the digital transition (pp. 6–9):** this part covers issues such as cybersecurity requirements for products with digital elements, quantum technologies, EU trusted data framework, virtual and augmented reality ecosystem and economy, harmonization of barcodes, and AI. Here, safety and security are constantly stressed as critical elements for standardisation of different kinds of digital technologies. This part also emphasizes the importance of interoperability⁹ (regarding numerous technologies), privacy and autonomy (e.g., data protection and access), and trust (e.g., among vendors, customers, and service providers). In relation to standardisation of AI, the Commission explicitly calls for respect for fundamental values and human rights.

⁹ Strictly speaking, interoperability may not be an ethical value. However, it facilitates various valuable aspects of technologies, enabling users to have greater freedom (e.g., allowing them to switch providers without being locked into proprietary systems), promoting fair competition by preventing monopolistic practices, providing users with greater control over their data, promoting inclusion and accessibility, and more.

- **Standardisation actions/deliverables supporting the green transition (pp. 10–23):** this is the longest part in the action plan, proposing a total of 42 actions to promote green transition. It includes standardisation activities with respect to issues such as hydrogen technologies, electricity grids, ecodesign and labelling of light sources, ecodesign and labelling of water heaters, climate resilience infrastructure, microplastic, assessment of ecosystem services, and many others. While this part pays considerable attention to environmental issues (e.g., energy consumption, air quality, greenhouse gas emissions, microplastic releases into the environment, biodiversity loss, soil contamination, and so forth), core values that are not related to environmental sustainability are virtually absent in it.
- **Standardisation actions/deliverables supporting the internal market for services and products (pp. 23–27):** this part covers issues such as medical devices, weighing and measuring instruments, interoperability of the rail system, electromagnetic compatibility, radio equipment, consumer products safety standards, and others. In this part, safety is mentioned in most of the proposed standardisation areas that concern services and products for the internal market with few mentions of other values. Environmental protection, consumer protection, and fair trading are mentioned in relation to standardisation of weighing and measurement instruments.

In sum, the Commission stresses the importance of safety in relation to numerous standardisation areas within the categories of digital transition and the internal market for services and products. Environmental sustainability is the central focus of standards for the green transition, whereas standards supporting the resilience of European industry must account for sustainability more generally. The most diverse value concepts appear in the context of digital standardisation and AI in particular, including requirements for safety, privacy, autonomy, trust, interoperability, and respect for fundamental values and rights.

9. Concluding Remarks and Implications for Standardisation Education

In sum, the presence of value concepts in the analysed documents varies considerably as does their degree of specificity. For example, the strategic initiative “Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe’s Recovery” makes few mentions of EU core values altogether, whereas “The EU Strategy on Standardisation” refers to “EU values” in a few cases but without specifying them, except for democratic values which are emphasized more strongly. Similarly, the “Standards and Guidelines for Quality Assurance in the European Higher Education Area” contains parts that indicate commitment to some of the core EU values—such as fairness, non-discrimination, and transparency—but only in a more implicit manner, with few direct mentions of the values themselves.

The other three analysed documents—“The EU AI Act,” “ICT Standardisation Priorities for the Digital Single Market,” and “The 2024 Annual Union Work Programme for European Standardisation”—are more explicit on ethical issues

relevant to standardisation. Not only do their contents embody a diverse set of values (e.g., safety and security, privacy and autonomy, transparency, accountability, fairness, and non-discrimination, among others) and a human-centric approach to emerging technologies, but the mentioned documents also make explicit references to the notion of fundamental rights, which is at the heart of both ethics and EU policies. While “The EU AI Act” and “ICT Standardisation Priorities for the Digital Single Market” call for respect for fundamental rights in the context of digital technologies and AI, “The 2024 Annual Union Work Programme for European Standardisation,” specifically stresses the need for standardisation professionals to take fundamental rights into consideration in relation to AI, underscoring the importance of ethics in this context.

Based on the findings of this report and on the current state of emerging socially disruptive technologies, such as AI, it is evident that the EU’s standardisation landscape is increasingly becoming intertwined with ethics and requires additional ethical expertise to address new challenges. This expertise presupposes knowledge and skills in numerous fields of ethics (e.g., technology/AI ethics, engineering ethics, business ethics, environmental ethics, social ethics, human rights, etc.), as well as understanding key ethical notions that are commonly present in EU policy documents relevant to standardisation, including fundamental/human rights, moral values, justice, fairness, wellbeing, non-discrimination, inclusion, (un)acceptable risk, and others. Although this report may not warrant drawing strong conclusions regarding the place of ethics in standardisation curricula, understanding the ethical dimensions of digitalization, business practices, cultural differences, and sustainability initiatives seems essential for preparing students to navigate the diverse and interdisciplinary challenges that come with the professional practice of responsible and value-sensitive standardisation propagated by the EU.

Table 10-1. Value concepts in the "The Charter of Fundamental Rights of the European Union"

	Concepts	Definitions and Sources
1.	Democracy	<p>"Democracy" refers very generally to a method of collective decision making characterized by a kind of equality among the participants at an essential stage of the decision-making process. The most important element of democracy as a form of government is self-rule, equally distributed among the people. Other noteworthy elements include respect for minority rights, rule of law, protection of human rights, and mechanisms for accountability and participation.</p> <p>Sources: Democracy (Stanford Encyclopedia of Philosophy); Democracy: Definition and Explanation (politicalsciencenotes.com)</p>
2.	Dignity	<p>"Dignity" is a complex and contested concept that, in general terms, refers to absolute, intrinsic, and unconditional value. It is a sense of self-worth, which we have a duty to develop and respect in ourselves and a duty to protect in others. The concept of human dignity features in ethical, legal, and political discourse as a foundational commitment to human value or human status, but the source of that value, or the nature of that status, are contested.</p> <p>Sources: What is dignity? - Ethics Explainer by The Ethics Centre; How to define dignity and its place in human rights – a philosopher’s view (theconversation.com); Human Dignity Internet Encyclopedia of Philosophy (utm.edu)</p>
3.	Equality	<p>"Equality" is a contested concept that signifies correspondence between a group of different objects, persons, processes, or circumstances that have the same qualities in at least one respect, but not all respects, i.e., regarding one specific feature, with differences in other features. "Equality" can be used in the very same sense both to describe (e.g., when two people are said to have the same weight) and prescribe (e.g., when it is said people ought to be equal before the law). The fundamental idea between the widely accepted principle of human equality is that human beings, despite their differences, are to be regarded as one another’s equals in terms of their worth, dignity, and respect they deserve.</p> <p>Source: Equality (Stanford Encyclopedia of Philosophy)</p>
4.	Ethical principles	<p>In the context of ethics, principles refer to fundamental guidelines that help determine what acts are morally right or wrong. While they do not offer a straightforward formula for determining the right course of action, they provide essential considerations to weigh when faced with ethical dilemmas. Ethical principles prescribe actions that promote certain moral values such as autonomy, beneficence, nonmaleficence, and justice. Principles that are highly specific are typically referred to as rules.</p> <p>Sources: Exploring Ethics: Understanding the History, Theories, and Applications of Moral Principles (ererearch-ethics.org); What is Ethical principles - Meaning and definition - Pallipedia; Beauchamp, T., and J. F. Childress. 2001. <i>Principles of Biomedical Ethics</i> (5th ed.). New York: Oxford University Press.</p>
5.	Freedom	<p>Freedom (or liberty) in a general sense refers to the quality or state of being free: the absence of necessity, coercion, or constraint in choice or action. Negative freedom is the absence of obstacles, barriers or constraints. One has negative freedom to the extent that actions are available to one in this negative sense. Positive freedom is the possibility of acting—or the fact of acting—in such a way as to take control of one’s life and realize one’s fundamental purposes.</p> <p>Sources: Freedom Definition & Meaning - Merriam-Webster; Positive and Negative Liberty (Stanford Encyclopedia of Philosophy)</p>
6.	Justice	<p>Justice is the ethical, philosophical idea that people are to be treated impartially, fairly, properly, and reasonably by the law and by arbiters of the law, that laws are to ensure that no harm befalls another, and that, where harm is alleged, a remedial action is taken—both the accuser and the accused receive a morally right consequence merited by their actions. In ethics, the concept of justice is closely related to that of "rightness" or morality in general, but particularly in the sense of morality in the sense of "what we owe to each other."</p> <p>Sources: justice Wex US Law LII / Legal Information Institute (cornell.edu); Justice (Stanford Encyclopedia of Philosophy)</p>
7.	Moral duties	<p>In its most fundamental sense, a moral duty or obligation refers to a moral requirement to follow a certain course of action, that is, to do, or refrain from doing, certain things. It is not tied to any legal requirement, whether perfect or imperfect, nor is it connected to receiving any material or pecuniary benefit. Moral duty springs from a sense of justice and equity that an honourable person would have, and not from a mere sense of doing benevolence or charity.</p> <p>Sources: Introduction to Ethical Concepts, Part 2 (mit.edu); Moral Obligation Law and Legal Definition USLegal, Inc.</p>

	Concepts	Definitions and Sources
8.	Morality	<p>At the most minimal, morality is a set of norms and principles that govern our actions with respect to each other and which are taken to have a special kind of weight or authority. More fundamentally, we can also think of morality as consisting of moral reasons, either grounded in some more basic value, or, the other way around, grounding value.</p> <p>Source: Moral Theory (Stanford Encyclopedia of Philosophy)</p>
9.	Rights (fundamental rights, human rights)	<p>Rights are entitlements (not) to perform certain actions, or (not) to be in certain states; or entitlements that others (not) perform certain actions or (not) be in certain states. To accept a set of rights is to approve a distribution of freedom and authority, and so to endorse a certain view of what may, must, and must not be done. Rights correlate with duties: if someone has a right, then others have a corresponding duty toward the right-bearer. Moral rights are commonly distinguished from legal and customary rights, with moral rights being grounded in moral reasons, legal rights deriving from the laws of the society, and customary rights existing by local convention.</p> <p>Source: Rights (Stanford Encyclopedia of Philosophy)</p>
		<p>Human rights are primarily moral rights of high priority that are universally valid, independent of any legal recognition by particular nation-states or of particular times and places. All human beings are endowed with these rights simply by virtue of their humanity. In this respect, human rights are commonly seen as inborn, unalterable and inalienable. In addition, they are considered the minimal standards necessary to protect the most vital and precious interests and values of human beings—for example, their freedom, safety, equality, political participation and social security, to name just a few.</p> <p>Source: Gordon, J.-S. 2015. “Human Rights and Cultural Identity.” <i>Baltic Journal of Law & Politics</i> 8(2): 112–135. (see pages 114–115)</p>
		<p>Fundamental rights, according to the EU, largely refer to the same substance as human rights. They are the rights of people in the EU as enshrined in the EU Charter of Fundamental Rights, which contains rights and freedoms grouped under six titles: dignity, freedoms, equality, solidarity, citizens’ rights and justice. In a more general ethical sense, fundamental rights can be seen as basic moral rights of high priority that subsume but are not limited to human rights.</p> <p>Sources: What are fundamental rights? European Union Agency for Fundamental Rights (europa.eu); Why do we need the EU Charter of Fundamental Rights? (europa.eu); Gordon, J.-S. 2023. <i>The Impact of Artificial Intelligence on Human Rights Legislation</i>. Palgrave Macmillan. (see § 5.3)</p>
10.	Solidarity	<p>Since the early- to late-nineteenth century, when the term “solidarity” became prevalent, it has always been used to describe a special relationship of unity and mutual indebtedness within a group. In social and political philosophy, the concept of solidarity is primarily used to evaluate, guide, and describe activities within groups and between individuals and groups. The concept of solidarity has been invoked with increasing regularity in contemporary social movements (Movement for Black Lives, Occupy, MeToo, climate change activism), law and politics (COVID, EU, constitutions around the world, human rights), and even bioethics.</p> <p>Source: Solidarity in Social and Political Philosophy (Stanford Encyclopedia of Philosophy/Summer 2023 Edition)</p>
11.	Values (universal values)	<p>In the most abstract sense, values refer to valuable and desirable aspects or qualities of something that motivate one’s action. Values and disvalues are expressed through certain evaluative concepts, such as “good” and “bad”, “better” and “worse,” “right” and “wrong,” “just” and “unjust,” and so forth. Personal values are personal beliefs about right and wrong, whereas cultural values are values accepted by religions or societies and reflect what is important in each context. Personal and cultural values may or may not align with moral values, which are typically seen as objectively valid and binding, regardless of whether they are accepted or not.</p> <p>Sources: Value Definition & Meaning - Merriam-Webster; Value Theory (Stanford Encyclopedia of Philosophy); What are Values? - Ethics Sage; Moral Anti-Realism > Moral Objectivity and Moral Relativism (Stanford Encyclopedia of Philosophy/Summer 2020 Edition)</p>
		<p>In an ethical sense, a value judgment can be said to be universal if it applies to all similarly situated individuals. Universalizability is commonly seen as a distinguishing feature of moral judgments—moral imperatives must be regarded as equally binding on everyone. The force of this principle, however,</p>

	Concepts	Definitions and Sources
		depends upon the generality of the judgments and the particularity of the situations to which they are applied. Source: Philosophical Dictionary: Uebermensch-Utilitarianism (philosophypages.com)
12.	Well-being	In a general philosophical sense, well-being describes what is non-instrumentally or ultimately good for a person. The question of what well-being consists in is of independent interest in moral philosophy, but it is of particular importance in the case of utilitarianism, according to which the only moral requirement is that well-being be maximized. In social sciences, well-being is seen as a broad and multifaceted construct that can essentially be divided into two large domains: objective and subjective well-being. Subjective well-being refers to a person's self-reported "global assessment of all aspects" of their life. Objective well-being often refers to a set of societal circumstances generally captured by material, tangible, and quantitative indicators. Sources: Well-Being (Stanford Encyclopedia of Philosophy) ; Well-Being Measurement – Lee Kum Sheung Center for Health and Happiness (harvard.edu) ; What is "wellbeing" — and why should we measure it? - ABC Religion & Ethics

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11. Appendix PA-2. Standardisation concepts in EU policy documents

By Kęstutis Mosakas <kestutis.mosakas@knf.vu.lt>

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The EU operates in a complex network of policies and regulations aimed at promoting harmonization and cooperation among member states. In this network, standards and standardisation processes play a vital role in ensuring interoperability, innovation, safety, sustainability, and efficiency in various sectors. As part of our broader study, this appendix provides an overview of how the analysed EU policy documents reference standards and standardisation. By examining the language and contexts in which standards are mentioned, we may gain additional insights into the expectations of the European Commission regarding the role and significance of standardisation practices within the EU. Below, a list of the documents is provided along with the details on how the notions of standards and standardisation are represented in them.

1. The EU AI Act (The European Commission, 2021)

The term “standardisation” is mentioned 4 times in the document, whereas the term “standards” is mentioned 36 times, although not always in the context of standardisation. The contexts in which these terms are mentioned could be roughly classified as follows:

- **Importance of shaping standards on a global level:** on p. 5, it is stated that the proposal “strengthens significantly the Union’s role to help shape global norms and standards” and that “it provides the Union with a powerful basis to engage further with its external partners, including third countries, and at international fora on issues relating to AI”. A similar statement is also made on p. 6.
- **Importance of standardisation for compliance with requirements:** p. 6 states that “the proposal defines common mandatory requirements applicable to the design and development of certain AI systems before they are placed on the market that will be further operationalised through harmonised technical standards”. On p. 7, it is claimed that harmonised standards will assist providers and users in complying with the requirements for high-risk AI systems (high quality data, documentation and traceability, transparency, human oversight, accuracy and robustness). On p. 13, it is noted that standards or other technical specifications may provide precise technical solutions to achieve compliance with legal requirements for high-risk AI systems. P. 32 similarly states that “Standardisation should play a key role to provide technical solutions to providers to ensure compliance with this Regulation” and that “compliance with harmonised standards ... should be a means for providers to demonstrate conformity with the requirements of this Regulation.” P. 53 highlights that standards should be part of the quality management system “to ensure

that the high-risk AI system complies with the requirements ...”. P. 78 states that the market surveillance authorities shall consider whether non-compliance with AI system requirements (should it occur and not be corrected by the operator) stems from “shortcomings in the harmonised standards or common specifications referred to in Articles 40 and 41 conferring a presumption of conformity” or a failure to meet certain other requirements. P. 79 follows up on this: “Where the national measure is considered justified and the non-compliance of the AI system is attributed to shortcomings in the harmonised standards or common specifications referred to in Articles 40 and 41 of this Regulation, the Commission shall apply the procedure provided for in Article 11 of Regulation (EU) No 1025/2012”.

- Title III, Chapter 5 (“Standards, Conformity assessment, certificates, registration”) is in particular worth mentioning in relation to standardisation and conformity. In general, it states that high-risk systems “shall be presumed to be in conformity with the requirements set out in Chapter 2 of this Title, to the extent those standards cover those requirements” (p. 63), with Chapter 2 referring to the chapter that sets out the requirements for high-risk AI systems (e.g., compliance, transparency, data, documentation, etc.). Additionally, on p. 63, it is stated that “Where harmonised standards ... do not exist or where the Commission considers that the relevant harmonised standards are insufficient or that there is a need to address specific safety or fundamental right concerns, the Commission may, by means of implementing acts, adopt common specifications in respect of the requirements set out in Chapter 2 ...”. P. 64 specifies the conformity assessment procedures that the provider shall follow to demonstrate compliance of a high-risk system with Chapter 2 (namely, procedure based on internal control on the one hand and, on the other, procedure based on assessment of the quality management system and assessment of the technical documentation, with the involvement of a notified body). P. 65 states that where the manufacturer is enabled to opt out from a third-party conformity assessment by legal acts, “provided that that manufacturer has applied all harmonised standards covering all the relevant requirements, that manufacturer may make use of that option only if he has also applied harmonised standards”.
- **Importance of standardisation for managing high-risk AI systems:** on p. 20, the document stresses the importance of standards for EU core values regarding high-risk AI systems: “In order to ensure a consistent and high level of protection of public interests as regards health, safety and fundamental rights, common normative standards for all high-risk AI systems should be established. Those standards should be consistent with the Charter of fundamental rights of the European Union (the Charter) and should be non-discriminatory and in line with the Union’s international trade commitments”. Pp. 46–47 state that the risk management system (for high-risk AI systems) “shall consist of a continuous iterative process run throughout the entire lifecycle of a high-risk AI system, requiring regular systematic updating”, part of which is adoption of suitable measures. These measures “shall take into account the generally acknowledged state of the art, including as reflected in relevant harmonised standards or common specifications” (p. 47). P. 49

states that the systems should be developed with automatic recording of events (“logs”) capabilities which should be on while the system is operating and which “shall conform to recognised standards or common specifications”.

- **European standardisation bodies for AI:** p. 35 states that “in order to facilitate a smooth, effective and harmonised implementation of this Regulation a European Artificial Intelligence Board should be established. The Board should be responsible for a number of advisory tasks, including issuing opinions, recommendations, advice or guidance on matters related to the implementation of this Regulation, including on technical specifications or existing standards regarding the requirements established in this Regulation and providing advice to and assisting the Commission on specific questions related to artificial intelligence”. On p. 51, it is highlighted that “notified bodies shall participate in coordination activities as referred to in Article 38 [the conformity assessment procedures of AI systems]. They shall also take part directly or be represented in European standardisation organisations, or ensure that they are aware and up to date in respect of relevant standards”. Then, p. 73 states that “When providing advice and assistance to the Commission ... the Board shall [among other things] ... issue opinions, recommendations or written contributions on matters related to the implementation of this Regulation, in particular (i) on technical specifications or existing standards regarding the requirements ... , (ii) on the use of harmonised standards or common specifications ..., (iii) on the preparation of guidance documents ...”. Finally, “Member States shall ensure that ... national competent authorities shall have a sufficient number of personnel permanently available whose competences and expertise shall include an in-depth understanding of artificial intelligence technologies, data and data computing, fundamental rights, health and safety risks and knowledge of existing standards and legal requirements” (p. 73).

2. Standards and Guidelines for Quality Assurance in the European Higher Education Area (European Association for Quality Assurance in Higher Education et al., 2015)

While the term “standardisation” is not present in the document, it mentions the related terms “standard” or “standards” 60 times, mostly in relation to quality assurance in higher education. However, many of those mentions are only there to set out a particular standard¹⁰ rather than to convey a general strategic perspective of on standardisation. For this reason, the focus here is placed on those instances of the term that are presented in a certain context.

According to the description of the scope and concepts in the document,

¹⁰ For example: “**Standard:** Institutions should consistently apply pre-defined and published regulations covering all phases of the student “life cycle”, e.g. student admission, progression, recognition and certification” (p. 10; emphasis added).

The ESG are a set of standards and guidelines for internal and external quality assurance in higher education. The ESG are not standards for quality, nor do they prescribe how the quality assurance processes are implemented, but they provide guidance, covering the areas which are vital for successful quality provision and learning environments in higher education. The ESG should be considered in a broader context that also includes qualifications frameworks, ECTS and diploma supplement that also contribute to promoting the transparency and mutual trust in higher education in the EHEA [European Higher Education Area]. (p. 4)

According to the Commission, the ESG need to be “reasonable generic”, given that acceptance of standards is important for fostering common understanding of quality assurance in the European higher education (p. 6). The document also divides the standards for quality assurance into three parts—internal quality assurance, external quality assurance, and quality assurance agencies—with the three parts being “intrinsically interlinked and together form the basis for a European quality assurance framework” (p. 7). In general, the ESG are meant to set out “agreed and accepted practice for quality assurance in higher education in the EHEA” that should “be taken account of and adhered to by those concerned, in all types of higher education provision” (p. 7).

The rest of the document puts forth particular standards supplemented with guidelines that explain why the standard is important and how it may be implemented. The document also contains an annex, which summarizes the list of standards (pp. 21–23).

3. An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market (The European Commission, 2022a)

This document mentions “standardisation” 7 times, “standard” 23 times, and “standards” 13 times. Since standardisation is the key focus of the document, most of the mentions of the term relate to the central ideas raised in it. Microsoft Copilot provides the following summary of the document:¹¹

“‘An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market’ is a strategic document from the European Commission that aims to strengthen the EU’s global competitiveness and enable a resilient, green, and digital economy.

¹¹ Generated using the prompt “Provide a comprehensive summary of ‘An EU Strategy on Standardisation: Setting Global Standards in Support of a Resilient, Green and Digital EU Single Market’ that is at least 10 sentences long” in the “Precise” conversation mode. The output was reviewed and compared to the contents of the document thereafter.

The strategy recognizes that standards are at the core of the EU single market and have delivered great benefits for companies and consumers. Over the last 30 years, the European Standardisation System has delivered more than 3600 harmonised standards, promoting interoperability, safety, and environmental protection.

However, the strategy also acknowledges that many third countries are taking an assertive stance to standardisation, providing their industries with a competitive edge. This has implications for Europe's competitiveness, technological sovereignty, and ability to reduce dependencies.

The strategy proposes that European standardisation needs to become more agile, flexible, and focused to anticipate standardisation needs. It also needs to respond to an increasingly rapid innovation pace and deliver standards fast, while preserving high-quality outputs.

The strategy identifies that often private and non-European industry-led consortia are leaner and faster in developing standards. In particular, in new and emerging technologies, the European standardisation system often fails to deliver in a timely manner.

The strategy proposes a set of actions to put standards back at the core of a resilient, green, and digital EU single market and to strengthen the global role of the European standardisation system. It aims to anticipate, prioritise and address standardisation needs in strategic areas and improve the governance and integrity of the European standardisation system."

A close look at the use of the standards-related terms in the document reveals that the summary presented above captures virtually all contexts relevant to the instances of their usage.

4. Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe's Recovery (The European Commission, 2021b)

This document mentions "standardisation" 7 times, "standard" 3 times, and "standards" 13 times. The contexts in which these terms are mentioned could be categorized as follows:

- **Addressing product shortages:** standardisation is mentioned as a mechanism for addressing critical product shortages by speeding up product availability and reinforcing public procurement cooperation (p. 7).
- **Benefits for companies and consumers:** the document mentions that the European goods standards have benefited companies and consumers by increasing "quality and safety, improving transparency, reducing costs and opening up markets for businesses" (p. 8). Similarly, it states that laying down technical requirements—e.g., levels of quality, performance, interoperability, environmental protection, protection of health or safety—through standardisation "can increase consumer confidence", "further integrate

European service markets”, and “overcome barriers linked to multiple national certification requirements” (p. 8). Moreover, harmonised standards are stated to have the potential benefits to “to facilitate cross-border activities, market potential and opening and overall economic benefit, including for SMEs and women entrepreneurs...” (p. 8).

- **Global leadership in standard-setting:** the document also stresses the importance of standard-setting for global leadership in technologies and for interoperability, stating that “global convergence on the same international standards helps reduce adaptation costs and strengthens EU and global value chains” (p. 14). It also strongly emphasises that EU industries need European and international standards for their resilience and competitiveness (p. 15).
- **The twin digital and green transition:** the document states that in the context of standardisation particular attention needs to be paid to the twin green and digital transition, which is identified as a key area (p. 15).
- **Green recovery:** the Commission seeks to pair green investments with the development of new standards for green finance to support the financing of a green recovery. This is done through the preparation of “Renewed Sustainable Finance Strategy” and a legislative initiative on sustainable corporate governance providing for due diligence by companies (p. 18).

5. ICT Standardisation Priorities for the Digital Single Market (The European Commission, 2016)

In total, this document contains 78 mentions of “standardisation”, 75 mentions of “standards”, and 30 mentions of “standard”. Due to the fact that the relevant terms are mentioned extensively on every page of the document, providing an outline of their usage contexts would be tantamount to summarizing the entire document. Therefore, one may consider the following summary of the key points by Microsoft Copilot:¹²

“The document ‘ICT Standardisation Priorities for the Digital Single Market’ is a key policy document of the European Commission. It outlines the importance of Information and Communication Technology (ICT) standards for achieving interoperability of new technologies, and the significant benefits they can bring to both industry and consumers.

The document emphasizes that ICT standards help ICT markets remain open and allow consumers the widest choice of products. It also highlights the EU’s role in ICT standardisation, stating that standardisation is an essential component of industrial competitiveness.

¹² Generated using the prompt “Provide a comprehensive summary of ‘ICT Standardisation Priorities for the Digital Single Market’ that is at least 10 sentences long” in the “Precise” conversation mode. The output was reviewed and compared to the contents of the document thereafter.

The document mentions that many of the most commonly used ICT technical specifications are produced by fora and consortia that have become leading ICT standards development bodies. It also explains that the Commission financially supports the work of the 3 European standardisation organisations: ETSI, CEN, and CENELEC.

The document underscores the importance of having common ICT standards to ensure that European industries are at the forefront of developing and exploiting ICT technologies. These standards ensure interoperability and guarantee that such technologies work smoothly and reliably together.

Finally, the document proposes to focus standard-setting resources and communities on 5 priority areas: 5G, Internet of Things, cloud computing, cybersecurity, and data technologies. These areas are considered essential for wider EU competitiveness and can accelerate digitisation, having an immediate impact on competitiveness in domains such as eHealth, intelligent transport systems, connected/automated vehicles, smart homes and cities, and advanced manufacturing.”

6. The 2024 Annual Union Work Programme for European Standardisation (The European Commission, 2024)

This document mentions “standardisation” 58 times, “standards” 140 times, and “standard” 16 times. Similar to the “ICT Standardisation Priorities for the Digital Single Market” covered above, it may be difficult to present the use cases of these terms without summarizing the entire document. However, it is noteworthy that most of the space in this document is dedicated to the table that lists and describes particular actions (72 in total) for the development and revision of European standards or European standardisation deliverables supporting the resilience of European industry. But if we focus on the introductory parts of the document, we can find the following strategic outlooks:

- **The general purpose:** “The Notice was drawn up to specifically support EU policies and legislation with the objective of contributing to a green, digital and resilient single market as well as the EU’s international objectives” (p. 1). Moreover, “Standards support EU policies to ensure that EU products and services are competitive worldwide and reflect state-of-the-art safety, security, health, social and environmental considerations. In addition, they are an important tool for research, development and innovation valorisation by demonstrating proof of concept and leveraging the roll-out of completely new industrial value chains in the green and digital areas” (p. 1).
- **Global partnerships:** the document also mentions cooperation on standardisation with Japan, South Korea, and Singapore by implementing digital partnerships in the context of the EU-US Trade and Technology Council and within G7/G20 groups (p. 1). Additionally, “The Commission will promote [international] cooperation and exchange of information on standardisation ... as an essential part of the chapter on technical barriers to trade and good regulatory practices in every free trade agreement it negotiates” and

“will continue dialogue with other countries to explore possible areas of cooperation on global challenges” (p. 1).

- **Promoting EU’s global leadership in standardisation:** it is stated that the annex to the “Annual Union Work Programme”—the table with a list of particular actions for developing European standards—presents standardisation deliverables that “are necessary and suitable for the support of EU legislation and policies, and thereby strengthen the EU’s leading role in setting global standards” (p. 1).
- **Strategic priorities:** The document contains a list of priority deliverables that “support critical EU policies in achieving a green, digital and resilient single market and deserve particular attention from the European standardisation system, including fast-track deliverables” (p. 1). The following areas are identified as policy priorities: 1. Technologies for European high-performance computing and European quantum communication infrastructure; 2. Critical raw materials – recycling of permanent magnets and exploration, extraction, refining and recycling of critical raw materials; 3. EU Trusted Data Framework; 4. European Digital Identity framework; 5. Ecodesign of air-to-air conditioning and heat pumps; 6. Cybersecurity requirements for products with digital elements; 7. Hydrogen technologies and components; 8. Electric vehicle charging infrastructure (p. 2).

7. Summary

Based on the contexts in which standardisation was mentioned in the policy documents as presented above, standardisation is presumed by the Commission to play an important role regarding the following objectives:

- Global competitiveness and leadership (mentioned in 5 documents).
- Reliability and quality assurance, environmental protection (mentioned in 4 documents).
- Protection of health, safety, and security, resilience of the EU single market, interoperability, the twin digital and green transition, fostering research and innovation, benefits for companies and consumers (mentioned in 3 documents).
- International cooperation and partnerships, compliance with regulatory requirements, social considerations (mentioned in 2 documents).
- Risk management, improving governance, addressing product shortages, transparency, sustainability (mentioned in 1 document).

This list, however, is not meant to be exhaustively representative of the EU standardisation objectives outlined in the policy documents. Rather, it serves as a general indicator of the objectives that were associated with specific occurrences of terms like “standards” or “standardisation”.

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12. Appendix PA-3. Report on Green, Digital Skills and Gender Equality in the EU Policy Documents and Standardisation Higher Education

By Oksana Kuzmuk <oksana.kuzmuk@knf.vu.lt>

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The aims:

The goal of this report is to provide an overview of policies on gender equality, and digital and green skills as represented in EU policy documents with special emphasis on standardisation in higher education and summarise the collection of knowledge on standardisation education from leading players in the field.

This report provides an overview of the activities performed by VU team from the mid-February until the mid-September, 2024 and main findings as a result.

The structure:

- I. The first section for each key concept presents a brief definition of critical concepts established by EU green, digital and gender equality policies regarding standardisation: gender equality in standardisation, gender-responsive standards, sustainability and standardisation, European leadership in standardisation, digital skills for standards professionals. Also, this section presents an overview/analysis of how these concepts appear in the EU policy documents.
- II. The description of the work done to analyse how gender equality, green and digital skills in regards to standardisation education are defined in the policy documents. The progress on collecting knowledge on standardisation education from leading players in the field, among partners of the Edu4Standards project.
- III. A review of existing teaching methods and best practices in teaching standardisation and identification of gaps in knowledge and teaching methods, including relevant content, which has the potential to be integrated into standardisation education. Analysis, systematisation and classification of content obtained as a result of isology investigation (the study of references, standards and standardisation).

The Scope:

Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), 2015; Strategic Engagement for Gender Equality 2016-2019; Strategic Framework for European Cooperation in Education and Training (ET 2020), European Commission's Strategy for Equality between Women and Men (2020-2025), Decision

(EU) 2023/936 of the European Parliament and of the Council of 10 May 2023 on a European Year of Skills European Commission, Directorate-General for Education, Youth, Sport and Culture, Key competencies for lifelong learning, Publications Office, 2019, Directive 2006/54/EC of the European Parliament and of the Council of 5 July 2006, European Union, European Commission (2020). Joint Communication to the European Parliament and the Council: EU Gender Action Plan (Gap) III – an Ambitious Agenda for Gender Equality and Women’s Empowerment in EU External Action, Charter of Fundamental Rights of the European Union, An EU Strategy on Standardisation - Setting global standards in support of a resilient, green and digital EU single market (2022) Digital Education Action Plan (2020-2027) EU Digital Competence Framework for Citizens (DigComp) European Skills Agenda for Sustainable Competitiveness (2020) European Skills Agenda for sustainable competitiveness, social fairness and resilience (2020), and European Green Deal (2019).

Main Findings: The EU's strategy for standardisation acknowledges the need for new skills in response to technological challenges and horizontal considerations such as artificial intelligence, data protection, and cybersecurity. However, it does not specifically address certain skills for standardisation. While digital skills are not explicitly defined within the Strategy, the Digital Competence Framework for Citizens outlines critical elements of digital competencies across five areas, identifying 21 specific competencies (DigComp 2.2, 2022). The EU policy on standardisation emphasises the urgency of preparing new standardisation specialists to replace the retiring generation of experts. It also highlights the necessity of building bridges between the research, innovation, and standardisation communities (An EU Strategy on Standardisation, 2022, p. 8–9).

The EU's industrial strategy views the development of green and digital skills as a strategic investment in the workforce, crucial for Europe's recovery and the strengthening of the Single Market. This strategy, however, does not mention gender equality (Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe’s Recovery, COM/2021/350 Final, p. 20). The EU education strategy identifies business, law, and engineering as fields of study that require the integration of standardisation into their curricula. EU policies on standardisation advocate for gender equality by recommending balanced representation of men and women in organisations, developing gender-responsive standards, eliminating biases, and ensuring that the needs of both women and men are met. While green and digital skills are highlighted in the EU's green and digital strategies as essential for the green and digital transition, these skills are not explicitly detailed in the context of standardisation. The reviewed policy documents provide specific objectives and examples of how desired skills can be promoted through education, but they do not directly address the education of standardisation specialists. Overall, the task of standardisation aims to position the EU as a global leader in setting standards for modern technologies and upholding democratic values.

1. The List Of The Most Important Definitions and How They Appear in EU Policy Documents

Digital Skills: Individuals should be able to use digital technologies to support their active citizenship and social inclusion, collaboration with others, and creativity towards personal, social or commercial goals. Skills include the ability to use, access, filter, evaluate, create, program and share digital content. Individuals should be able to manage and protect information, content, data, and digital identities and recognise and effectively engage with software, devices, artificial intelligence or robots (p. 10 of Key competencies for lifelong learning¹).

Green skills: Knowledge, abilities, values and attitudes needed to live, work and act in economies and societies seeking to reduce the impact of human activity on the environment.

Skills for the green economy consist of the following:

- Transversal skills linked to sustainable thinking and acting, relevant to all economic sectors and occupations;
- Specific skills required to adapt or implement standards, processes and services to protect ecosystems and biodiversity and to reduce energy, materials and water consumption;
- Highly specialised skills are required to develop and implement green technologies such as renewable energies, sewage treatment or recycling (according to Terminology of European Education and Training Policy²).

Gender equality: Equal rights, responsibilities and opportunities of women and men and girls and boys. Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born female or male³. Gender equality implies that the interests, needs and priorities of both women and men are considered, thereby recognising the diversity of different groups of women and men. Gender equality is not a women's issue but should concern and fully engage men as well as women. Equality between women and men is seen as a human rights issue and a precondition for an indicator of sustainable people-centred development.

Well-being: Subjective well-being refers to how people perceive the quality of their lives. European Foundation for Improvement of Living and Working Conditions defines three categories of well-being:

- Evaluative well-being – life satisfaction and satisfaction with domains of life
- Positive and negative affect – happiness, vitality, feeling calm, feeling cheerful, feeling depressed
- Eudaimonic well-being consists of optimism, autonomy, a sense of purpose, time to enjoy life, and resilience (according to the European Quality of Life Survey⁴).

Gender Equality. Gender equality is a core value of the EU, a fundamental right and a vital principle of the European Pillar of Social Rights. It is also essential for an innovative, competitive and thriving European economy. “In business, politics and society as a whole, we can only reach our full potential if we use all of our talent and diversity”⁵. EU treaties emphasise that the Union should work to eliminate gender inequalities and promote transversal equality in all its activities. The European Council recalls that ‘mainstreaming the principle of equality between women and men in all its activities represents a general aim for the Union. By integrating the gender perspective into all policy areas, gender mainstreaming is also considered a tool to promote and reinforce good governance. The Treaty of Lisbon reaffirms the EU's commitment to promoting gender equality as a fundamental principle. Article 2 of the Treaty on European Union (TEU) states that the EU is founded on freedom, democracy, respect for human rights and fundamental freedoms, and the rule of law, including the principle of gender equality⁶.

Mainstreaming Gender Equality in Higher Education Policies: The EU encourages Member States to mainstream gender equality principles into their higher education policies and strategies. This involves integrating gender equality objectives into funding programs, quality assurance mechanisms, and institutional development plans. The EU's efforts contribute to promoting gender equality in and through quality, affordable and inclusive education at all levels, building more muscular gender-responsive education systems to promote gender equality and deliver more equitable education results for girls and boys through safe and healthy learning environments, teacher recruitment, training and professional development, curriculum, and learning materials, increasing investment in girls' education to ensure equal access across all educational domains, including STEM fields, digital literacy, and technical and vocational training. 1) Robust measures to counteract gender stereotypes, discriminatory social norms, and instances of gender-based violence within educational settings, supporting research and data collection on gender imbalances in higher education to inform policy development and monitoring efforts (pp. 13–14 of the EU GENDER ACTION PLAN (GAP) III⁷).

Many countries have shown significant improvements in equalising educational opportunities for men and women, according to the EU Gender Equality Index 2023⁸. Besides, the EU member states have developed various tools and practices to support the inclusion and equal opportunity of students, researchers and staff from diverse backgrounds in European R&I systems⁹. Gender equality in higher education is a priority area for the European Union (EU), and several policy documents and initiatives address this issue. Here are some key EU policy documents related to gender equality in higher education:

- **The European Higher Education Area (EHEA):** While not a specific policy document, the EHEA promotes gender equality as one of its core values. It emphasises the importance of ensuring equal opportunities for all individuals in higher education, regardless of gender.
- **Strategic Framework for European Cooperation in Education and Training (ET 2020):** This framework sets

out strategic objectives and priorities for education and training in Europe. Gender equality is highlighted as a cross-cutting priority, focusing on promoting equal access, participation, and success for women and men in education, including higher education.

- **The European Commission's Strategy for Equality between Women and Men (2020-2025)** outlines the EU's approach to advancing gender equality across various sectors, including education. It emphasises the importance of addressing gender stereotypes, promoting women's participation in STEM (science, technology, engineering, and mathematics), and combating gender-based discrimination in education, including higher education.
- **European Charter for Researchers and Code of Conduct for the Recruitment of Researchers:** These documents promote gender equality in research and higher education institutions. They encourage institutions to create a supportive and inclusive environment for all researchers, regardless of gender, and to implement gender equality measures in recruitment, career development, and work-life balance policies.
- **Horizon Europe:** The EU's framework program for research and innovation, Horizon Europe, includes specific objectives and funding opportunities to promote gender equality in research and innovation. This includes supporting research projects that address gender inequalities and promoting women's participation in research and innovation activities, including those conducted in higher education institutions. These plans typically include measures to support women's career progression, improve work-life balance, and prevent gender-based discrimination and harassment.

Gender Equality Plans: EU advocates for gender equality plan to be adopted and implemented in universities and other higher learning institutions to eliminate gender stereotyping for women's career progression.

The pillars of gender equality policies are the following:

- **Monitoring and Evaluation:** Standardisation defines ways of working and establishes norms for measuring progression towards accomplishing goals and objectives on gender equality in higher learning institutions. This may entail compiling and analysing data on gender distribution, productivity, career advancement, and engagement to identify disparities and determine the success of gender mainstreaming policies and approaches.
- **Capacity Building and Training:** Measures of promotion may also include provision of support, training and other forms of support to HEIs, staff and students to enhance the institution's commitment to gender equality and diversity. This may entail organisational learning approaches, such as workshops, seminars, and professional development of the faculty and students in gender-sensitive instruction and

research, gender mainstreaming, stereotyping and bias, and gender-sensitive leadership.

- **International Collaboration and Exchange:** The EU promotes the exchange of information and knowledge between HEIs, policymakers, and other stakeholders at the national and EU levels. This may involve participation in networks, working groups and projects on women's promotion in higher learning institutions, information sharing and benchmarking, and learning about what has worked well in other settings.

Gender Equality and Standardisation. According to ISO Standard 26000, Guidance on Social Responsibility, organisations are recommended to have a balanced mix of men and women in governing structures and management, ensure both sexes are treated equally when it comes to recruitment, career opportunities, and pay, and ensure the needs of men and women are given equal consideration in company decisions and activities to promote parity and eliminate bias.

In addition, ISO strives to promote equal representation in standardisation, increase women's participation in the development of ISO International Standards, and improve standardisation for women worldwide. The ISO 53800 Standard is being developed to tackle this goal: guidelines for promoting and implementing gender equality and women's empowerment.

While ISO 53800 does not feature the necessary skills for the incorporation of gender equality into standardisation, it establishes the following benefits:

- Promote a comprehensive understanding and implementation of gender equality
- Support the creation of inclusive and equitable organisational cultures
- Encourage gender equality as a fundamental human rights issue
- Aids organisations in fulfilling legal obligations regarding gender equality.

One more direction of ISO and IEC efforts towards gender equality is the development of gender-responsive standards. Thus, experts are recommended to develop/obtain, as required, the skills and expertise needed to create and implement a gender action plan.

- **Gender-Responsive Standards: ISO-UNECE, 2022, A Joint Initiative by ISO and UNECE:** Building upon the UNECE document, the ISO-U cease on gender-responsive standards goes further in providing specific guidelines and case studies. The present document stresses the role of international cooperation in advancing gender equality through standardisation and offers several examples of gender-sensitive

standards that have been introduced. One of the pillars of this approach is the focus on elaborating and adopting gender action plans in standardisation bodies. These plans are intended to provide a progressive approach to integrating the consideration of gender in all phases of the standardisation process. This includes establishing measurable goals for gender equality, defining concrete steps towards achieving these goals, and evaluating the progress through periodic evaluations and reviews.

The document also examines how gender audits can be conducted in standardisation organisations. Gender audits are assessments undertaken to determine to what level gender aspects are incorporated into organisational systems and products. Gender audits help organisations to find out where changes are required, and remedial measures are put in place to make the organisation gender-responsive. Also, the initiative points out the need to incorporate gender disparities when setting standards for the use of data. Gathering and comparing data on how standards affect men and women can help understand how standards influence people differently. It can then assist in creating better standards that will consider the needs of all genders.

According to ISO Standard 26000, Guidance on Social Responsibility, in order to promote parity and eliminate bias, organisations are recommended to have a balanced mix of men and women in governing structures and management, ensure both sexes are treated equally when it comes to recruitment, career opportunities and pay, and make sure the needs of men and women are given equal consideration in company decisions and activities.

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One more direction of ISO and EIC efforts towards gender equality is development of gender responsive standards. Thus, there's a recommendation for experts to develop / obtain as required the skills and expertise needed to create and implement a gender action plan (Group of actions n. 3: Creating gender responsive standards bodies), but the skills are not listed (Declaration for Gender Responsive Standards and Standards Development, n.d.).

Thus, it can be concluded that the exact skills are not identified, while the goals/outcomes of gender equality in standardisation are emphasized in most of all the documents of the EU related to gender equality.

Higher education institutions and private and public R&I organisations should explore which research fields can potentially be involved in standardisation and how standardisation can help valorise research results (2.1, 8 Commission Recommendation (EU) 2023/498 of 1 March 2023 on a Code of Practice on standardisation in the European Research Area, retrieved from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32023H0498&qid=1678171117168>).

- **Green Skills and Knowledge: Defining ESCO (UNECE, 2022):** The paper Green Skills and Knowledge: labelling within the ESCO (UNECE) framework is dedicated to the relationship between environmental sustainability and skills. This paper aims to illustrate the need for training and educating the workforce to prepare them for the green transition, which is imperative for the EU to meet its environmental objectives. This paper identifies and describes critical green skills necessary in various fields, such as renewable energy, energy efficiency and sustainable resource management. For this reason, these skills are vital in fostering innovation in green technologies and practices that can help minimise carbon emissions in society. The document aims to standardise the recognition of green competencies by labelling these skills within the ESCO framework so employers can easily attract suitable candidates with the appropriate skills.

One of the critical elements of the document is the focus on learning and training throughout the working career. Regarding the green transition, there will be an increasing need for new and emerging skills as the process advances. The document emphasises the importance of continuing education and training in light of these workforce changes. This includes the incorporation of green skills in conventional education and training systems as well as in the development of new programs with an emphasis on sustainability. Also, the role of certification and accreditation in the development of green skills is presented in the document. The UNECE also seeks to enhance the quality of green skills training by developing standards and accredited certification in green competencies. It can foster more confidence among employers and other relevant stakeholders to invest in green training and education.

- In early 2024, the Commission published a study on the inclusiveness of anthropometric provisions in harmonised European standards¹⁰. This assessment aimed to determine whether the standards that have an anthropometric dimension sufficiently consider the diversity of the European population, including factors such as gender and age, and the various anthropometric measurements (e.g. height, weight and strength).

Digital Skills. The UNESCO Institute for Statistics (2009) defines digital skills as “a range of abilities to use digital

devices, communication applications, and networks to access and manage information”. These abilities make creating and sharing digital content possible, communicating and collaborating with others, solving problems, and finding creative opportunities. Similarly, the Council Recommendation on Key Competences for Life-long Learning defined digital competence as ‘the confident, critical and responsible use of, and engagement with, digital technologies for learning, work, and participation in society. It is defined as a combination of knowledge, skills, and attitudes.

There is a strong link between digital skills and key competencies enabling lifelong learning. European citizens should be equipped with critical skills needed for an increasingly digital world: the ability to filter, use, access, or manage private data, personal information, and one’s digital footprint, stay safe online, and effectively use technologies like AI and other software. People should also ‘be able to use digital technologies to support their active citizenship and social inclusion, collaboration with others, and creativity towards personal, social, or commercial goals’ (European Commission, 2019). This concept of digital skills is more concerned with European citizens than ICT professionals’ specialised skills. The EU framework for citizens’ digital competence (DigComp) outlines the digital skills citizens need to remain competitive in the labour market, socialise, shop, and learn in today’s digital world.

Several EU policy documents address digital skills as a critical training and workforce development priority. Here are some notable ones:

- Digital Education Action Plan (2021-2027): This action plan aims to support the digital transformation of European education and training systems. As stated in Priority one, this action plan supports digital transformation through Erasmus Cooperation projects for all levels of education, enhances pedagogy and expertise in using digital tools for teachers through Erasmus Teacher academies and launches an online self-assessment tool for teachers, SELFIE for Teachers. It includes initiatives to improve digital skills among students, educators, and other stakeholders, promote digital literacy and citizenship, and foster innovation in digital education.
- Digital Skills and Jobs Coalition: The Digital Skills and Jobs Coalition is a multi-stakeholder partnership launched by the European Commission to promote digital skills and employment in Europe. As stated on page 3, everyone needs digital skills not only to work but also to take part in society. With the introduction of ever more sophisticated digital technologies, having sufficiently skilled people to develop and use these technologies is essential. Today, only 57% have the digital skills needed for our digital world. One in six Europeans aged 16-74 had no digital skills, and one in four only had low-level digital skills. It brings together governments, businesses, education providers, and civil society organisations to take action on digital skills development through various initiatives, campaigns, and funding programs¹¹.

- **New Skills Agenda for Europe:** The New Skills Agenda for Europe sets a framework for improving the quality, relevance, and effectiveness of skills development in Europe. It includes initiatives to promote digital skills and digitalisation across different sectors, support lifelong learning and upskilling, and address digital divides and inequalities. The workforce demands of the future call for skills for dual transformations. The green transition also entails investment in the skills of people to create more experts who are involved in making green technologies such as digital technologies, developing green products, services and business models, as well as creating nature-based solutions to reduce impacts on the environment of all activities (p. 12).
- **European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience:** The European Skills Agenda presents a clear roadmap for preparing people for today's and future occupations. It covers measures to increase digital literacy, encourage vocational education and training, develop digital assets, and promote digital advancement and business.

The above-discussed policy reveals the EU's vision to close the digital skills gap, support digital literacy, and provide people with the necessary competencies for the digital era. They offer a structure that enables national governments, education institutions, employers, and other parties to work in unison and address the need for digital skills promotion in Europe. Policies on digital skills development in higher education within the European Union (EU) are defined by the following strategies and initiatives: Using digital technologies in teaching and learning more effectively, acquiring appropriate digital capabilities and knowledge for digital learning, and Enhancing education by using data more effectively.

- **Digital Competence Frameworks:** The EU has created models like the Digital Competence Framework for Citizens (DigComp) and the DigCompEdu¹² model for learners to identify the digital literacy skills and abilities essential for employment, education, and social life in the contemporary world. These frameworks provide a standard reference for higher education institutions to design curricula, develop learning outcomes, and assess students' digital competencies.

According to the Digital Education Action Plan, the following initiatives are included¹³: Integrating digital skills and competencies into higher education curricula across different disciplines and fields of study. This may include offering courses, modules, or programs focused on digital literacy, information technology, data analysis, programming, cybersecurity, digital communication, and digital citizenship.

- **Assessment and Certification:** Standardisation efforts include developing common assessment methods and criteria to evaluate students' digital skills and competencies effectively. This may involve using standardised tests, rubrics, portfolios, or digital badges to assess students' proficiency

in various digital domains and provide them with recognised certifications or credentials upon completing digital skills training programs.

- **Professional Development for Educators:** Standardisation entails providing professional development to enhance educators' ICT competencies and content knowledge on how best to incorporate ICTs in teaching and learning. It can entail offering workshops, training, and interest groups dealing with areas like integrating technology in the teaching-learning process, distance education, LMS, and e-assessment.
- **Quality Assurance and Accreditation:** Standardisation is geared towards the quality and relevance of training in digital skills training programmes offered in higher learning institutions through quality assurance and accreditation. This may involve ensuring that the digital skills curricula taught in the institution match the current market needs, evaluating the digital learning activities from time to time and seeking recognition from the right authorities.

According to the Terminology of European Education and Training Policy, curriculum development is designing, improving, organising and planning educational or training activities¹⁴. Overall, EU policies on digital skills development in higher education seek to equip students with the digital competencies they need to thrive in a rapidly changing digital world, enhance the quality and effectiveness of digital learning experiences, and foster innovation and competitiveness in higher education.

To conclude, digital skills are defined generally for all fields of study and inclusive citizenship in the EU, but there wasn't found any specific document with descriptive and adaptable explications on digital skills for standards professionals within the EU. Outside the EU, for example, there's a document developed by the **Institute for Apprenticeships and Technical Education in the UK "Digital Skills and Characteristics Framework A guide for Trailblazer Groups and Route Panels"**, which defines digital skills for standards professional and provides the description of acquires skills at seven levels (*Digital Skills and Characteristics Framework A Guide for Trailblazer Groups and Route Panels*).

Green Skills. The European Classification of Occupations, Skills and Competences (ESCO) responded to this call to action. ESCO skills and knowledge concepts needed to live in, develop and support a society that reduces human activity's environmental impact (Cedefop, 2012) are now labelled as green. This report provides information concerning the labelling process and guides ESCO implementers in their use of ESCO green concepts.¹⁵

- **Green Skills Index:** The Green Skills Index is a metric used to assess the availability, relevance, and development of skills related to sustainability and environmental stewardship within a given context, such as a country, region, or industry sector.

- **Availability of Green Skills:** This includes educational programs, training courses, and initiatives focused on sustainability, environmental conservation, renewable energy, and other green topics. As the European Skills Agenda states on p. 12, the focus is on "boosting the supply of green skills to meet the demand in various sectors." These are offered by schools, universities, vocational training centers, employers, government agencies, and non-profit organizations.
- **Relevance of Green Skills:** This assesses how well the skills being taught align with the current and future needs of the labor market and society regarding sustainability. As the European Skills Agenda states, the importance of aligning skills with "the needs of the green transition and the evolving labor market" (p. 15). It evaluates whether training programs cover vital topics, address emerging trends and challenges, and meet industry standards and certification requirements.
- **Development of Green Skills:** This pertains to the effectiveness of measures to promote green skills among students, workers, and professionals. As the European Green Deal states, "investing in education and training to equip people with the skills required for the green transition" is essential (p. 20). It includes learning outcomes, acquired skills and expertise, participation rates, and satisfaction levels of green skills training.

These policy documents provide a framework for promoting digital and green skills in higher education and guide EU member states in implementing strategies to address these priorities. Higher education institutions are encouraged to align their curricula, teaching methods, and research activities with the objectives outlined in these policy documents to prepare students for the digital and green economy of the future:

- European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience (2020): This document outlines a plan to improve European skills and employment, emphasizing the digital and green economy. The agenda states there is a need for "re-skilling and up-skilling to support the green and digital transitions"¹⁶ It points out the necessity of education and training to meet the labour market's needs, emphasising digital and green skills in tertiary education.
- European Green Deal: While not explicitly targeting education, the European Green Deal aims to transform the EU's economy to be more environmentally friendly. It recommends promoting green skills and innovation in higher education institutions, integrating sustainable development and environmental issues into academic curricula and research priorities.¹⁷ The deal states, "education and training systems must be fit for the green transition" (p. 15). Within this framework, efforts are made to encourage integrating sustainable development and environmental issues into higher learning institutions' academic curricula and research priorities.

- Digital Skills and Jobs Coalition: This is an action plan of the European Union that calls for the participation of government, business, and educational institutions in promoting the development of e-skills in Europe.

These dimensions can be measured using several quantitative and or qualitative measures that may be used to develop the Green Skills Index¹⁸, such as the number of green occupational classifications, the number of employees trained for sustainable development, the amount of money invested in education and training on sustainability, the demand in green skills according to employers and greening self-reported beliefs and practices among employees. Consequently, the Green Skills Index is an analytical tool that offers an overview of green skills and the opportunities and threats inherent in the given context; it also outlines the prospects for improving green skills and building human capital necessary to address environmental issues.

According to the European Commission's Recommendations and Strategies on Sustainable Development and Environmental Policies, EU Framework Programs for Research and Innovation, European Commission's Communications and Directives on Education and Skills Development, Reports and Publications from the European Parliament, European Council, and European Institute for Gender Equality (EIGE), Documentation from EU-funded projects and initiatives focused on sustainability education and green skills training in higher education, the main aspects of EU policy regarding green skills in higher education are the following:

- Integration of Sustainability into Curricula: EU policies promote the idea of mainstreaming sustainability principles, concepts, and practices in higher education institutions for all fields of study offered in tertiary institutions, covering environmental conservation, climate change, energy, sustainability, and corporate responsibility. They emphasize "mainstreaming sustainability in all curricula and educational programs."
- Promotion of Interdisciplinary Approaches: EU policies support the use of a combination of disciplinary approaches in teaching and learning about sustainability. This includes promoting interdisciplinary cooperation within academic units to deliver interdisciplinary courses, research, and programs encouraging "cross-disciplinary cooperation to tackle complex environmental challenges."
- Experiential Learning and Practical Skills Development: EU policies focus on one key approach that stresses the necessity of teaching and enhancing green skills within students through practical activities. This may involve providing students with internships, field trips, and other forms of experiential learning where the students are able to hone the practical skills required to solve sustainability problems.
- Partnerships with Industry and Stakeholders: EU policies promote cooperation of higher education institutions with industry, government, other non-profit organizations, and other partners in order to

define requirements for new green skills and develop corresponding training¹⁹. This may encompass "partnerships between educational institutions and industry to develop relevant green skills".

- Promoting Lifelong Learning and Continuous Professional Development: EU policies encourage citizens to be lifelong learners and to continue to upgrade their knowledge and skills in sustainable development. This includes providing professional development for professionals to acquire more training occasionally and brush up on their green skills, awareness and readiness in the new context through training programs, short courses, workshops, and seminars.
- Recognition and Certification of Green Skills: EU policies promote effective learning and qualification of green skills in both formal and informal settings. This may include the innovation of qualification frameworks, standards, and certification programs for green careers, as well as the encouragement of the validation of non-formal and experiential learning in volunteering, internships, and community engagement.

Overall, EU policies for higher education introduce green skills as a response to environmental challenges and fostering sustainable development, as well as green skills as preparation for a green work environment and jobs for students. To make higher education institutions attain these goals, it is possible to advance sustainability within teaching, learning, interdisciplinary cooperation, practical training, and involvement of stakeholders.

Summarising, having reviewed the selected policy documents, it was found:

- 1) EU strategy for standardisation does not address certain skills, but it defines that new technology challenges and horizontal considerations like artificial intelligence, data protection and cyber security require new skills in the development of standards (An EU Strategy on Standardisation, 2022). The digital skills are not explicitly defined, although the Digital Competence Framework for citizens describes key elements of digital competences in five areas, identifying 21 competencies across all 5 areas (DigComp 2.2, The Digital Competence Framework for Citizens - Publications Office of the EU, 2022).
- 2) EU policy on standardisation declares the urgency to prepare standardisation specialists to replace the retiring generation of working experts. At the same time, it outlines the need to build important bridges between the research, innovator and standardiser communities (p. 7, (An EU Strategy on Standardisation, 2022)
- 3) EU industrial strategy declares the skills development, both green and digital, to be a strategic investment in the workforce (COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Updating the 2020 New Industrial Strategy: Building a Stronger Single Market for Europe's Recovery COM/2021/350 Final, n.d., p. 20). Gender equality is not mentioned.

- 4) EU Education strategy defines the following fields of study that require standardisation incorporation into curriculum: business, law, engineering.
- 5) EU policies on standardisation focus gender equality in terms of: a recommendation to balance the quantity of men and women in organisations; developing gender responsive standards; eliminating biases; ensuring that both the needs of both women and men are met.
- 6) The green and digital skills are not explicated specifically for standardisation, although the green and digital strategies outline developing necessary skills for green and digital transition.
- 7) The reviewed policy documents do offer specific objectives/provide specific examples on how the desired skills can be promoted through education, but there's no connection to educating standardisation specialists.
- 8) Given the task of standardisation to make the EU a global leader in standards-setting with regard to modern technologies and democratic values.

II. The description of the work done to analyse how gender equality, green and digital skills in regards to standardisation education are defined in the policy documents. The progress on collecting knowledge on standardisation education from leading players in the field, among partners of the Edu4Standards project

To analyse the state of the art of the definition of gender equality, twin digital and green skills related to standardisation in the EU documentation, 24 documents have been analysed. Some of them, devoted to skills, for example, define the skills needed for active citizenship and both green and digital transitions, but these skills are not defined for standardisation education. Moreover, there is no guideline on how to incorporate the development of the given skills into the curriculum of any university course.

The result of it is that the strategies already exist, tools have been developed, but educators struggle to incorporate the streamline issues into their curriculum.

The progress on collecting knowledge on standardisation education from leading players in the field, among partners of the Edu4Standards project. A review of existing teaching methods and best practices in teaching standardisation and identification of gaps in knowledge and teaching methods, including relevant content, which has the potential to be integrated into standardisation education but has not been used for any purposes yet.

Throughout March-September 2024 two surveys were conducted and a chain of interviews was launched to collect data from the leading players in the field. The questionnaires included questions on relevant topics, teaching methods, and content of standardisation education, as well as best practices related to topics, learning environment and teaching methods within different venues of professional engagement: pre-normative standardisation, formal and consortia standards development, policy development and safeguarding of EU core values.

Eleven responses were collected, systematised and questions categorised. Eleven partners participated in the

survey, conducted by the VU Team.

According to the survey results, the lecturers involved in education about standardisation do not always/at all know/understand how the EU-desired values, as well as the Gender Equality and Green Deal Strategy and DigComp can be meaningfully (and to what extent) incorporated in their teaching.

The interviews of the national standard bodies representatives and educators are still being collected by partners of WP 2 and will be analysed as soon as the task is completed by all the participating partners.

48 websites were visited to collect data on gender, green and digital skills incorporated into standardisation curricula worldwide.

The content of 118 standardisation courses of both European and American higher educational institutions was analysed. The data on the courses is aggregated in two XLS tables.

The following conclusions have been made on the standardisation education, including best practices in delivering education.

Stemming from the overview of university courses related to standardisation, it has been concluded that if the discipline is related to sustainability, it is evident that teachers do incorporate green skills into the content. The same situation can be observed within the field of medical studies, genetics, biology and nature sciences. In this case, some ethical considerations are included into the curriculum. Gender equality issues remain unaddressed by the majority of educators.

But the main streamline of the content is that if it goes beyond nature sciences, it does not incorporate developing knowledge on gender equality or digital skills in standardisation education. Thus, the policy documents require academia to tackle main European strategies - transition to green and digital Europe with gender equality in education and research while university teachers struggle to identify the necessary skills and choose/create a working competence model from existing or prospective instruments and tools.

The majority of standardisation courses still do not contain topics to develop green and digital skills, as well as gender equality awareness.

To support the above-mentioned conclusions, the following numerical results on the data analysis have been produced.

Green/sustainability issues	Digital skills	Gender equality	Ethics
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7	2	4	8
48	48	48	48

Table 1. The number of universities incorporating ethics, gender, digital, and green skills into the curriculum (some disciplines overlap, thus the information is provided analysing institutions' approach).

III. A review of existing teaching methods and best practices in teaching standardisation and identification of gaps in knowledge and teaching methods, including relevant content, which has the potential to be integrated into standardisation education. Analysis, systematisation and classification of content obtained as a result of isology investigation (the study of references, standards and standardisation)

To identify the best teaching practices and categorise the teaching methods to intended learning outcomes, two objectives have been defined:

- the survey on best practices has been developed;
- the list of best practises was created based on publications.

As can be seen from the documents created as a result of this task, empirically, the best practices have been defined. A survey among practitioners and lecturers is aimed to enlarge the existing list and to find the best teaching practices that are not included into the list.

The US presents a good example of cooperation between a national standardisation body and universities. Thus, this example was studied to identify best practices in cooperation and teaching standardisation as well as to find if gender equality, and green and digital skills are developed under study programs. While gender equality is not mentioned in the curriculum of the 106 study programs of 41 US universities, some programs include sustainability or ethical aspects. Mostly, these are:

- civil engineering;
- biomedical engineering;
- creative design;
- industrial design;
- medical device design;
- environmental studies;
- business ethics and social responsibility courses;
- risk assessment and management;

- aeronautical disciplines.

It can be concluded, that ethical issues are considered by engineering, business and economics studies, which respond to the Standardisation Strategy and thus, can be used as an example of good practice for the EU higher educational institutions. About EU study courses and standardisation, programs that incorporate standardisation, can be categorised as follows: engineering and technology, business and management studies, supply chain, quality management and standardisation study programs. The skills that are developed by programs are majorly not identified as gender equality awareness or green or digital skills, sometimes the description of a program only mentions hard and soft skills development, according to desk research of 67 EU universities.

The list of the sources has been created, as well as the XLS table on the existing teaching methods used by survey participants.

Final Summary

Although the documents outline policies that comply with the European social model of participation, environmental responsibility, and intelligent development, they do not provide guidelines on how to incorporate gender equality into curriculum of higher educational institutions.

The critical analysis of the gaps revealed in the digital, green skills related to standardisation and the approaches to the gender equality require the development of a new curriculum model. Some techniques employed while designing curricula in green skills for higher learning institutions include curriculum infusion, collaboration and integration, experiential learning, faculty development, infrastructure, industry collaboration and accreditation. Establishing common standardisation education guidelines has not been sufficiently completed, thus implementing green and digital transition is hindered by the lack of standardisation professionals possessing necessary knowledge on the mainstreaming EU policies. Aligning education and training programs with workforce needs, facilitating skills recognition will contribute to the transition to a green and sustainable economy. Incorporation of gender equality content is required by the EU policies, but the content isn't strictly defined for standardisation education while significant achievements have been accomplished by practitioners in terms of creating approach to gender-responsive standards. The digital skills are not specified exactly for standardisation as can be seen in the documents. The green skills policies are general and do not tackle standardisation education exclusively. The range of activities and programs to promote gender equality, green and digital transition is wide, though educational institutions, faculties, and educators have difficulties to define and deliver at least minimum requirements for gender, green, and digital skills.

Overall, there are no specific guidelines on incorporation of gender equality topics into curriculum of standardisation subjects, as well as green and digital skills are required, but not specified for standardisation

education.

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13. Appendix LR-1. Edu4Standards.eu literature review

The literature review conducted by Hugo Alexer Parada Gelvez and Jose M. del Alamo, UPM, <hugalexer.parada@upm.es>, <jm.delalamo@upm.es>

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Table 13-1. Summary of the Current State of Standardisation Education Based on a Systematic Literature Review from WoS

Paper Topic	Teaching Methods	Teaching Content	Intended Learning Outcomes	Challenges	Level of Education	
Education for Engineering Standards, Product Development, and Quality Control (Fernandes and Rocha, 2015)	A case study of an educational activity about standardisation, encompassing around 700 youngsters aged 12 to 17, as part of an in- and out-of-school project.	Formal teaching sessions (groups of 20 students, total duration of 24 hours), hands-on activities, field trips, simulation games, and laboratory activities. Distance learning activities (encompassing two presential sessions) utilizing the Internet to access an LMS (Learning Management System).	Games. Labs: robotics, energies, electronics, prototyping, 3D design software, metrology, mechanics, education on standards and health and safety at work.	To foster understanding of standards, quality control, and their applications in daily life.	Negative perception of industry careers, limited student interest.	Summer School – Out-of-School Program
Syllabuses Crawling and Knowledge Extraction of courses about Global Standardization Education (Nakanishi et al., 2015)	Propose a web crawling technology to collect and analyse the syllabuses of courses published on university websites to understand the standardisation education courses offered by Japanese universities.	N/A	The work focuses on analysing syllabuses to understand the state of the education on global standardisation courses at Japanese universities.	Identify courses related to global standardisation.	Lack of structured access, diverse formats of syllabuses.	N/a
Standardization: A Primer (Krechmer, 2015)	This paper introduces the concept of standardisation through a theoretical lens called isology and discusses the role and significance of standardisation in technology, design, manufacturing, and economic activities. The author aims to address the gap in academic interest and the lack of structured education regarding the importance of standardisation.	Propose lecture-based, discussion of the evolution of standards.	Evolution of standards, role in technology and economy. Material to train teachers and professors: http://www.standardization.de/_sites/_elehre/standardisierung_en.htm	The paper recommends introducing isology into existing courses, especially technical and higher-level courses.	Lack of academic interest, perception as arbitrary.	General

Deliverable D2.2

<p>Integrating Standardization into Engineering Education: The Case of Forerunner Korea (Choi and de Vries, 2013)</p>	<p>This study explores how South Korea integrates standardisation education into university engineering programs through the University Education Promotion on Standardization (UEPS) initiative. It provides an analysis of the development, implementation, and effectiveness of UEPS as a national education which could be used as benchmark to introduce technical standards into science and technology education.</p>	<p>Lectures, company visits, guest speakers.</p>	<p>Encouraging professors to incorporate the textbook "Future Society and Standards", as well as topics on standardisation policies, business models, and ISO standards, into their courses. The teaching plan is based on a proposed common syllabus consisting of four parts: Introduction to standardisation, Standardisation activities, Content standards, and Use of standards.</p>	<p>Equip students with skills for standardisation activities.</p>	<p>Challenges include funding sustainability and limited expertise among faculty, with many professors lacking the necessary expertise to teach standardisation effectively.</p>	<p>Undergraduate, graduate</p>
<p>A World Built on Standards (Bøgh, 2015)</p>	<p>The textbook aims to provide a comprehensive overview of standardisation and its importance across various sectors, serving as an educational resource for higher education students. It highlights the role of standards in business, public bodies, and everyday life, while also emphasizing the critical skills students need to effectively understand and work with standards in their future careers.</p>	<p>To support the teaching of standards and standardisation, the book includes case studies, interactive quizzes (multiple-choice questions), and PowerPoint presentations.</p>	<p>The book introduces students to different types of standards, including measurement, compatibility, and safety standards, as well as the global context. The case studies focus on the interdisciplinary impact of standards in fields such as construction, healthcare, and environmental management, among others.</p>	<p>Understand the role of standards in everyday life.</p>	<p>N/A</p>	<p>The book proposes topics suitable for both undergraduate and graduate levels</p>
<p>Employable Knowledge: Benchmarking Education about Standardization in the UK (Whitney et al., 2014)</p>	<p>This study presents the results of a benchmarking on how standardisation education is integrated into higher and further education in the United Kingdom. It focuses on assessing how standards are taught, the challenges faced by educators, students, and employers, and provides recommendations for improving access to standards in academia.</p>	<p>The book describes various teaching experiences, such as project-based learning (group project or final year project) and industry assignments.</p>	<p>Standards like BS8888, ISO 9001, risk assessment standards.</p>	<p>The research results highlight the belief among both students and academics that learning about standards improves employability by increasing familiarity with technical standards (e.g., in construction and engineering).</p>	<p>Limited access to standards, cost of resources, inadequate search tools, and complex navigation through resources like British Standards Online, lack of awareness among students and academics regarding available resources. Employers noted that most graduates lacked practical knowledge about standards.</p>	<p>Higher education</p>

Deliverable D2.2

<p>Analysis of Education about Standardisation in Universities (Nakanishi and Matsuyuki, 2015)</p>	<p>This paper presents a detailed analysis of education programs on global standardisation in Japanese and Swiss universities, focusing on understanding how these programs are structured, their educational goals, and the variety of content offered to students. It emphasizes the development of educational strategies to equip students with the skills required for global standardisation activities.</p>	<p>N/A</p>	<p>Geneva, Kanazawa IT, and Osaka universities offers plural courses (on global standardisation): Standardisation processes, Technology standardisation, international standardisation, ICT & Standardisation, Global Standardisation, Synthetic imagination on standardisation, negotiation, intellectual property, business management. Programs: designed to offer required knowledge by combining courses, single course offer general concepts on global standardisation</p>	<p>Comprehensive understanding of global standardisation, acquisition of skills on development of standardisation professionals, working as specialists for global standardisation, acquiring insights on global standardisation. Programs allows get various kind of knowledge systematically, single course allows students obtain partial knowledge about global standardisation.</p>	<p>Low awareness of standardisation, limited global access.</p>	<p>Graduate schools (33 courses), Professional graduate schools (7 courses) and undergraduate schools (5 courses)</p>
<p>Interactive Research-Based Instruction Strategies for Standards Education: Project ISTEE (El-Bawab and Effenberger, 2017)</p>	<p>The paper provides an overview of the Project ISTEE, which aims to integrate standards into telecommunication engineering curricula using interactive research-based instruction strategies. The objective is to fill the knowledge gap in standards and standardisation processes within STEM education, focusing specifically on telecommunication engineering.</p>	<p>Workshops simulating real standardisation meetings, interactive lectures.</p>	<p>Topics on: Standardisation in telecommunications, technology life cycle (TLC), and the impact of market and regulatory factors on standards. Case studies include practical examples like the VHS vs. Betamax competition and the rise of DSL technologies, providing students with a historical perspective on how standards affect technology and market outcomes. Course parts: Introduction to Standards and Standardisation: A Telecom Perspective, International, Regional, and National Standards Organizations, Academic and Industrial Standards Development Organizations (SDOs) Organizations, The Standardisation process, Standards in Relation to Technology Life Cycle, Telecom Market Forces, Miscellaneous Topics.</p>	<p>Students are expected to demonstrate skills in negotiation, understanding standardisation protocols, and applying standards in real-world scenarios, enhancing their problem-solving and critical thinking abilities. Understanding of the telecommunication standardisation process and how technical, market, and regulatory elements interact in the development of standards.</p>	<p>The project faces challenges due to its complexity and budget dependency, along with limited engagement from students (37 participants).</p>	<p>Undergraduate (senior), graduate</p>
<p>Implementing Standardization Education at the National Level (de Vries, 2011)</p>	<p>This paper discusses how standardisation education can be systematically implemented at a national level, emphasizing the need for coordinated efforts among industry, government, academia, and standards organizations. The research presents a framework that integrates both bottom-up and top-down approaches to promote a national culture of standardisation.</p>	<p>N/A for teaching methods, however the paper remarks the importance of collaboration across multiple sectors—industry, standardisation bodies, academia, government, and other educational institutions—to successfully implement a national standardisation education strategy. They propose an approach that combines both bottom-up (engaging individual schools, teachers, and students) and top-down (national policy initiatives) strategies.</p>	<p>N/A</p>	<p>N/A</p>	<p>Perception that standardisation is "dull" or overly complex, which deters student interest. This barrier is exacerbated by the reluctance of teachers to introduce new content into already overloaded curricula.</p>	<p>National Level - General</p>

Deliverable D2.2

<p>Experience of Incorporating NIST Standards in a Digital Forensics Curricula (Roy et al., 2019)</p>	<p>This paper presents the development and implementation of a Digital Forensics specialization program at Bowling Green State University (BGSU) that integrates NIST standards into its curriculum.</p>	<p>Lectures-based course, seminars, interdisciplinary projects modular lab exercises, hands-on testing.</p>	<p>NIST standards covering three key topics: Hardware Write Blocker (HWB), Deleted File Recovery (DFR), and Mobile Forensics. Tools to simulate digital forensic investigations (Federated Testing systems, Autopsy/SleuthKit, and Magnet Axiom).</p>	<p>Make students familiar with NIST's Hardware Write Blocker Device (HWB) Specification, improving computer security and digital forensics skills.</p>	<p>High cost of equipment, difficulty in expanding coverage.</p>	<p>Master, Graduate</p>
<p>Lump of Knowledge Based Design of the Global Standardization Education Program for Graduate Students (Hiroshi Nakanishi, 2013)</p>	<p>This paper examines the current state of global standardisation education in Japan and proposes a new interdisciplinary education program for graduate students. It aims to equip students with comprehensive knowledge about global standardisation, focusing on aspects such as intellectual property rights, negotiation, management, and technical standards to address the shortage of human resources in the field.</p>	<p>"Lump of knowledge" approach combines multiple courses to cover multiple topics.</p>	<p>Propose a curriculum made of ten courses designed to provide students with a complete understanding of standardisation, its application, and relevance in various industry: Global business and standardisation, Info-telecommunication and global standardisation, business and global standardisation, intellectual property right and exercise on intellectual property right, knowledge value society, project study on negotiation, Design topics in technology, Exercise on technological innovation, Advanced technological innovation.</p>	<p>Qualifying students with the skills needed to navigate global business strategies involving standardisation.</p>	<p>Lack of recognition among Japanese management regarding the importance of global standards and the necessary communication and negotiation skills to effectively engage in international standardisation, Lack of the human resources for global standardisation activities.</p>	<p>Graduate</p>
<p>Education about Global Standardization in Japan: IEICE Questionnaire Survey (IEICE, 2013)</p>	<p>The report presents the findings from a questionnaire survey conducted to assess the current state of standardisation education in Japanese universities and enterprises.</p>	<p>N/A for teaching. However, to extract information the study uses a survey methodology involving 100 enterprises and 63 universities to gather insights into the current educational practices and expectations regarding standardisation.</p>	<p>Findings from universities show that 82% offer courses in technology management, while 100% provide courses on intellectual property rights (IPR). Additionally, 45% of these universities offer courses specifically focused on global standardisation.</p>	<p>Universities focus on specific technological knowledge.</p>	<p>Fewer universities are offering dedicated courses on global standardisation. Universities believe that knowledge is fundamental for technicians, while firms tend to believe that On-the-Job Training (OJT) is more effective than university education for acquiring specific technical skills.</p>	<p>N/A</p>

Deliverable D2.2

<p>Using Online Learning Modules for AM Standards (Budinoff, 2023)</p>	<p>This study describes the development and implementation of online learning modules designed to enhance students' understanding and application of technical standards in the field of additive manufacturing (AM). The modules aim to fill a gap in engineering education regarding the use of technical standards, especially in emerging technologies like AM, by integrating interactive and diverse teaching approaches within engineering courses.</p>	<p>The modules were designed with a backwards design approach (identify the desired results of the modules, determine acceptable evidence, plan learning activities), using diverse online learning techniques including interactive videos, quizzes, readings, and industry representative interviews.</p>	<p>Modules: Introduction to technical standards, introduction to AM standards, standards for AM process development, and standards for testing and evaluation of AM parts. The content includes specific standards such as: ISO/ASTM52900-21, ISO/ASTM 52910, ISO/ASTM52901-16, ASME Y14.46, ASTM F3049-14, ISO/ASTM52904-19, ASTM F3122-14, ASTM F2971-13,ISO/ASTM52902-19.</p>	<p>Increasing students' confidence in their ability to identify, locate, and apply technical standards within their engineering work. Understand the significance of AM standards in both process development and product evaluation and be able to utilize relevant databases to find and interpret these standards.</p>	<p>Standards often receive only cursory coverage in engineering curriculum.</p>	<p>Undergraduate</p>
<p>The State of the Use of Standards in Engineering and Technology Education (Khan, Karim, McClain, 2013)</p>	<p>This paper presents the results of a faculty survey on the current state of standards education in engineering and technology courses in the United States. The aim is to gauge the status of use of standards in engineering course and identify benchmark practices, and propose recommendations to Standard development organizations, industry and academia to help enhance the use of standards in engineering and technology curricula.</p>	<p>The study recommends the use of case studies, design projects, visits to standardisation organizations for hands-on experience, webinar lectures by industry experts, and workshops for students and faculty.</p>	<p>Ther survey finds the following organizational resources are available for students: ANSI, IEEE, ASTM, ASME, IEEE, ISO, NST standards.</p>	<p>ABET's criteria for engineering and technology education require students to learn and apply standards in their class projects.</p>	<p>Findings: Lack of textbooks that provide the fundamentals and examples of application of technical standards, Cost of access to technical standards documents, Lack of faculty expertise on application of standards, Lack of access to technical standards documents.</p>	<p>Undergraduate, graduate</p>

<p>A Curriculum Innovation Framework to Integrate Manufacturing-related Materials and Quality Control Standards into Different Level Engineering Education (Li, Jin, Zhang, 2018)</p>	<p>This paper presents a curriculum innovation framework developed at Texas A&M University-Kingsville (TAMUK) to integrate manufacturing-related materials and quality control standards into engineering education at different levels (freshman to graduate). The goal is to improve the understanding and application of standards in manufacturing, preparing students for careers in engineering and quality control.</p>	<p>For Teaching: Lectures, webinars and e-conferences, projects. For implementing the curriculum, the project proposes a three-phase implementation plan: 1. Course module creation and testing: Initial testing in selected pilot courses, including UNIV 1102, a freshman success course. 2. Continuous improvement and internal sharing: Improvement of modules for use in TAMUK’s internal curriculum. 3. Sharing results and external collaboration: Dissemination of course materials and results beyond TAMUK. Teaching methods include a mix of lectures, hands-on projects, industrial experience webinars, and e-conferences to provide both theoretical and practical exposure.</p>	<p>Entry Level: Introduces the background and importance of standards, the basics of ASTM and ISO standards, and the use of standards in manufacturing processes. Mid-Level: Provides hands-on experience with the application of standards for material selection and testing, including ISO ICS 83 topics like plastics, rubber, and adhesives. Advanced Level: Focuses on developing new standards if none exist, as well as covering internal and external audit processes under ISO 9001.</p>	<p>Entry level: understand the necessity of standards in materials selection and testing; and gain basic knowledge about various types of materials standards that are appropriate for use in manufacturing. Mid-Level: students should be able to discuss the contents of the 10 sections of ISO ICS 83 family; identify the criteria for selecting a standard; and choose appropriate standards for materials selection, preparation and testing. Advance-Level: students should be able to develop standard procedures if there’s no available standards for a product; identify one ASTM and/or ISO standard test procedure that correlate with the developed procedure; and evaluate the developed standard procedure and give suggestions on manufacturing system design. In general ILOs include the ability for students to understand and apply manufacturing and quality control standards effectively, gain hands-on experience in material selection and testing, and develop new standards if required. Graduates are expected to be capable of evaluating and implementing quality management systems, such as ISO 9000, and lead internal and external audits.</p>	<p>Lack of courses that cover the contents of materials standards knowledge. Low initial students’ awareness. Making the content available both in in-class and online formats to ensure that other institutions can adopt and adapt the course content.</p>	<p>Undergraduate & Graduate</p>
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Deliverable D2.2

<p><i>Integrate Manufacturing related Materials and Quality Control Standards into Master Level Engineering Education (Li, 2020)</i></p>	<p>This paper introduces a curriculum developed at Texas A&M University-Kingsville (TAMUK) for integrating manufacturing-related materials and quality control standards into Master-level engineering education. The main goal is to improve graduate students' practical experience and understanding of key standards used in manufacturing, with an emphasis on preparing them for roles in quality control and process management.</p>	<p>The approach to teaching involves a three-phase implementation: Module Development and Course Integration: Modifying existing courses and developing a new one. Course Pilot and Continuous Improvement: Testing the modules with student feedback to improve content. Certification and Scalability: Creation of a graduate-level certificate program to encourage participation. The teaching methods used include a combination of lectures, hands-on projects, individual and team-based assignments, and case studies to provide practical insights into standardisation.</p>	<p>The curriculum features three main courses: IEEN 5333-Six Sigma and ISO Standards: Covers the techniques and processes involved in internal and external audits based on ISO standards. IEEN 5332-Manufacturing Systems Design: Focuses on the development of standards for manufacturing processes, including hands-on projects where students develop and evaluate standards for materials selection and testing. IEEN 5303-Standards of Product Design and Manufacturing: Provides a comprehensive overview of standards related to product design and manufacturing, covering materials, processes, and quality control.</p>	<p>EEN 5333-Six Sigma and ISO Standards: students are expected to be able to understand and discuss the aims of the audits, including how to verify a system is working as it is supposed to, how to find out where it can improve, and how to correct or prevent problems identified; lead or participate in a team to prepare for the internal and external audits; identify the opportunities and strategies of continuous improvement. IEEN 5332-Manufacturing Systems Design: students are expected to be able to develop standard procedures if there is no available standards for a product; identify one ASTM and/or ISO standard test procedure that correlate with the developed procedure; and evaluate the developed standard procedure and give suggestions on manufacturing system design. IEEN 5303-Standards of Product Design and Manufacturing: students are expected to be able to apply the materials standards for metal, ceramic, polymer and composite, select and/or develop standards for a product, and develop solutions of standards for modern production.</p>	<p>Initial low awareness of standards: fewer than 25% of students had ever heard about relevant standards before taking these courses. The survey also revealed differences in student outcomes between online courses and in-class sessions, with better results for in-person classes due to opportunities for team projects and interactive learning experiences.</p>	<p>Master</p>
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<p>Integrating Technical Standards into ET Curricula to Meet ABET Standards and Industry Needs (McPherson, 2019)</p>	<p>This paper discusses the integration of technical standards into the Mechanical Engineering Technology (MET) curriculum at Purdue University and provides strategies for incorporating these standards into more courses within the MET curriculum. The aim is to meet ABET accreditation requirements and ensure that students are familiar with the use and application of standards before entering the workforce, thereby aligning educational outcomes with industry needs.</p>	<p>Scaffolded learning, practical design projects (hands-on projects), miniature case studies.</p>	<p>IEEE, ASME Y14.5, ISO9001 standards.</p>	<p>The ability of students to locate, navigate, interpret, and apply technical standards in the context of engineering projects, specifically for design and manufacturing, is essential. Students must also understand quality control systems such as ISO 9001 and TS 16949.</p>	<p>Limited faculty familiarity. Students lack awareness and experience with standards before taking the course. There is a lack of involvement from industry and academia to promote standards education. Faculty do not have access to a sufficient number of examples on how to apply standards in the industry.</p>	<p>Undergraduate</p>
<p>Standardization and the European Standards Organisations (Orviska, Nemeč, 2013)</p>	<p>The paper provides an in-depth analysis of the role, functions, impact, and evolution of European Standards Organisations (ESOs) in the context of EU integration and regulatory governance. The authors examine the contributions of these organizations in promoting the single market, as well as the interplay between standardisation and political integration in the EU.</p>	<p>N/A</p>	<p>N/A.</p>	<p>N/A</p>	<p>N/A</p>	<p>N/A</p>
<p>Educating Students About Standardisation to Universal Design Relating (Darzentas, 2016)</p>	<p>This paper explores the lack of standardisation education in design disciplines, specifically focusing on how it could benefit students of Universal Design. It examines the barriers that prevent the integration of standardisation in design education and provides examples of successful teaching approaches that incorporate standards in the Design for All context.</p>	<p>The approach included the use of simple quizzes, project work, and defence of best practice cases brought by students.</p>	<p>standards relevant to Universal Design and accessibility, ISO 71, CEN Guide 6.</p>	<p>Students are expected to gain an understanding of the importance of accessibility standards in design and develop an appreciation of the role of standardisation in promoting innovation and inclusivity.</p>	<p>Many standards are not freely available and are written in complex language, making them difficult for design students to understand and apply. There is also a general reluctance among design students and professionals to engage with standards, as they are often perceived as prescriptive, constraining, and stifling to creativity.</p>	<p>Undergraduate</p>

14. Appendix TM-1. An inventory of materials on education about standardisation.

14.1. Existing materials and resources for education on standards, as Compiled by Rudi Bekkers and Paul Wiegmann, TU/e

Handbooks

Hesser, Wilfried & Alex Inklaar (Ed.) (1997) An Introduction to Standards and Standardization. DIN Normungskunde Band 36, Beuth Verlag, Berlin / Vienna / Zurich, 328 pp.

Hesser, Wilfried (ed.) (2010). Standardisation in Companies and Markets. Helmut Schmidt University Hamburg. 1114 pp. ISBN 978-3-940385-97-0

Abdelkafi, N., Bekkers, R. N. A., Bolla, R., Rodriguez-Ascaso, A. & Wetterwald, M. (2021). Understanding ICT Standardization: Principles and Practice (2nd edition). Sofia Antipolis, France: ETSI. 280 p. ISBN: 979-10-92620-50-1. Open Access publication. [URL](#).

ETSI: Handbook A Guide To Writing World Class Standards, [URL](#)

ISO: Handbook: Guidance for writing standards taking into account micro, small and medium-sized enterprises' needs, [URL](#)

R. Hawkins (ed.) (2017). Handbook of Standards and Innovation. Edward Elgar Publishing. DOI: 10.4337/9781783470082. [URL](#)

Serious games

Danish Standards / DIROS. New Games for Education on Standardization (available via license) [URL](#)

DKE Standardisation Quest (escape-room roleplay) [URL](#)

DKE 'Standard in a Day' Bootcamp

DIN (new game developed in 2023, more information will follow)

IEEE: Game "Mars Space Colony: A Game of Standardization". (available via license) [URL](#)

AFNOR, Serious Game Le Défi d'Emma, [URL](#)

UNE (Spanish Association for Standardization), escape room game [URL](#)

ISO Setting standards, a Delft University of Technology and United Knowledge simulation exercise on strategy and cooperation in standardization [URL](#)

Other (online) teaching materials¹³

EEE STANDARDS UNIVERSITY: Online Tutorials, Webinars, serious games, videos, e-magazine, MOOCs, etc. [URL](#)

¹³ The provided list has benefited from the work of Amelie Leipprand of DIN, who put together many materials at <https://din.one/display/DMN/International> (accessible by registration)

DIN: Series of sheets (German and English) and audiovisual material (German) by DIN Young Professionals / DIN Folien, (accessible after registration). [URL](#)

DIN: Podcast series, 12 episodes: Human Beings Are Not Ants [URL](#)

BSI: Podcast „The Standards Show“ ([URL](#)); Free online course The power of standards ([URL](#))

DS: Handbook A world built on standards. [URL](#); Free online course “Standards, the EU Machinery Directive and CE marking” [URL](#)

NSAI (National Standards Authority of Ireland): training modules and videos, [URL](#)

ISO, SNV und University of Genf, teaching materials, [URL](#), WSC Academic Day, [URL](#), Video [URL](#)

DKE: Next Generation DKE, a dedicated initiative with the aim of strengthening the influence of young people at DKE. [URL](#)

SNV: Series of 12 stories: Standards in training and education. [URL](#)

Tom Scott (YouTuber). Making an international standard cup of tea (has 2.3M views). [URL](#)

IEC, various materials (Basecamp). [URL](#)

EOUS Standards Academy (by StandICT.eu 2026), offers a range of materials originating from IEC, DIN, OpenForum Europe, ETSI, and Centre for International Governance Innovation (CIGI) [URL](#)

Other relevant materials:

Young professionals in standardization: CEN and CENELEC are launching a campaign, <https://www.cencenelec.eu/news-and-events/news/2022/brief-news/2022-03-17-young-professionals-in-standardization/>

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Folke Hermansson Snickars (s.a.). Learning about standardisation as an adult. [URL: https://www.researchgate.net/profile/Folke-Hermansson-Snickars/publication/236620262_Learning_about_standardisation_as_an_adult/links/00b4951866c7e2172f000000/Learning-about-standardisation-as-an-adult.pdf](https://www.researchgate.net/profile/Folke-Hermansson-Snickars/publication/236620262_Learning_about_standardisation_as_an_adult/links/00b4951866c7e2172f000000/Learning-about-standardisation-as-an-adult.pdf)

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14.2. Compilation of materials by Stephanie Bijlmakers, Irene Kamara, Panos Delimatsis TiU

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