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SELFIEforTEACHERS: Validation of a Tool Supporting Teachers' Self-Reflection on Their Digital Competence

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ABSTRACT

Supporting teachers to build their digital competence remains key to educational systems for responding to the continuous implications that new technologies entail. SELFIEforTEACHERS was designed to support teachers across Europe in reflecting on and improving their digital competence. Grounded in the DigCompEdu conceptual framework, the tool supports a guided and structured self-reflection process to scaffold and promote teachers' agency and self-directed professional learning. This study assesses the validity, reliability, and participants' perceived relevance of SELFIEforTEACHERS, using a mixed-methods approach with 3218 teachers in four European countries. Psychometric analysis confirmed the tool's validity and reliability, while qualitative data revealed that teachers found it highly relevant for identifying strengths, weaknesses, and areas for improvement. Overall, SELFIEforTEACHERS provides a tool for fostering evidence-based improvement of teachers' digital competence and enhancing their capacity to integrate digital technologies meaningfully in education.

1 | Introduction

Teachers play a key role in the digital transformation of education. In the European Digital Education Action Plan (DEAP 2021–2027) teachers' digital competence is considered essential for all teachers and trainers and should be embedded in all areas of teacher professional development, including initial teacher education (European Commission 2020b). During the COVID-19 pandemic, many schools were forced to switch to online and remote teaching (OECD 2021). Moreover, in the rapidly changing technological world, teaching professionals need even more complex competences to respond to teaching and learning demands. Teachers are faced with the fact that digital technologies, current and emerging ones, such as generative artificial intelligence (AI), are entering their professional and personal lives, providing opportunities but also challenges (Lucas et al. 2024; OECD 2025). At the same time, teachers are called to support their students who bring with them skills or a lack of skills in dealing with the implications of an increasingly digitalised world (Ng et al. 2023; OECD 2024).

Education systems continue seeking meaningful and impactful professional development programmes to support teachers develop their digital competence. To respond to the need to support teachers' professional learning and development of their digital competence, the European Commission designed and developed SELFIEforTEACHERS, under Strategic Priority 1 'Fostering the development of a high performing digital education ecosystem' Action 5 of the DEAP 2021–2027 (European Commission 2020b). At the time, there were a few tools aiming to support teachers' digital competence, as for example the To Know Me tool, the MENTEP TET-SAT and the DigCompEdu CheckIn tool. The new SELFIEforTEACHERS tool aimed to provide a scientific-based self-reflection tool to support teacher-specific digital competence, following a rigorous research and validation methodology and be available to teachers for free. As of today, some

of the above-mentioned tools are being updated while other relevant tools are evolving (e.g., Pix for teachers).

The use of self-reflection as a learning process was chosen to encourage teachers to actively engage in their professional development, identifying their training needs and (co)designing their learning paths in a context of autonomous lifelong learning (European Commission 2007). Following this, a study was conducted to test the reliability and validity of the new SELFIEforTEACHERS tool and investigate its relevance to teachers' professional development of their digital competence in the quite heterogeneous European teacher education landscape. The tool is available online with open access to teachers, teacher trainers, and other education professionals who are interested in building their digital competence.

In this paper we present the study conducted in four countries—Estonia, Italy, Lithuania and Portugal—and its findings. We discuss cross-cutting results from all countries as one group and country-specific results if outstanding and diverging from the main trends. The paper aims to provide evidence of the validity and reliability of SELFIEforTEACHERS to be used as a tool to support teachers' self-reflection on their digital competence proficiency. Thus, it aims to contribute to research related to teachers' professional learning and development of their digital competence with the following research questions:

- RQ1: Is SELFIEforTEACHERS a valid and reliable tool for supporting teachers to reflect on their digital competence?
- RQ2: How relevant do teachers perceive SELFIEforTEACHERS for their digital competence development?

2 | Theoretical Background

2.1 | Educators' Digital Competence and DigCompEdu

Educators' development of their digital competence is important for supporting their professional practice, enhancing their students' learning outcomes, and facilitating their (students') digital competence. The term 'educator' is used to cover a broader perspective, including educators from all learning sectors (e.g., early childhood professionals, school education teachers, vocational education providers, lifelong learning providers, trainers, university teachers). When referring specifically to school education teachers (primary and secondary) the term 'teacher' is used. Over the years, several frameworks have been developed to address educator-specific digital competence and support educators to build their digital skills, such as the 'Technology, Pedagogy, and Content Knowledge' (TPACK) framework (Mishra and Koehler 2006), the European Framework for the Digital Competence of Educators (DigCompEdu) (Redecker 2017), the Spanish Government 'Common Digital Competence Framework for Teachers' (INTEF 2017, 2022), the Norwegian 'Professional Digital Competence Framework for Teacher' (Kelentrić et al. 2017), the International Society for Technology in Education (ISTE) standards for educators (ISTE 2008, 2017, 2024) and the UNESCO ICT Competency Framework for Teachers (ICT CFT) (UNESCO 2018), while recent ones focus specifically on Artificial Intelligence (AI) such as the 'AI competency framework for teachers' (UNESCO 2024).

DigCompEdu is a widely accepted framework, with 25,357 downloads (JRC 2024) and 1713 matched references in 806 policy documents from 107 different sources and 37 countries (Overton 2024). The framework describes educator-specific digital competence in a six-level proficiency progression model. It is structured around 22 key digital competences, under six different areas: (1) professional engagement, (2) digital resources, (3) teaching and learning, (4) assessment, (5) empowering learners, and (6) facilitating learners' digital competence. The six proficiency levels are aligned with Bloom's taxonomy and the Common European Framework of Reference for Languages, ranging from A1 to C2. Proficiency levels are accompanied by role descriptors. A Newcomer corresponds to A1 basic level and a Pioneer corresponds to C2 advanced level (Redecker 2017).

Over the past years, the use of the DigCompEdu framework includes, among others, its adoption or adaptation to support national strategies (Laanpere et al. 2022; Carvalhais and Azevedo 2024) or professional development programmes and training material (Lucas, Dorotea, et al. 2021; Johnson et al. 2024), and providing the theoretical background for research projects on educators' digital competence (Ghomi and Redecker 2019; Horváth et al. 2024; Lucas, Bem-Haja, et al. 2021; Rubio-Gragera et al. 2023) or the development and validation of a self-assessment tool for various educational sectors (Cattaneo et al. 2022; Economou 2023b, Kontovourki et al. 2024; dos Inamorato Santos et al. 2023).

2.2 | Professional Learning and Self-Reflection

Teachers' continuous professional development is essential to provide them with the necessary competence to address the new demands of a heavily digitalised society and complex learning settings. *Professional learning* emphasises teachers' active role and own agency as reflective professionals (Boeskens et al. 2020), while supporting teachers' self-initiated learning practices to stimulate their engagement in continuous professional learning (Minea-Pic 2020).

Self-reflection is an essential part of the teaching profession supporting the professional learning process (Economou et al. 2024). In a conceptual analysis of major definitions of reflection, Nguyen et al. (2014) identified as a first and foremost common element to all of the reviewed definitions the thinking process, while the following core components were yielded as necessary to allow a thinking process to become reflective: (i) thoughts and actions; (ii) attentive, critical, exploratory and iterative processes; (iii) the underlying conceptual frame; (iv) the view on change; and (v) the self. They coined the following as a definition of reflection: 'Reflection is the process of engaging the self in attentive, critical, exploratory and iterative interactions

with one's thoughts and actions, and their underlying conceptual frame, with a view to changing them and with a view on the change itself' (Nguyen et al. 2014, 1182).

Focussing explicitly on the 'self', a self-reflection involves looking inward at one's own thoughts, competence and actions, while reflection can be a broader term for processing information or experiences. Self-reflection as a personal process can deepen one's understanding of self and trigger self-assessing capacity to improve (Desjarlais and Smith 2011). Through the self-reflection process, 'teachers are encouraged to actively engage and assume a central role in their professional learning, by capturing their current digital competence through guiding self-reflection items' (Economou 2023b, 5–6). Critical self-reflection can lead to engaging in strategies for continuing personal, professional, and career development, such as setting goals (Cheng et al. 2015). By engaging in a self-reflection process, teachers can identify strengths and gaps based on which they can design their own professional learning paths to further develop their digital competence.

Self-reflection is closely connected with self-assessment; however, there is a distinction between the two. Desjarlais and Smith (2011) performed a comparative analysis of reflection and self-assessment in which they argue that reflection and self-assessment are both meaningful processes that can lead to learning from experience, yet they have different purposes and goals. They acknowledge that there can still be confusion regarding the distinctions between these two concepts in terms of their purposes and outcomes; however, an important difference is that in the process of studying one's own performance in order to improve it, self-assessment incorporates defined performance criteria before the action in question begins and which are recorded during the process with the use of an instrument. By discussing the link between self-assessment and reflection, Harvey-Lloyd (2013) proposes a self-assessment tool to facilitate reflection among practice educators, acknowledging that reflective practice is an integral part of professional development. Leise (2010) indicates that self-assessment can make a difference in future performance when the performers apply a critical reflection process to enable them to expand the insights gained from the assessment. Furthermore, assessment results can be used as a trigger for reflection and planning of future learning (Harvey-Lloyd 2013). Hence, learning and development can benefit when incorporating assessment and reflection processes in a spiral process during the learning cycle. SELFIEforTEACHERS embeds self-assessment in the self-reflection process through a three-stage teacher involvement: 'teachers reflecting on their professional practice and self-assessing their digital competence guided by the tool items; reflecting on their results and the tool feedback to plan their professional learning paths; and reflecting on the whole process and their progress' (Economou 2023a, 1244).

The engagement of learners in an assessment process requires that 'their subjective perspectives be taken into account as well as their ways of handling discipline knowledge and skills' (Leise 2010, 66). Self-assessment and self-reflection indicate the self-perceptions of one's understanding of self, and often the challenge is how to develop the necessary skills in order to reflect in a meaningful way. Moreover, there are many hindrances in the effective implementation of reflective practice, such as lack of motivation, difficulty in doing effectively, cultural and personal hindrances, and bland mechanical thinking (Finlay 2008). Mann (2016) argues that reflective practice demonstrates many benefits, such as being integral to self-assessment, enhancing diagnostic accuracy, facilitating acceptance of feedback, and supporting professional development. However, the challenge remains how to effectively scaffold the development of critical reflection skills and support constructive feedback to foster growth.

2.3 | SELFIEforTEACHERS Design and Development

SELFIEforTEACHERS builds on self-reflection as a process to support teachers develop their digital competence by identifying their current strengths and weaknesses and encouraging them to design their professional learning paths.

Previous efforts aiming to provide teachers with a tool to self-assess their digital competence include, for instance the 'To Know Me platform' (https://2gno.me) based on the ISTE Standards for Educators, the 'MENTEP TET-SAT' tool as part of a policy experimentation project (European Schoolnet 2018) based on the European Framework for the digital competence for Citizens, or the 'CheckIn' tool developed in 2018 (Ghomi and Redecker 2019)—a beta version of a self-assessment tool based on DigCompEdu. SELFIEforTEACHERS builds on and advances these tools, enriching its content and capturing current pedagogical and technological trends. These are incorporated into the tool self-reflection items to ensure an up-to-date tool. Examples include an emphasis on learner-centred pedagogies (e.g., problem solving and active learner roles in designing or co-creating their learning) or the integration of emerging technologies (e.g., robotics, virtual reality and artificial intelligence).

SELFIEforTEACHERS uses the DigCompEdu conceptual framework as a grounding reference for teachers to gain an understanding of what educator-specific competence entails and to self-assess their current situation. As DigCompEdu was published in 2017 and SELFIEforTEACHERS was developed later in 2020 during the Covid-19 pandemic, several new pedagogical and technological trends emerged. These included competences related to online learning environments, data management, computational thinking, blended learning, well-being, emerging technologies, artificial intelligence, and ethical considerations. The DigCompEdu framework's 22 key competences were analysed in their key elements within the emerging context and in relation to schoolteachers, leading to the development of 32 items to guide teachers' self-reflection. The tool content was reviewed and revised by a team of four experts. The pilot version of the tool used for the study to investigate its validity and reliability was an improved iteration of the initial version, refined through a validation workshop, two rounds of expert and stakeholder consultation, and a pre-pilot study (Economou 2023b). Hence, SELFIEforTEACHERS comprises 32 self-reflection items corresponding to the DigCompEdu framework's 22 key competences under the six DigCompEdu areas (Figure 1).

Area 1 – Professional engagement 1.1 Organisational communication 1.2 Online learning environments 1.3 Professional collaboration 1.4 Digital technologies and school level infrastructure 1.5 Reflective practice 1.6 Digital life 1.7 Professional learning (through digital technologies) 1.8 Professional learning (about digital technologies) 1.9 Computational thinking	**Area 2 – Digital resources** 2.1 Searching and selecting 2.2 Creating 2.3 Modifying 2.4 Managing and protecting 2.5 Sharing	**Area 3 – Teaching and learning** 3.1 Teaching 3.2 Guidance 3.3 Collaborative learning 3.4 Self-regulated learning 3.5 Emerging technologies
Area 4 – Assessment 4.1 Assessment strategies 4.2 Analysing evidence 4.3 Feedback and planning	**Area 5 – Empowering learners** 5.1 Accessibility and inclusion 5.2 Differentiation and personalisation 5.3 Actively engaging learners 5.4 Blended learning	**Area 6 – Facilitating learners' digital competence** 6.1 Information and data literacy 6.2 Communication and collaboration 6.3 Content creation 6.4 Safety and wellbeing 6.5 Responsible use 6.6 Problem solving

FIGURE 1 | The six areas and self-reflection components of the SELFIEforTEACHERS tool.

FIGURE 2 | SELFIEforTEACHERS structure of items—an example (*Source:* Economou 2023c, 14).

Each item provides an introductory statement describing what the corresponding competence is and six statements aligned with the DigCompEdu progression model, from which teachers can choose the one that best captures their competence level. The statements use action verbs related to the proficiency level (e.g., I am aware, I have tried, I use, I analyse, I design, I initiate) and provide indicative examples relevant to teachers' practice. The tool allocates one to six points for each response—with 1 being the lowest response option and 6 being the highest—resulting in a maximum total score of 192 points across all 32 items. Figure 2 below presents an example of a self-reflection item with its main elements and structure.

After the self-reflection completion, the tool generates a personal report for each teacher with results and feedback with suggestions on how to level up in each key competence, while the tool aggregated anonymised data can be used to identify gaps and strengths of a whole group of teachers. Users can monitor their self-reflections and their progress through the user dashboard and obtain a digital badge for their participation.

SELFIEforTEACHERS envisioned a new tool to support teachers' digital competence by providing a teacher-specific, scientific and validated, up-to-date tool. It:

i. Uses a professional learning approach aligned with new pedagogies and suggesting a learning process where self-reflection and self-assessment are combined to support teachers' understanding of their digital competence proficiency level and to foster their agency to develop further. It does so by providing guided self-reflection, quantitative and qualitative feedback of the self-assessment outcomes and suggestions for next steps on how to level up.

ii. Used DigCompEdu, a widely accepted theoretical framework that addresses specifically pedagogical digital competence as its grounding base. The framework was adapted for schoolteachers, providing relevant context and examples related to their practice, supporting a realistic evaluation of teachers' digital competence.

iii. Went through several phases of development starting with a literature review on related areas such as teachers' digital competence, self-reflection and self-assessment, teachers' professional development, adult learning, software design and development. A first prototype was developed followed by iterative consultations with digital education stakeholders and experts (including practitioners, trainers, researchers, and policy makers). Finally, a pre-pilot and a pilot implementation were performed using

advanced validation methodologies to test its validity and reliability before the tool was released. Moreover, various SELFIEforTEACHERS use cases have been investigated to identify enablers and hindrances of its use to support further development of the SELFIEforTEACHERS tool and learning process.

iv. Is available online with open free access to educators, under the infrastructure and procedures in relation to data privacy and security of a large public organisation.

v. Is under a Creative Commons licence, allowing its adoption, adaptation or starting point for new tools, according to specific needs.

3 | Materials and Methods

To validate the SELFIEforTEACHERS tool, we used a mixed-methods approach, combining both quantitative and qualitative research techniques. The quantitative component included psychometrics analysis of the self-reflection responses to assess the tool reliability and validity (RQ1) as well as statistical analysis of the questionnaire responses in relation to teachers' perceptions about the tool (RQ2), while the qualitative component included focus group discussions to gain deeper insights into teachers' experiences and perceptions about the tool and its relevance for their digital competence development (RQ2) as well as to support a better understanding of the quantitative results (RQ1). This triangulation of data sources ensured a comprehensive evaluation that captured both measurable results and nuanced reflections.

The study was conducted in four countries– Estonia, Italy, Lithuania, and Portugal– in April 2021, allowing for cross-cultural validation and wider applicability. By integrating these methods across multiple contexts, the study aimed to confirm the robustness and generalisability of the tool. Mixed methods research, as described by Creswell and Plano Clark (2018), strengthens validation by combining numerical data with rich, contextual insights, making it particularly effective for complex social science research.

3.1 | Data Collection

The instrument used for data collection was purposefully divided into three parts.

The first (and core) part consisted of the self-reflection component, which included the pilot version of SELFIEforTEACHERS with 32 self-reflection items. Participants were asked to rate their competence on a progressive scale by choosing in each item one of the six provided response options. Each item could receive a score ranging from one to six points, with a total score for all 32 items ranging from 32 to 192 points.

The second part of the instrument collected demographic data from the participants through 21 items. These items collected background information including gender, country, school, teaching level, and subject area. In addition, this part explored participants' teaching experience, confidence in using digital tools, and the facilities and support available in their schools.

The third part focused on gathering feedback about SELFIEforTEACHERS. It included questions to collect different aspects of participants' experiences and perceptions about the tool and its relevance to their digital competence development (RQ2). This section also provided an opportunity for participants to share additional insights through an open-ended question. The responses to this qualitative question were analysed to gain a deeper understanding of users' perspectives and to complement the quantitative findings.

The SELFIEforTEACHERS tool was hosted on the platform developed by the Joint Research Centre (JRC) and each part of the tool was translated and adapted into Estonian, Italian, Lithuanian and Portuguese. The translation and adaptation process was led by the countries' national coordinators, who were experts in the field of education and digital technologies, and included the following steps: (i) reviewing the tool content in English and identifying key terminology used in the tool in relation to the country context; (ii) linguistic translation of the tool content and user interface; (iii) adapting and validating the translation to the country context; (iv) involving educators (two to five) in each country to review the translated tool; and (v) checking randomly selected translated content with reverse translation (at least one item per tool area).

To gather further data on teachers' perceptions of their self-reflection, eight semi-structured focus group discussions were conducted (one for each educational level—primary and secondary—in each country). The focus groups were conducted in the participants' native language, had an average of nine participants per group, and lasted an average of 80 min. All the focus groups were video and audio recorded.

Following the semi-structured focus group methodology, a set of thematic areas for discussion with triggering questions were developed to be introduced beforehand rather than specific pre-defined questions. The main thematic areas for the semi-structured focus group discussions were: (i) motivation and relevance: motivation to go through the self-reflection, incentives that could increase this motivation, relevance of self-reflection for Continuous Professional Development (CPD), uses of the self-reflection results/report, follow-up activities after self-reflection, usefulness of group self-reflection; (ii) tool content: clarity and meaningfulness/usefulness of items, help texts, progression scale, feedback report; and (iii) user experience of the tool platform: value (how useful it is), usability (how easy it is to use), adoptability (how easy it is to learn/get started), desirability (how engaging it is).

The research team used the Nominal Group Technique (NGT) to conduct the focus groups. The NGT is a structured brainstorming/engagement method that has been used for problem solving and planning educational programs (O'Neil et al. 1980), evaluating study programs (Varga-Atkins et al. 2017), and validating conceptual models and research instruments (Hedayati and Laanpere 2017). The NGT process typically involves four phases: (i) divergent thinking phase: silent (written) idea generation by participants without interaction or discussion; (ii) deliberation phase: moderated discussion to elicit input from all participants and to elaborate the submitted ideas; (iii) convergent thinking phase: moderated discussion to group and merge the similar ideas; and (iv) priority-setting phase: voting and ranking the merged ideas.

TABLE 1 | Distribution of respondents by country, gender, ISCED level and teaching experience.

Country	Estonia	Italy	Lithuania	Portugal	Total
Gender					
Female	401 (90%)	548 (82%)	762 (87%)	838 (68%)	2549 (80%)
Male	39 (9%)	105 (16%)	100 (11%)	362 (30%)	606 (18%)
Unspecified[a]	7 (1%)	11 (2%)	21 (2%)	24 (2%)	63 (2%)
ISCED levels[b]					
ISCED1	196 (44%)	275 (41%)	228 (26%)	396 (32%)	1095 (34%)
ISCED2	168 (38%)	163 (25%)	466 (53%)	480 (39%)	1277 (40%)
ISCED3	71 (16%)	204 (31%)	114 (13%)	291 (24%)	680 (21%)
n/a	12 (2%)	21 (3%)	75 (8%)	57 (5%)	165 (5%)
Experience					
1–5 years	107 (24%)	155 (23%)	85 (10%)	43 (3%)	390 (12%)
6–15 years	79 (18%)	183 (27%)	113 (13%)	185 (15%)	560 (17%)
16–25 years	100 (22%)	177 (27%)	240 (27%)	623 (51%)	1140 (35%)
26–35 years	99 (22%)	114 (17%)	311 (35%)	268 (22%)	792 (25%)
> 36 years	51 (11%)	24 (4%)	113 (13%)	93 (8%)	281 (9%)
Prefer not to say	11 (3%)	11 (2%)	21 (2%)	12 (1%)	55 (2%)

[a]Other/Prefer not to say/Missing.
[b]ISCED 1: Primary education. ISCED 2: Lower secondary education. ISCED 3: Upper secondary education.

Combining divergent and convergent thinking allowed every participant to express their thoughts using their own authentic vocabulary, while eventually converging the shared ideas in a common format.

3.2 | Sampling

Four EU Member States—Estonia, Italy, Lithuania and Portugal—were purposefully selected for the study needs, considering geographic location (Italy in Southern Europe, Portugal in Southwest Europe, Lithuania in Central-north Europe and Estonia in Northern Europe), the Digital Economy and Society Index (DESI) profile (Estonia 7th and Lithuania 14th both above EU average and Portugal 19th and Italy 25th below EU average according to DESI 2020 index on Connectivity, Human capital, Use of internet services, Integration of digital technology, and Digital public services) (European Commission 2020a) and the educational system (Italy and Portugal are more centralised systems and Lithuania and Estonia more decentralised), in order to maximise diversity and plurality within the provided timeframe and resources. Within each country a clustered (school-based) sampling approach was followed, with 6–8 primary and 6–8 secondary schools for each country, stratified by school size, and geographical region. All teachers from these schools were invited to participate in the study.

3.3 | Participants

A total of 3218 teachers comprised the study sample. The sample size—both in the whole group and in each country—ensures representativeness with a low degree of statistical error. The sample sociodemographic characteristics and International Standard Classification of Education (ISCED) levels can be found in Table 1.

In terms of gender, the majority of participants are female, accounting up to 80% of the total sample. This disparity is particularly marked in Estonia, where 90% of the participants are women, followed by Lithuania (87%) and Italy (82%). Portugal shows a slightly more balanced distribution, although still with a clear majority of women (68%). The situation aligns with the teachers' gender distribution in Europe where teachers are predominantly women, with 85.5% of primary and 64.7% of secondary school teachers being women (European Commission 2019a). In the case of Estonia, only 17% of school-teachers (ISCED 1–3) are men, being lower than the EU average (European Commission 2019b).

In terms of ISCED levels, the distribution shows a greater concentration at ISCED2 (40% of the total), followed by ISCED1 (34%) and ISCED3 (21%). However, there are important differences between countries: in Lithuania, more than half of the participants (53%) work at ISCED2 level, while in Estonia and Italy, ISCED1 is more prevalent (44% and 41% respectively).

In terms of work experience, the data show that the majority of participants have considerable experience, with 35% having worked between 16 and 25 years and 25% between 26 and 35 years. Only 12% of the participants have limited experience (1–5 years). Portugal stands out for its high number of professionals with 16–25 years of experience (51%), while Lithuania

has the highest proportion of professionals with 26–35 years of experience (35%).

Of the 3218 teachers who completed the self-reflection, 71 volunteered to take part in the focus groups. 22 teachers were from Lithuania and 13 from Portugal. Estonia and Italy participated with 18 teachers each. In total, there were 35 teachers from primary school and 36 from secondary schools[1] who were evenly distributed across educational levels.

3.4 | Procedure

Data was collected from Estonian, Italian, Lithuanian, and Portuguese teachers in April 2021. The study followed a structured procedure that began with working with the Education Authorities in each country to identify a diverse range of candidate schools, varying in location, size, and educational level, to ensure an appropriate and adequately sized participant population. Within each selected school, participating teachers could start their self-reflection and revisit it several times within the provided period before finishing and submitting it.

To recruit primary and secondary teachers for the qualitative focus groups, an invitation link was posted on the SELFIEforTEACHERS platform, allowing interested teachers to volunteer directly. Prior to the interview, teachers were asked to review the content of the SELFIEforTEACHERS tool, to recall the main challenges and strengths of their experience during the self-reflection process. The core of the discussion took place in Mural (https://www.mural.co), using the Nominal Group Technique.

3.5 | Data Analysis

3.5.1 | The Quantitative Data

The quantitative data were cleaned, producing the data set for analysis with 3218 responses by teachers who had completed both self-reflection and feedback parts in the instrument.

To define the construct or constructs that are measured by the SELFIEforTEACHERS instrument, we interpreted digital competence as a single construct (a latent trait of an individual teacher) that is measured by the 32 items of the SELFIEforTEACHERS instrument (DeVellis 2016). This digital competence construct has proposedly six dimensions defined by application domains in the DigCompEdu model (Professional engagement, Digital resources, Teaching and learning, Assessment, Empowering learners, and Facilitating learners' digital competence) that include 32 indicators (items/measures) in total; such dimensionality or factor structure needs to be confirmed as a result of psychometric analysis of the piloting results. This paper covers the analysis of the cleaned data set that involved five main steps:

- Descriptive analysis of self-reflection data, background information and perceptions about the tool.
- Confirmatory Factor Analysis for confirming the dimensionality of the construct.
- Classical Item Analysis using the jMetrik software (https://itemanalysis.com/jmetrik).
- Item Response Theory analysis (Rasch model analysis), using the jamovi software (snowIRT module) by Joint Maximum Likelihood (JML) (https://www.jamovi.org), to evaluate how well the data fits the model.
- Descriptive analysis of background information and perceptions about the tool.

3.5.2 | The Qualitative Data

The qualitative data collected from the Mural (post-its), audio recordings and open-ended responses to the online questionnaire were analysed using the NVivo software (https://lumivero.com/product/nvivo) and coded using an axial predefined code set. As the qualitative materials differed in form and length, they were first reviewed separately to identify comparable meaning units. Mural post-its were treated as single statements, while longer transcripts and written responses were divided into shorter analytic segments. This ensured consistent application of the predefined axial code set across all data sources. The initial set of structural codes was predefined in line with the main aims of the focus groups, that is, to know more about participants' motivation to go through the self-reflection and to understand how relevant the self-reflection was to the participants' career and CPD choices.

The research team chose a collaborative coding approach to reach agreement about coding decisions. A consensus coding approach was followed, as it is known to be a more rigorous and effective approach when working in larger groups of coders, where coding consistency concerns are more likely (Olson et al. 2016). During each iteration of coding, team members coded the same two to three transcripts into the codebook. In this process, new codes were added into the codebook. Then, during research team debriefings, each coded statement was compared across members of the research team. Disagreements were discussed until the group reached consensus. After all the transcripts were coded using consensus coding, the research team met one final time to review the codebook. During the meeting, the codebook was developed into a categorisation structure comprising categories and associated subcategories that describe the participants' perspectives. The structure was reviewed and approved by all members of the research team. Importantly, through the earlier stages of collaborative coding, all members of the research team had a hand in shaping and agreeing with the categories and subcategories. This process, therefore, capitalised on the enhanced trustworthiness provided by multiple analysts, while minimising issues related to coder variability, without attempting to quantify the qualitative data analysis process (Richards and Hemphill 2017; Patton 2015). The codebook with the relevant categories and subcategories for the present paper, as well as illustrative examples, can be found in Table A1 in Annex 1. All participant statements were coded to capture the full range of perceptions, both positive and negative, regarding the clarity, usefulness, and professional relevance of the tool. The analysis was conducted in the participants' original language, and only the excerpts used were translated into English. Following the coding process, the coded instances were examined across categories and subcategories to explore commonalities, variations, and representative examples. This allowed the research

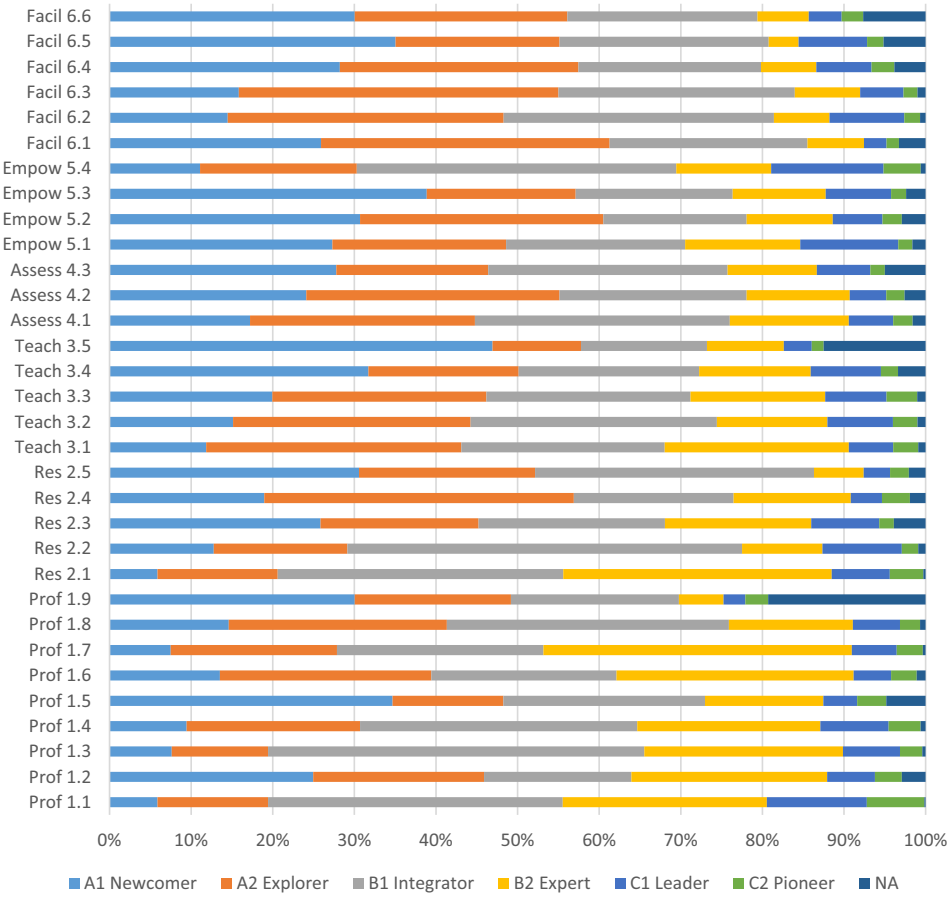

FIGURE 3 | Distribution of self-reflection responses item-by-item (all four countries together). Please refer to Figure 1 for labels descriptions.

team to interpret how participants articulated their motivations, perceptions, and challenges related to the self-reflection process.

4 | Results

4.1 | Reliability and Validity of the Tool

The results related to RQ1 'Is SELFIEforTEACHERS a valid and reliable tool for supporting teachers to reflect on their digital competence?' derived from the self-reflection data analysis. For the purposes of this paper, the self-reflection responses were analysed to explore patterns of distribution and variability of the items, and a confirmatory factor analysis was performed to explore the data collected under the proposed six dimensions of the 'digital competence' construct. The results were analysed further, exploring the data collected under each item using the Rasch model item analysis. The data analysis and results are presented in the next three subsections.

4.1.1 | Descriptive Analysis of Self-Reflection Data

Figure 3 indicates that although some items (most notably item 1.9 'Computational thinking' under Area 1 'Professional engagement' and item 3.5 'Emerging technologies' under Area 3 'Teaching and learning') show quite distinct patterns of distribution and variability, many other items seem to have quite similar responses with each other (e.g., items 1.1 'Organisational communication' and 1.3 'Professional collaboration both under Area 1 'Professional engagement', or 1.7 'Professional learning through digital technologies' under Area 1 'Professional engagement' and 2.1 'Searching and selecting' under Area 2 'Digital resources').

The correlation analysis (Table B1 in Annex 2) gives more reliable confirmation about items that behave in a similar manner, but as none of the pairs have correlation above 0.75, it did not suggest removal of any items from the instrument due to their too high similarity pairwise. The same conclusion can be drawn from Confirmatory Factor Analysis in the next chapter. Table B1 in Annex 2 shows the highest correlations (Pearson's $r > 0.63$, one-tailed) between item pairs.

Table C1 in Annex 3 presents the descriptive statistics for all 32 self-reflection items. Note the high skewness of items Prof 1.9 'Computational thinking' and Res 3.5 'Emerging technologies', indicating the low variability and high endorsability ('difficulty') of these items.

4.1.2 | Confirmatory Factor Analysis

Confirmatory Factor Analysis (CFA) was conducted to validate the dimensionality of the teachers' digital competence model

TABLE 2 | CFA: Chi-square test.

Model	χ^2	df	*p*
Baseline model	82,684.8	496	
Factor model	4149.46	449	< 0.001

TABLE 3 | Comparison of fit indices for four different models.

Indices	1-Factor	2-Factor	6-Factor	7-Factor
Chi-square	9188	6273	4149	28,610
df	464	463	449	434
CFI	0.89	0.929	0.956	0.643
RMSEA	0.076	0.062	0.051	0.142
TLI	0.887	0.924	0.949	0.618
NNFI	0.887	0.924	0.949	0.618

used for the tool. The CFA tested the 6-factor structure of the DigCompEdu framework, as suggested by the panel of experts. Maximum Likelihood estimation was used with robust error calculation (CI width 95%). The model showed a poor fit in Chi-squared test (Table 2), as the Chi-squared value divided by df is significantly higher than the threshold value (2).

However, the sample size is too large to rely merely on the Chi-squared test for establishing significant fit, as it often shows low fit in case of large samples. Instead, we focus on the additional fit indices (Table 3) such as CFI (0.956), TLI (0.949) and NNFI (0.949) and RMSEA (0.051) that indicate a good fit of the 6-factor model.

CFA showed very good reliability (McDonald's ω 0.975 and Cronbach's α 0.975). We also tested CFA on an alternative unidimensional model of teachers' digital competence, where all items belong to a single factor. The fit of this model was significantly poorer compared to the 6-factor model that was analysed above. Table 3 below compares the values of five different fit indices for four models:

- 1-factor model, where all items belong to the same factor.
- 2-factor model, suggested by Exploratory Factor Analysis.
- Original 6-factor model proposed by the expert panel for DigCompEdu
- 7-factor model, where the three outlier items Prof 1.9 'Computational thinking', Res 2.1 'Searching and selecting' and Teach 3.5 'Emerging technologies' formed a separate factor related to emerging technologies

The data in Table 3 confirms that the original 6-factor model shows the best fit with the data. Although Chi-squared divided by df is significantly larger than 2 for all four models, it is the second lowest for the 6-factor model. Hu and Bentler (1999) consider CFI > 0.95 showing a good fit, and only the 6-factor model meets this requirement. Browne and Cudeck (1992) have suggested that RMSEA value of < 0.05 indicates a 'close fit', and that < 0.08 suggests a reasonable model–data fit. Again, in comparison with alternative models, the original 6-factor model shows the best RMSEA fit with the data. The same can be said about TLI and NNFI indices.

To conclude the findings from the Confirmatory Factor Analysis, the validation of dimensionality of the 6-factor model of teachers' digital competence gave reasonably good results. The alternative models (1-, 2-, and 7-factor) were showing clearly worse fit with the data so we recommend relying on the original 6-factor model.

TABLE 4 | Rasch models tested.

Model	AIC	BIC	CAIC
Rating scale	73,938	74,329	74,393
Partial credit	70,825	71,453	71,556

Abbreviations: AIC, Akaike Information Criteria; BIC, Bayesian information criterion; CAIC, Consistent Akaike Information Criterion.

TABLE 5 | Item statistics for professional engagement (partial credit).

Item	Item mean	Measure	S.E. measure	Infit	Outfit
Prof 1.9	1.84	1.1600	0.0193	1.307	1.324
Prof 1.8	2.80	0.1198	0.0211	0.752	0.747
Prof 1.7	3.25	−0.4103	0.0216	0.839	0.833
Prof 1.6	2.94	−0.0544	0.0205	0.950	0.947
Prof 1.5	2.38	0.4929	0.0189	1.106	1.079
Prof 1.4	3.13	−0.3583	0.0207	0.777	0.777
Prof 1.3	3.21	−0.3464	0.0227	0.848	0.855
Prof 1.2	2.68	0.2243	0.0190	1.209	1.228
Prof 1.1	3.47	−0.8277	0.0208	1.013	1.015

4.1.3 | Item Analysis

Item analysis with Rasch model was conducted with Jamovi software (snowIRT module) by Joint Maximum Likelihood (JML) estimation, separately for each of the six dimensions of Digital Competence of Educators. Two different Rasch models were tested: rating scale model and partial credit model (Table 4).

As the rating scale model resulted with larger AIC, BIC and CAIC values than the partial credit model, it indicates the better fit of the data with the Rasch partial credit model. The item statistics (Table 5) show infit and outfit values for item Prof 1.9 'Computational thinking' coming relatively close to the threshold (both infit and outfit should remain between 0.5 and 1.5), but this fact does not suggest exclusion of this item from the instrument.

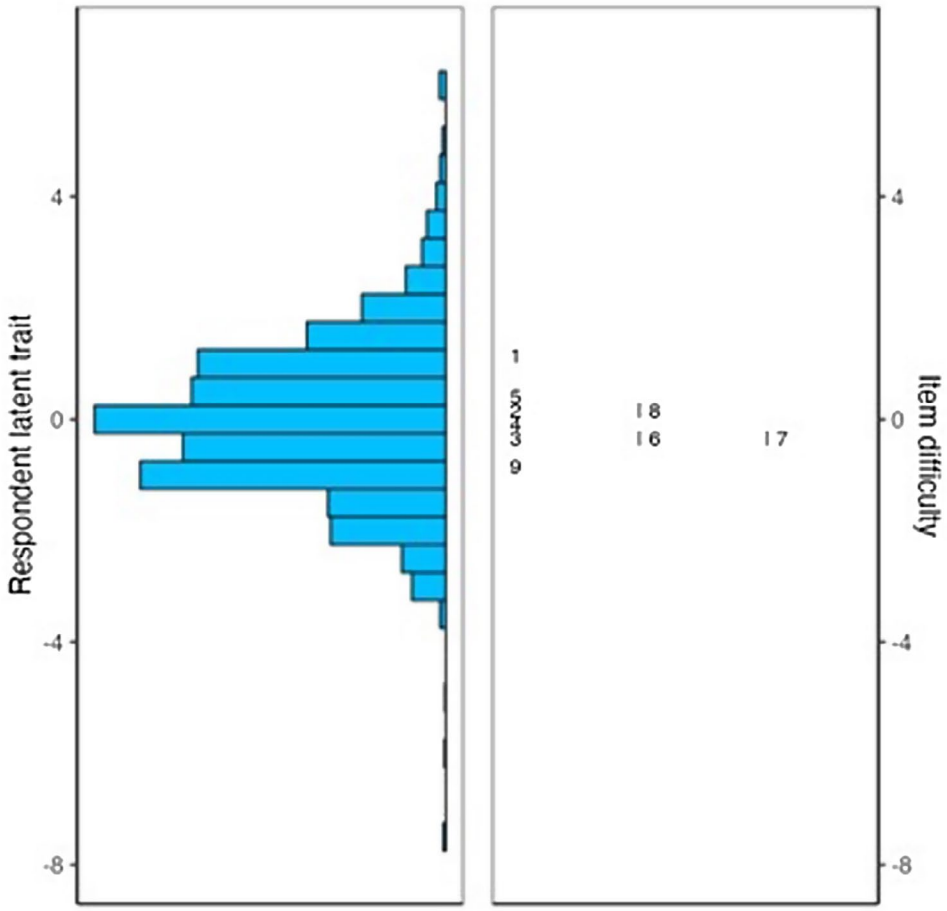

FIGURE 4 | Wright map for professional engagement items.

Wright Map (Figure 4) for the 'Professional Engagement' items shows two outliers: the difficulty (endorsability) of item 1 seems to be lower and of item 9 higher compared to the rest of the items. However, both of these outliers are close enough to the main group of the items to suggest keeping them in the instrument.

The similar Rasch model analysis with model testing and Wright maps was conducted on the remaining five factors of the DigCompEdu model, but all items had acceptable infit and outfit measures.

To conclude the item analysis, we were unable to identify any evidence that would suggest the need for removal of any existing items from the SELFIEforTEACHERS instrument that was piloted in four countries.

4.2 | Teachers' Perception of the Tool Relevance

To answer RQ2 'How relevant do teachers perceive SELFIEforTEACHERS for their digital competence development?' we analysed the data collected through the third part of the instrument and through the qualitative data collected through the focus groups.

4.2.1 | Descriptive Analysis

We collected data in three areas related to the SELFIEforTEACHERS relevance for teachers' professional learning: (1) Satisfaction with the self-reflection tool, items and process (2) Satisfaction with the tool feedback report and (3) Future use of the self-reflection results. In general, the participants agreed or strongly agreed with their satisfaction with the self-reflection tool, items and process (Figure 5). Participants were mostly in agreement or strong agreement about recommending SELFIEforTEACHERS to colleagues (65%), using the outcomes of their self-reflection towards their professional learning (66%), finding the total time to complete the self-reflection reasonable (68%), finding the progression of the proficiency level within the items distinctive (70%), and indicating that the statements in the 32 items reflected their everyday practice (63%). On the other hand, the highest percentage of disagreement among the participants was about the statements being easy to understand (17%), while 15% were not satisfied with their participation in the self-reflection. In addition, using Kruskal-Wallis one-way analysis of variance (Daniel 1990), ISCED1 teachers were supportive of a different version of SELFIEforTEACHERS for themselves ($p < 0.001$).

Regarding their satisfaction with the feedback given to them after their self-reflection of their digital competence, participants

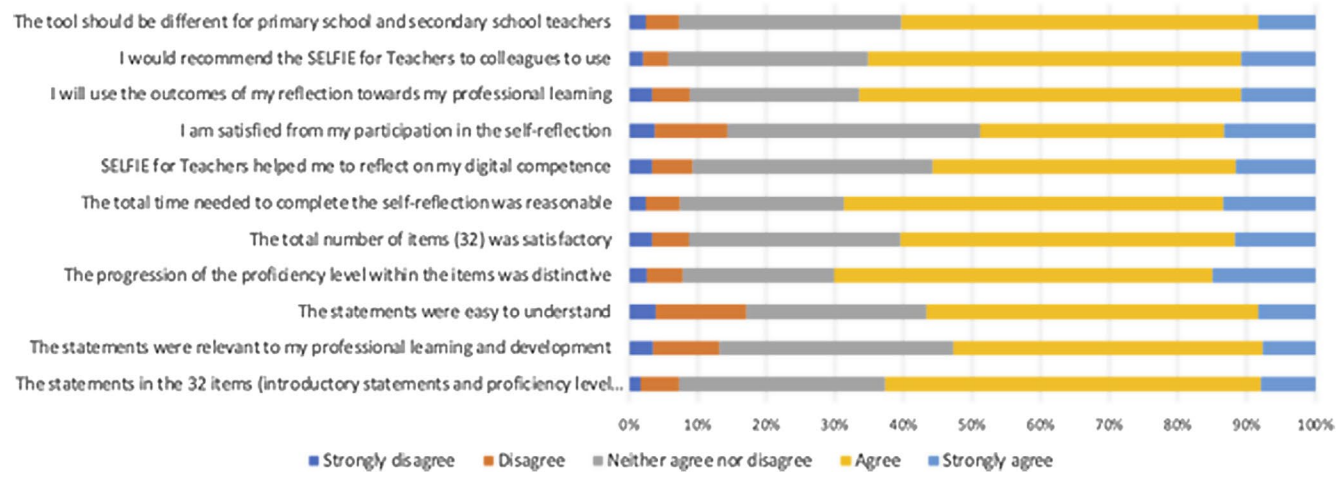

FIGURE 5 | Satisfaction with the self-reflection tool, items and process.

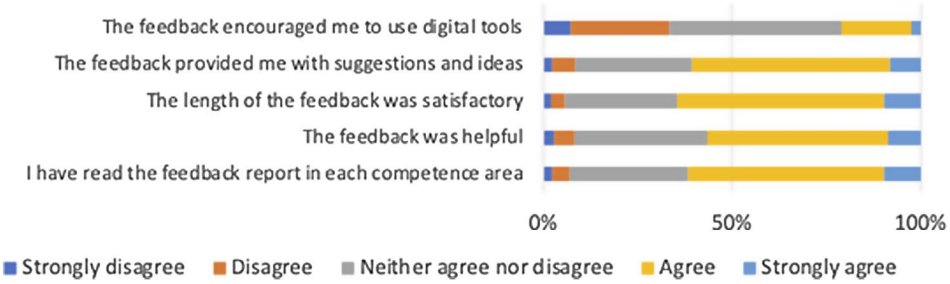

FIGURE 6 | Satisfaction with the SELFIEforTEACHERS feedback report.

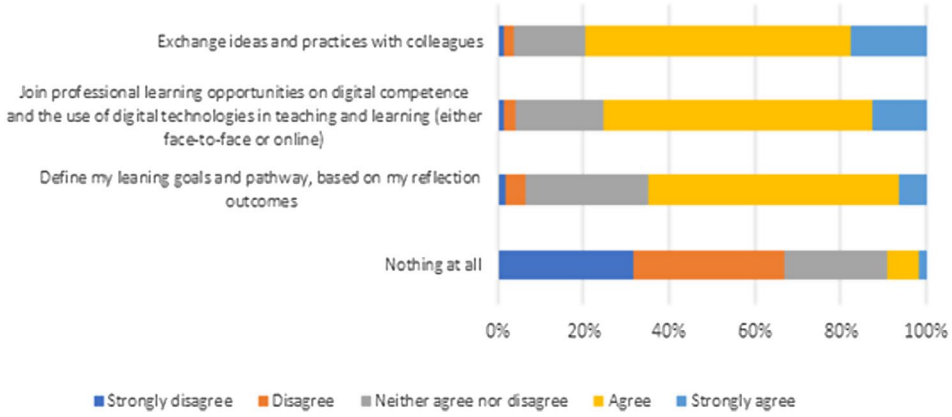

FIGURE 7 | Future use of the self-reflection results.

agreed or strongly agreed that they had read the feedback in each competence area and that it was helpful, of satisfactory length, and provided suggestions and ideas. There was less agreement, however, that the feedback encouraged them to use digital tools (Figure 6).

The participants gave even more positive feedback regarding the future use of their self-reflection results for actions to take (Figure 7). The final section in the feedback questionnaire included one 'negative' question that shows a clearly different response pattern, indicating less than 10% of respondents 'Agree' or 'Strongly agree' with the statement that they will make no use of the self-reflection results in any way.

4.2.2 | Qualitative Analysis

To further understand how participants considered and perceived the relevance of SELFIEforTEACHERS to their professional practice, we conducted eight focus group discussions in four countries. The scope of the study did not include comparative results among countries and this article

presents summarised results of all countries. A total of 198 coded instances—individual statements or comments—were identified across the Mural post-its, audio recordings, and open-ended questionnaire responses. The present analysis focuses on seven subcategories (Satisfied with clarity of report, Unsatisfied with clarity of report, Increase usefulness, Decrease usefulness, Relevant to Continuing professional development (CPD), Relevant to job, Irrelevant to job) that form part of the larger collaboratively developed codebook (see Section 3.5.2), selected for relevance to professional development. There were no instances of the subcategory *tool's irrelevance to CPD*. This article focuses on subcategories related to professional development that contain 20 or more instances in total. The threshold of 20 was established to ensure adequate representation across the dataset, allowing for meaningful interpretation, whereas subcategories with fewer instances were deemed insufficiently supported for reliable analysis.

Teachers were most active (37 instances, 19%) in expressing their *satisfaction with the clarity of the SELFIEforTEACHERS report*, emphasising that its well-structured format provides clear and detailed recommendations to support individual improvement and identification of learning needs (Table 6). Across these 37 instances, teachers most frequently mentioned that the report facilitates self-reflection and awareness, assists in planning digital literacy training, stimulates professional improvement, and encourages reflection on one's competence levels.

TABLE 6 | Summary of subcategories and key qualitative findings from focus group discussions.

Subcategory	Key findings
Satisfied with clarity of report	• The report is very detailed and focus on specific improvements • The report helped teachers understand their practice • The report includes recommendations for reaching the next level
Unsatisfied with clarity of report	• The report could be presented as a summary • The report should have visuals like a graph • The report does not provide indications on specific training that teachers could attend to improve in the areas that emerged as needed
Increase usefulness	• Knowing one's competences eases self-reflection. • It helps to plan actions at school level aimed at accompanying teachers on their learning and teaching journey • Explore the system's potential to link the present with the future. • Clearly articulated areas for improvement maintain a broad scope of digital technology use • To have a mechanism in which teachers have forcibly to answer by stages
Decrease usefulness	• Recommend two or more different versions • For the primary education language should be simplified • The tools mentioned are not part of the primary education teachers' daily practice • Teachers 'lost' the language options or did not complete tool • The resistance of some teachers still shows regarding the use of digital technologies for teaching and learning
Relevant to CPD	• The tool supports and stimulates teachers to explore their own level of digital skills • Supports to plan specific actions to increase knowledge on the topic • The tool is very complete and help teachers to reflect upon things they weren't used to think • The first step for wanting to learn more about different tools • A useful tool to reflect on our strengths and weaknesses • The direction of self-improvement is indicated
Relevant to job	• Promotes self-reflection in certain areas and practices • Perfect for use in various fields (even when filling in the CV) • The tool is very suitable, appeared on time • Such self-reflection tool might become useful in qualification process • Useful and important to reflect on teaching skills and strategies • This will help for planning next year's activities in the school • Useful to understand the relation between technology use and everyday practice
Irrelevant to job	• Teachers confident in their abilities perceived self-reflection as irrelevant • Unclear if activities outside work could be included • Questions are more focused on IT teachers • A regular teacher does not need some of these competences

The second largest subcategory in terms of number of instances (30 instances, 15%) was the *relevance of the tool to Continuing professional development (CPD)*. Teachers from all four countries found that this tool is valuable for reflecting on personal strengths and weaknesses, offering clear and comprehensible recommendations while providing a well-defined direction for self-improvement (Table 6).

The third largest subcategory was teachers' *unsatisfaction with the clarity of the report* (26 instances, 13%). Teachers from all countries found the report too long, unclear, or lacking visuals, and others struggled to access feedback or felt it didn't fully reflect their competences. In addition, teachers argued that the report lacks a combined summary, level indications, and specific training recommendations, making it less valuable to some teachers.

Two opposite subcategories – *Increase usefulness* (23 instances, 12%) and *Decrease usefulness* (21 instances) – collected almost an equal number of teachers' statements. Teachers suggested ways to increase the usefulness of the tool, such as using it to plan school-level actions that support teachers' professional growth based on their self-reflection results. They also highlighted the need for immediate training, specific recommendations, and locally relevant professional development opportunities (Table 6). Participants further proposed expanding the tool's functionality by linking current results with future learning goals and by giving greater attention to students with special educational needs. Regarding subcategory *Decrease usefulness*, teachers found that some of the suggested digital tools and online services were irrelevant or did not align with primary teachers' needs. Secondary school teachers highlighted that the tool's effectiveness was challenged by questionable objectivity, item complexity, unclear targets, language navigation issues, and some teachers' resistance to digital technologies in teaching (Table 6).

During the discussion, some teachers mentioned how the tool was suitable for their job (22 instances, 11%). Teachers overall highlighted that the tool proved invaluable for planning next year's school activities, offering critical insights and enhancing teaching skills and strategies. Also, teachers found that the tool can be a valuable asset in the qualification process, inspiring new ideas for classroom tools and proving versatile for use across various fields, including when updating a CV (Table 6).

Meanwhile, *irrelevance to the job* (20 instances, 10%) was indicated by some secondary school teachers who questioned the necessity of higher-level digital competences, doubted their own digital skills, and discussed whether certain skills were truly applicable to regular teachers.

Cultural or country dimension variations were not apparent during the discussions. The qualitative patterns related to clarity, usefulness, and relevance were broadly consistent across countries and no distinct national trends were identified. The focus groups discussions indicated some variance in individual participants' perceptions about the tool. For example, in some cases the tool was considered very useful while in others the tool's usefulness was related to other factors such as school-level actions or locally relevant professional development opportunities. Moreover, in some cases tool relevance was not perceived the same way, with primary school teachers suggesting more alignment with their needs.

5 | Discussion and Conclusion

This study aimed to provide evidence on the validity and reliability of SELFIEforTEACHERS to be used as a tool to support teachers' self-reflection on their digital competence proficiency by answering the following two research questions:

- RQ1: Is SELFIEforTEACHERS a valid and reliable tool for supporting teachers to reflect on their digital competence?
- RQ2: How relevant do teachers perceive SELFIEforTEACHERS for their digital competence development?

In relation to RQ1 factor analysis confirmed a good fit for the suggested six-factor model of teachers' digital competence. Confirmatory Factor Analysis and Item Response Theory did not suggest any changes to the dimensionality (factor structure) of this construct. Analysis confirmed that all items had good, or at least satisfactory, factor loadings and there was no evidence to support an argument for removing, adding or replacing items for any factor. Two items—'Computational thinking' and 'Emerging technologies'—showed a higher difficulty level with distinct patterns of distribution and variability. As they are related to recent technological trends, they may indicate the complexity of building related competences. Correlation analysis did not reveal significant overlap between any two items in the self-reflection tool, and none of the item pairs correlated so highly with each other as to suggest removal of one. The study findings are aligned with other research using self-assessment tools based on the DigCompEdu framework, such as Ghomi and Redecker's (2019) study with 335 participants in Germany, which demonstrated the instrument's reliability and validity, and a study with 1071 primary and secondary teachers in Portugal (Lucas, Bem-Haja, et al. 2021), which similarly confirmed its applicability and usefulness for assessing teachers' digital competence.

In relation to RQ2, the quantitative data analysis showed that in general, the participants agreed or strongly agreed with their satisfaction with SELFIEforTEACHERS and its relevance and usefulness for their professional learning and development of their digital competence. Further exploration of the research question involved the analysis of the open-text responses in the online questionnaire, post-it notes written and audio recorded during the follow-up focus group interviews. This analysis showed that teachers found SELFIEforTEACHERS easy to use and relevant to their job. It helps them to reflect on their digital competence proficiency and identify their strengths and weaknesses. The tool also provides feedback with recommendations for self-improvement and professional development. The study results reinforce the idea put forward by different authors regarding the process of self-reflection as an essential aspect of learning from experience and improving professional practice (Brookfield 2017; Cheng et al. 2015).

Even though the qualitative analysis results were broadly consistent across countries, variances in individual participants' perceptions about the tool were identified. For example, in some cases the tool usefulness was related to other factors such as school-level actions or locally relevant professional development opportunities. As discussed in the literature (see Section 2.2), self-reflection entails many challenges in order to be successful and meaningful, as for example limited awareness about reflective practice, cultural and personal hindrances, or lack of motivation (Finlay 2008). At the same time, effective scaffolding is needed for critical reflection to take place, including constructive feedback to foster growth. The study results supported the need for additional research on how SELFIEforTEACHERS can be used in different contexts to investigate the conditions—enablers and hindrances—in order to constitute a meaningful and effective way to support building teachers' digital competence. Such research is already taking place, as for example the implementation of various 'use cases'—such as the use of SELFIEforTEACHERS at school level, as part of a training programme or for co-designing professional development activities – and a multi-case research study across six EU countries. The findings align with the preliminary indications of the present study and emphasise the need that SELFIEforTEACHERS is integrated into scaffolded professional development programmes providing access to resources to complement the tool feedback (Economou et al. 2024).

The two research questions address different dimensions of the study, the psychometric validity and the perceived relevance of SELFIEforTEACHERS, in a distinct and complementary way. The quantitative findings establish the statistical robustness and construct validity of the tool, providing the empirical foundation necessary to justify its use. In turn, the qualitative results offer insight into how teachers experience and value the tool in their professional contexts, thereby demonstrating its pedagogical utility and perceived contribution. Together, these strands of evidence form a convergent validation argument: the quantitative analyses confirm that the tool measures what it is intended to measure, while the qualitative data illustrate its meaningfulness and applicability in practice.

The study results were discussed with the expert team involved in the creation of the tool items to further assure the external validity of the tool. Based on the study results and the experts' input, the tool's development team proceeded with improvements of the tool and the tool user interface to respond to the teachers' learning needs, but also to specific contextual needs. These include: the addition of a seventh option 'I am not aware of this competence', to respond to the expressed need that all teachers can find a best fit for their current competence level; the redesign of the tool user interface with improved menu structure and a dashboard navigation page; and the addition of a new feature where new areas of competence and new reflection items that are specific to a group needs can be added. Moreover, a new dedicated version of the tool for early childhood professionals has been developed (Kontovourki et al. 2024) with more dedicated versions for different education sectors under consideration.

Finally, a number of suggestions that can improve the use of SELFIEforTEACHERS in the future include: adding practical examples of applications for teachers to understand how to implement recommendations in their teaching; providing localised training suggestions immediately after report completion to help teachers act on the results; ensuring that suggested digital tools and services align with teachers' daily practices and needs; promoting the tool's value beyond IT-related competences, showing its broader relevance to teaching and learning practices.

Undoubtedly, teachers are faced with continuous challenges in responding to the rapid developments of technology. Providing professional development programmes relevant to their needs and supporting their agency to build their digital competence is necessary. SELFIEforTEACHERS encourages teachers to identify and challenge teachers' assumptions about teaching and learning with digital technologies, which can lead to more effective and inclusive practices. As part of a learning cycle, SELFIEforTEACHERS can support the identification of digital competence pedagogical gaps and the design of tailored professional learning programs as evidenced by different studies (Lucas, Dorotea, et al. 2021). Teachers' digital competence extends from their individual skills to facilitating their learners' digital competence, supporting their active contribution to society.

Results of recent international studies such as the International Computer and Information Literacy Study (ICILS) and the Programme for the International Assessment of Adult Competencies (PIAAC) (IEA 2024; OECD 2024) show that most students internationally seem to lack the necessary skills to deal with technological challenges like finding and critically evaluating information online, while one fifth of the participating adults are considered low performers in the ability to process information in digital environments and problem solving in technology-rich environments. These results indicate the urgency to support building the digital competence of educators as one of the measures to improve the necessary skills of citizens in the digitalised era.

Moreover, with the rapid evolution of generative artificial intelligence, we need to reconsider skills and competences in the light of emerging human-computer interaction entanglements towards a human-centred digital transformation (Tuomi et al. 2023). Human agency is important in the learning and development cycles, with self-reflection and self-regulation supporting lifelong learning approaches. SELFIEforTEACHERS aimed to put teachers in the centre of their professional learning by using self-reflection as a learning process (Economou 2023b). It is pertinent that education systems continue providing teachers with the tools and support that are relevant and aligned to the new needs.

The paper aimed to provide evidence on the validity and reliability of SELFIEforTEACHERS to be used as a tool to support teachers' self-reflection and development of their digital competence proficiency. Further research can investigate how the tool can be effectively used to support teachers, while at the same time redefining digital competence under the emerging technologies providing relevant support to teachers.

The study entails some limitations to be considered. The generalisability of the findings is limited by the contextual variability in teachers' perceptions of the tool across school-level

and support structures, as well as by the predominance of female participants, which—although consistent with European teacher gender statistics—may still restrict applicability to more gender-balanced contexts. The study also presents some limitations to be taken into account when interpreting the findings. First, voluntary participation may have introduced a self-selection bias, as those who chose to engage with the tool and participate in the study were likely more motivated or more digitally confident than the wider teacher population. Second, differences in national digital competence frameworks and policy priorities across participating countries may have influenced how teachers interpreted specific descriptors, potentially shaping their perceptions of the tool's relevance and accuracy. Finally, because the data relied on self-assessment, the results are subject to inherent biases associated with reflective judgement, including tendencies towards both underestimation and overestimation of one's digital competence.

Author Contributions

Anastasia Economou: conceptualization, methodology, writing – original draft, writing – review and editing, supervision. **Gabrielė Stupurienė:** methodology, data curation, writing – review and editing. **Mart Laanpere:** conceptualization, data curation, software, formal analysis. **Stefania Bocconi:** conceptualization, methodology, writing – original draft. **Margarida Lucas:** conceptualization, methodology, writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are not publicly available due to privacy or ethical restrictions.

Endnotes

[1] Primary education in Estonia, Italy, and Lithuania includes ISCED 1. In Portugal, primary education includes ISCED 1 and 2.

Secondary education in Estonia, Italy, and Lithuania includes ISCED 2 and 3, and in Portugal, ISCED 3.

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Annex 1

Codebook With Relevant for the Present Paper Categories, Subcategories and Illustrative Examples

TABLE A1 | Categories, subcategories and illustrative examples.

Category	Subcategory	Illustrative examples
Motivation	Motivated	'Fun, I found out my strengths'.
	Unmotivated	'Reading the possible answers, I understood what it means to be at a higher level, and if I ever want to achieve it, it takes a lot of work'.
	Motivation increased	'Thank you for your advice and for being able to understand that I can and should achieve even higher levels of digital use in teaching and learning. There are no limits to improvement'.
	Motivation decreased	'It can be frustrating for those [teachers] who don't have high levels of digital competence'.
Relevance for self-reflection/CPD	Relevant to job	'I found excellent feedback within the platform regarding my way of working and my future way of acting towards students'.
	Irrelevant to job	'It does not in any way fall into the reality of the school where I teach. Unfortunately, it is of no use to me and even less to my daily work with children'.
	Relevant to CPD	'It provides the possibility of being more guided in training... [as it] allows analytic and adequate self-analysis to rethink teaching methods'.
	Irrelevant to CPD	No examples found.
	Increase relevance	'Self-reflection is very important, specific improvement activities can be planned (suggestions are given)'.
	Decrease relevance	'On item 1.9 (but also on others) the answer is conditioned by the specific school community'.
Relevance for schools	Relevant to school	'When going through the questions, I got the feeling that my school is totally behind in terms of digital competence. We're very far away'.
	Irrelevant to school	'The selfie cannot be detached from the reality of the school. Without a picture of the school, the individual portrait is not very useful'.
Report	Satisfied with report	'One of the most positive aspects of the tool is the report, the profile generated at the end. Most questionnaires don't give you anything in return'.
	Unsatisfied with report	'The report is useful, but maybe it could be presented as a summary'.
Usefulness	Increase usefulness	'I would suggest to broaden the last two progression levels in each item to encompass not only those who have particular high level skills, who make themselves available to colleagues, but also a teacher who does not have a particular function/role inside the school but who is a very curious person, that always looks at new technologies, new applications, test them etc. or a person who does his utmost for others in the sense that he is a bit of a reference point, you know there are in the school colleagues to which you can go and ask directly if you know they are very good, especially very curious in this respect'.
	Decrease usefulness	'The whole reflection is based on the assumption that all institutes and schools are equipped with IT tools but unfortunately this is not the case and this generates a limit to the achievable activity'.
Future use	Intending to use	'I'll use it in the future, because I want to promote training in digital competence for colleagues and students, as all involved in Education today must have at least basic digital competences'.
	Not intending to use	'The questionnaire was difficult for me. I often had to think for a long time about what was expected from me'.

Annex 2

Self-Reflection Item Correlations

TABLE B1 | Self-Reflection Item Corres.

Item1	Item2	Pearson's *r*	significance	*p*	Lower 95% CI	Upper 95% CI
Facil 6.4	Facil 6.5	0.760	***	< 0.001	0.745	0.775
Assess 4.2	Assess 4.3	0.739	***	< 0.001	0.723	0.754
Empow 5.2	Empow 5.3	0.725	***	< 0.001	0.708	0.741
Assess 4.1	Assess 4.2	0.723	***	< 0.001	0.706	0.739
Empow 5.1	Empow 5.2	0.716	***	< 0.001	0.699	0.732
Assess 4.1	Assess 4.3	0.715	***	< 0.001	0.698	0.731
Teach 3.3	Teach 3.4	0.707	***	< 0.001	0.689	0.724
Assess 4.3	Empow 5.2	0.699	***	< 0.001	0.681	0.717
Assess 4.2	Empow 5.2	0.693	***	< 0.001	0.674	0.710
Teach 3.2	Teach 3.3	0.690	***	< 0.001	0.672	0.708
Facil 6.5	Facil 6.6	0.689	***	< 0.001	0.671	0.707
Teach 3.4	Empow 5.2	0.682	***	< 0.001	0.663	0.700
Teach 3.1	Teach 3.3	0.680	***	< 0.001	0.661	0.698
Teach 3.2	Assess 4.1	0.674	***	< 0.001	0.655	0.693
Empow 5.4	Facil 6.2	0.674	***	< 0.001	0.655	0.692
Assess 4.1	Empow 5.2	0.672	***	< 0.001	0.652	0.690
Assess 4.3	Empow 5.3	0.671	***	< 0.001	0.651	0.689
Facil 6.2	Facil 6.3	0.671	***	< 0.001	0.651	0.689
Teach 3.2	Assess 4.3	0.670	***	< 0.001	0.650	0.688
Teach 3.4	Assess 4.3	0.670	***	< 0.001	0.651	0.689
Empow 5.1	Empow 5.3	0.670	***	< 0.001	0.651	0.689
Facil 6.1	Facil 6.6	0.670	***	< 0.001	0.651	0.689
Teach 3.2	Assess 4.2	0.668	***	< 0.001	0.648	0.687
Teach 3.5	Empow 5.3	0.668	***	< 0.001	0.648	0.687
Teach 3.3	Empow 5.3	0.667	***	< 0.001	0.647	0.686
Teach 3.3	Assess 4.1	0.666	***	< 0.001	0.647	0.685
Teach 3.4	Assess 4.2	0.665	***	< 0.001	0.646	0.684
Facil 6.3	Facil 6.6	0.665	***	< 0.001	0.645	0.684
Teach 3.1	Teach 3.2	0.664	***	< 0.001	0.644	0.682
Teach 3.2	Teach 3.4	0.664	***	< 0.001	0.644	0.683
Facil 6.1	Facil 6.3	0.664	***	< 0.001	0.645	0.683
Facil 6.1	Facil 6.4	0.663	***	< 0.001	0.643	0.682
Empow 5.2	Facil 6.6	0.661	***	< 0.001	0.641	0.680
Facil 6.4	Facil 6.6	0.661	***	< 0.001	0.641	0.680
Prof 1.7	Prof 1.8	0.660	***	< 0.001	0.640	0.679
Teach 3.1	Assess 4.1	0.660	***	< 0.001	0.640	0.679
Teach 3.3	Assess 4.3	0.659	***	< 0.001	0.639	0.678
Empow 5.2	Facil 6.1	0.658	***	< 0.001	0.638	0.677

(Continues)

TABLE B1 | (Continued)

Item1	Item2	Pearson's *r*	significance	*p*	Lower 95% CI	Upper 95% CI
Teach 3.3	Assess 4.2	0.657	***	<0.001	0.637	0.676
Teach 3.3	Empow 5.2	0.657	***	<0.001	0.637	0.676
Teach 3.4	Empow 5.3	0.657	***	<0.001	0.637	0.677
Empow 5.3	Facil 6.3	0.655	***	<0.001	0.635	0.675
Facil 6.1	Facil 6.5	0.655	***	<0.001	0.634	0.674
Teach 3.3	Empow 5.4	0.654	***	<0.001	0.634	0.673
Empow 5.2	Facil 6.4	0.654	***	<0.001	0.634	0.673
Facil 6.1	Facil 6.2	0.653	***	<0.001	0.632	0.672
Assess 4.1	Empow 5.4	0.652	***	<0.001	0.631	0.671
Facil 6.3	Facil 6.4	0.652	***	<0.001	0.631	0.671
Teach 3.2	Empow 5.4	0.651	***	<0.001	0.631	0.670
Empow 5.1	Empow 5.4	0.651	***	<0.001	0.631	0.670
Teach 3.5	Empow 5.2	0.650	***	<0.001	0.629	0.669
Assess 4.2	Empow 5.3	0.650	***	<0.001	0.630	0.670
Empow 5.2	Empow 5.4	0.650	***	<0.001	0.629	0.669
Empow 5.2	Facil 6.5	0.650	***	<0.001	0.630	0.670
Assess 4.3	Empow 5.1	0.649	***	<0.001	0.629	0.669
Teach 3.1	Empow 5.3	0.647	***	<0.001	0.626	0.666
Teach 3.4	Assess 4.1	0.647	***	<0.001	0.627	0.667
Teach 3.1	Teach 3.4	0.646	***	<0.001	0.625	0.665
Teach 3.2	Empow 5.2	0.646	***	<0.001	0.626	0.666
Assess 4.1	Empow 5.3	0.644	***	<0.001	0.623	0.664
Empow 5.3	Empow 5.4	0.644	***	<0.001	0.623	0.664
Teach 3.1	Empow 5.4	0.643	***	<0.001	0.622	0.663
Empow 5.2	Facil 6.3	0.643	***	<0.001	0.622	0.662
Teach 3.1	Empow 5.2	0.642	***	<0.001	0.621	0.662
Empow 5.3	Facil 6.1	0.638	***	<0.001	0.617	0.658
Empow 5.3	Facil 6.6	0.638	***	<0.001	0.617	0.658
Teach 3.1	Assess 4.3	0.636	***	<0.001	0.615	0.656
Empow 5.3	Facil 6.4	0.636	***	<0.001	0.615	0.656
Teach 3.5	Assess 4.2	0.635	***	<0.001	0.614	0.656
Teach 3.4	Facil 6.1	0.633	***	<0.001	0.612	0.653
Assess 4.3	Facil 6.1	0.633	***	<0.001	0.612	0.654
Facil 6.2	Facil 6.4	0.633	***	<0.001	0.611	0.653
Facil 6.3	Facil 6.5	0.633	***	<0.001	0.611	0.653
Teach 3.1	Assess 4.2	0.632	***	<0.001	0.611	0.652
Assess 4.2	Empow 5.4	0.632	***	<0.001	0.611	0.652
Assess 4.2	Facil 6.1	0.632	***	<0.001	0.611	0.653
Assess 4.3	Facil 6.5	0.632	***	<0.001	0.611	0.653

(Continues)

TABLE B1 | (Continued)

Item1	Item2	Pearson's *r*	significance	*p*	Lower 95% CI	Upper 95% CI
Empow 5.2	Facil 6.2	0.632	***	< 0.001	0.611	0.652
Prof 1.3	Prof 1.4	0.631	***	< 0.001	0.610	0.652
Res 2.2	Teach 3.1	0.631	***	< 0.001	0.609	0.651
Res 2.3	Res 2.4	0.631	***	< 0.001	0.610	0.651
Teach 3.3	Empow 5.1	0.631	***	< 0.001	0.610	0.652
Assess 4.1	Empow 5.1	0.631	***	< 0.001	0.610	0.651
Assess 4.3	Empow 5.4	0.631	***	< 0.001	0.610	0.652

Annex 3

Descriptive Statistics

TABLE C1 | Descriptive statistics for all 32 self-reflection items.

	Prof 1.1	Prof 1.2	Prof 1.3	Prof 1.4	Prof 1.5	Prof 1.6	Prof 1.7	Prof 1.8	Prof 1.9	Res 2.1	Res 2.2	Res 2.3	Res 2.4	Res 2.5	Teach 3.1	Teach 3.2	Teach 3.3	Teach 3.4	Teach 3.5	Assess 4.1	Assess 4.2	Assess 4.3	Empow 5.1	Empow 5.2	Empow 5.3	Empow 5.4	Facil 6.1	Facil 6.2	Facil 6.3	Facil 6.4	Facil 6.5	Facil 6.6
Valid	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218	3218
Mean	3.449	2.659	3.183	3.089	2.361	2.915	3.220	2.761	1.821	3.321	2.907	2.573	2.506	2.306	2.850	2.763	2.736	2.451	1.785	2.659	2.413	2.402	2.626	2.299	2.298	3.097	2.200	2.661	2.499	2.316	2.209	2.132
Median	3.000	3.000	3.000	3.000	2.000	3.000	3.000	3.000	2.000	3.000	3.000	3.000	2.000	2.000	3.000	3.000	3.000	2.000	1.000	3.000	2.000	2.000	2.000	2.000	2.000	3.000	2.000	3.000	2.000	2.000	2.000	2.000
Std. dev.	1.248	1.458	1.093	1.245	1.477	1.284	1.171	1.209	1.467	1.135	1.190	1.439	1.293	1.241	1.251	1.287	1.374	1.458	1.413	1.253	1.292	1.386	1.445	1.364	1.435	1.326	1.167	1.213	1.145	1.374	1.413	1.364
Skewness	0.154	0.262	0.034	0.208	0.519	0.139	−0.08	0.406	0.784	0.027	0.230	0.253	0.719	0.662	0.355	0.476	0.447	0.457	0.922	0.403	0.600	0.381	0.376	0.767	0.676	0.300	0.737	0.659	0.755	0.763	0.741	0.736
Kurtosis	−0.25	−0.78	0.483	−0.19	−0.46	−0.46	−0.21	0.006	0.272	0.169	0.141	−0.80	0.245	0.398	−0.25	−0.17	−0.44	−0.70	0.096	−0.058	0.009	−0.438	−0.870	−0.019	−0.524	−0.379	0.780	0.173	0.659	0.150	−0.052	0.363
Shapiro–Wilk	0.932	0.925	0.907	0.938	0.904	0.930	0.918	0.925	0.898	0.924	0.902	0.931	0.905	0.887	0.929	0.926	0.926	0.911	0.852	0.931	0.918	0.926	0.911	0.895	0.875	0.924	0.903	0.899	0.895	0.902	0.888	0.909
p Shapiro–Wilk	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001