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Teachers' E-Assessment Competences and Practices in the Context of the Digitalization of Secondary Education

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Abstract

E-assessment is a key component of contemporary teaching and learning. This study examines teachers' e-assessment competences and practices in Bulgarian secondary education. It applies an embedded mixed-methods design combining quantitative self-assessment data from adapted Bulgarian versions of SELFIE for Teachers and SELFIE for Schools tools together with qualitative evidence from semi-structured interviews. Using a nationally representative selection of 30 schools, quantitative data was collected from 574 teachers related to their e-assessment competences and from 655 teachers on institutional e-assessment practices, which was complemented by interviews with 220 teachers. Teachers' self-assessed competences were found to be largely at the lower levels of awareness and limited implementation, rather than systematic use, with few teachers reporting advanced competence. Although institutional support for e-assessment is perceived as strong, this is not reflected in pedagogic practice. The interview data shows teachers' conceptual ambiguities, with formative e-assessment implemented in fragmented ways and rarely explicitly recognised. Innovative approaches, such as peer assessment, self-assessment, and the systematic use of digital evidence to inform instruction, are rarely used. The study reveals a misalignment between teachers' perceived competences, institutional conditions, and actual practice, highlighting the need for targeted professional development and clearer conceptual framing to support the meaningful integration of e-assessment.

Keywords: e-assessment; teacher competences; secondary education; DigCompEdu; SELFIE for Teachers

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1. Theoretical Frameworks of the Study

1.1. E-Assessment: Nature and Characteristics

The evolution of the idea of using technology in assessment has progressed from the early understanding of Computer-Assisted Assessment, where computers support various stages of preparation and implementation, through the use of Online Assessment, to the concept of an end-to-end assessment process. The broader definition of e-assessment as one that "covers a range of activities in which digital technologies are used in assessment" (JISC, 2007, p. 7) is particularly appealing from a research perspective, as it allows for the inclusion of diverse assessment-related activities mediated by different technologies under the common term electronic assessment. This is particularly important given the constant renewal of learning and assessment paradigms, as well as the digital technologies used in this context. However, there has also been a trend toward narrowing the scope

of the concept, defining it more strictly as an approach in which "the design, test implementation, recording the response and providing the feedback are all completed using ICT" (Alruwais et al., 2018, p. 34). The problem with such a definition lies in the potential exclusion of e-assessment practices that do not encompass all the activities listed or that involve digital technologies only at certain stages of the assessment process. In the present study we use the terms e-assessment and digital assessment as synonyms, and we adopt the broader definition of e-assessment, namely that it "covers a range of activities in which digital technologies are used in assessment" (JISC, 2007, p. 7).

From the perspective of the conceptual framework used in this article, it is essential to clarify the concepts of formative and summative assessment. Both concepts have been the subject of extensive theoretical debate and diverse interpretations. For the analysis of qualitative data in the present study, it is crucial to specify how each of these terms is understood. While summative assessment, understood as the evaluation judgement of learning achievements at the end of an instructional process, tends to be relatively unambiguous among both researchers and practitioners, formative assessment continues to provoke discussion.

Based on a meta-analysis, Børte et al. (2023) conclude that the most widely accepted interpretations of formative e-assessment build upon the definition proposed by Black and Wiliam (2009, p. 7): "Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited".

Such practices unfold through "moments" that, according to Black and Wiliam (2009, p. 8), include real-time corrections by teachers during individual instruction or whole-class discussion, assessment and use of evidence obtained from homework, students' own summaries made at the end of the lesson, etc. This understanding aligns with Pellegrino et al.'s interpretation of assessment as "a process of reasoning from evidence" (National Research Council, 2001, p. 42) and fits within the broader concept of alignment between content, learning technologies, and assessment.

Building on this idea, in their systematic review of research on teachers' technology use in formative assessment practices in primary and secondary education, Børte et al. (2023) conclude that analysing student data, generating automated feedback or recommending feedback to be provided either by the digital tool itself or by the teacher, developing assessment portfolios, and visualising learning behaviour and processes for learners or teachers all contribute to enhanced personalisation of learning, greater student engagement, and improved self-assessment.

1.2. E-Assessment from a Research Perspective

Based on an analysis of existing studies, it can be argued that the key challenges surrounding e-assessment as a phenomenon, as discussed in the academic literature, can be summarised into three main groups: at the theoretical and conceptual level, the definition and operationalisation of key terms; at the technological level, the pedagogical relevance of software in the context of e-assessment and the accessibility of technological infrastructure; and at the teacher readiness level, teachers' preparedness, attitudes, and perceptions regarding the implementation of e-assessment.

At the theoretical and conceptual level, the systematic review carried out by Børte et al. (2023) shows that most studies on formative assessment are grounded in the classical definition by Black and Wiliam (1998, 2009), which has been reinterpreted in a digital context. According to Black and Wiliam (2009, p. 9), formative interaction is defined as an "interac-

tion between external stimulus and feedback, and internal production by the individual learner." Following the analyses of Assessment to Assist Learning (National Research Council, 2001), another highly influential and related concept emerged—Assessment for Learning, described as "a process in which teachers and students collect and use evidence from assessment to improve subsequent teaching, learning, and assessment activities" (Chen et al., 2025, p. 1).

This diversity of interpretations has led to the reproduction of long-standing questions in new contexts: to what extent these definitions blur the line between assessment and feedback; whether they are conceptualised as distinct or interchangeable constructs; and whether they can, in fact, be operationalised (Børte et al., 2023). Furthermore, studies often appear with unclear or debatable theoretical foundations, raising doubts about the significance and comparability of their findings. This occurs despite the general consensus regarding the positive impact of formative e-assessment on personalisation, self-regulated learning, and identification of misconceptions, among other learning benefits (Børte et al., 2023; Hagos & Andargie, 2022).

At the technological level, although it is often claimed that there is substantial technological support for the implementation of formative assessment, research indicates a number of persistent challenges. These are related both to overcoming technological inequalities and to the need for software solutions that are pedagogically, and not merely technologically, sound (Pordanjani & Salehi, 2025; Børte et al., 2023; Ridgway et al., 2004).

At the teacher readiness level, a key factor for the pedagogically competent integration of digital technologies in education—and specifically for the effective implementation of e-assessment—is teachers' preparedness to apply it in their teaching practice. Studies show that teachers often demonstrate insufficient digital literacy and limited assessment literacy (Børte et al., 2023; Kapsalis et al., 2019). They tend to substitute or adapt technologies to their existing traditional practices rather than exploiting their transformative potential (Børte et al., 2023); frequently use them in conventional ways that do not realise their innovative capacity (Børte et al., 2023; Looney, 2019; Ridgway et al., 2004); and often lack access to high-quality professional development (Peytcheva-Forsyth & Mizova, 2025).

It is widely recognised that quality training and professional qualification could enhance teachers' use of digital tools (Tuparova et al., 2014). Moreover, perceived behavioural control (including confidence and self-assessed competence) and intentions have been identified as strong predictors of the actual use of e-assessment (Zhan et al., 2024). This highlights the need for in-depth and targeted research into the relationship between experience, self-assessed competences, and actual behaviour. In this respect, the study by Sarıgoz (2023) is particularly insightful, as it examines real e-assessment practices through the lens of teachers' self-assessed competence, their articulated experiences (including both advantages and limitations), and above all, its practical applicability, considering the availability of adequate infrastructure and equal access to technology for all students.

A valuable instrument for examining teachers' self-assessment of digital competence is SELFIE for Teachers, a standardised European survey tool based on the European Framework for the Digital Competence of Educators (DigCompEdu)[1], which includes a section on e-assessment. Research based on this instrument has produced similar conclusions across countries, pointing to the need for a coherent and targeted system of professional development of digital competences that is flexible to teachers' needs and differentiated in terms of policy planning and implementation in this field (Peytcheva-Forsyth & Mizova, 2025; Pitrella & Gulbay, 2025), though we are not aware of studies which have focussed in depth on the e-assessment element of SELFIE for Teachers.

The need for research in this area becomes even more evident against the background of reports and studies indicating a growing digitalisation of assessment practices (OECD,

2023; Backes & Cowan, 2019). In its 2023 report, the OECD acknowledges the key role of assessment in shaping educational policies and practices, while also identifying certain inconsistencies in the implementation of different digital assessment solutions. To explore the reasons behind this situation, the OECD conducted a study on the digitalisation of summative assessment across 29 countries and jurisdictions. The results show that, primarily for system-wide student evaluation, 18 of these countries have fully or partially digitalised assessments. In contrast, high-stakes examinations continue to be predominantly administered in paper-based formats.

A likely reason for these decisions lies in evidence suggesting differences in test scores between electronic and paper-based assessments, as well as the impact of digital inequality (Backes & Cowan, 2019).

Since the above-mentioned limitations are more significant in relation to summative assessment, the present study places particular emphasis on formative assessment, adhering to Black and Wiliam's (2009, p. 7) conceptualisation of its essence.

2. Methodology of the Study

2.1. Aim and Research Questions

The aim of the present study is to analyse the place and role of e-assessment in the process of the digitalisation of Bulgarian secondary education through an integrated approach that combines teachers' self-assessment, institutional practices, and verbalised pedagogical practice in the classroom.

The study is guided by the following research questions:

1. How do secondary school teachers assess their competences in e-assessment?.
2. How do secondary school teachers verbalise and describe their experience with e-assessment?
3. To what extent, and what is the nature of the alignment between teachers' self-assessed digital competences and their declared practices and experiences in e-assessment?

2.2. Research Design

This study is part of a larger study looking at digital education in Bulgarian schools and focuses only on the analysis of data related to e-assessment that arose from that study.

The study follows an Embedded Mixed Methods Design (Creswell & Plano Clark, 2011), in which the qualitative phase (QUAL) is embedded within a primarily quantitative (QUAN) research framework, with priority given to the quantitative component. The quantitative element of the study consists of data from two surveys (SELFIE for Schools and SELFIE for Teachers) completed by teachers in a nationally representative sample of schools, which provides an overall picture of the level of implementation of e-assessment. The qualitative data is based on interviews with teachers from these same schools which helps to triangulate the quantitative results, and also to contextualise the quantitative results, providing analytical depth for understanding complex pedagogical practices in area of e-assessment.

The procedure was sequential: quantitative data were collected between September and November 2024, followed by interviews conducted between December 2024 and February 2025.

2.3. Sample and Data Collection

The quantitative phase was conducted in 30 schools, selected through a stratified cluster sampling approach from among 359 secondary schools nationwide, ensuring the national representativeness of the sample. This sample constitutes an analytical microsam-

ple derived from a nationally representative one, following a rigorous methodological logic and design (see Table 1).

Table 1. Logic of construction and correspondence between the nationally representative sample and the analytical sample.

Characteristic	Nationally Representative Sample	Analytical (Micro) Sample for the Mixed-Methods Study
General Population	All general education schools (Grades I–XII, full-time, excluding vocational schools and special education centres)—N = 1967	Purposefully selected 30 schools—a subset of the national sample
Sampling Stages	Two-stage stratified cluster sampling (PPS)	Stratification based on key criteria; purposive selection ensuring maximum variability
Stage 1: Stratification	Administrative region (NUTS 3)—28 regions	Region (NUTS 2 + Sofia city; total 7)
	Type of settlement (village, town, regional city)	Type of settlement (urban/rural)
	Type of school (primary, lower secondary, upper secondary, specialised schools, others)	Type of school (primary/lower secondary/other; specialised high schools)
	School size (small: up to 100 students; medium: 101–300; large: over 300)	School size (small, medium, large)
Stage 2: Selection	Random selection of schools within strata using PPS (proportional to size)	Balanced selection ensuring representation by region, settlement type, and school size—10 schools from each size category
Sample Size	359 schools (n = 349 principals, n = 2190 teachers)	30 schools (microsample embedded in the previous one)
Internal Selection/Quotas	43% rural, 23% urban, and 34% regional centres.	The sample was balanced by school size, region, type of settlement, and school level; each school functioned as a cluster including selected teacher respondents.
	57% lower secondary schools, 25% upper secondary schools, 6% primary schools, 6% vocational high schools, and 6% other types.	
	35% small, 30% medium, and 35% large schools.	
Internal Selection/Quotas	Not applicable	Proportional model
		Quotas by school size relative to the number of teachers
		Quotas by subject areas (primary education, Bulgarian language and literature, foreign languages, mathematics, ICT, social sciences, natural sciences) with a planned minimum number of participants
Level of Study	Management and teachers (leaders + targeted teachers)	Management: interview with the school leadership in each school
		Teachers: quota-based selection by subject area, educational stage, and number of teachers
Purpose/Aim	National external validity, monitoring, policies	National external validity, monitoring, policies
Type of Analysis	Quantitative	Mixed (quantitative and qualitative, including observations/interviews)

In each of the 30 schools included in the analytical microsample, online versions of the instruments adapted for the Bulgarian context were distributed for completion. The response rates were as follows:

- For the Bulgarian version of SELFIE for Teachers—74% of all teachers (n = 574);
- For the adapted SELFIE for Schools—84% of all teachers (n = 655).

Within **the qualitative phase**, interviews were conducted with teachers from the same analytical microsample of 30 schools. The qualitative subsample was constructed through precise alignment of stratification criteria to ensure maximum diversity and representativeness across qualitative dimensions. Each of the 30 schools was treated as an independent cluster, within which teachers were selected according to strict quota criteria.

The first stratification criterion was school size (determined by the number of teachers), ensuring proportional representation of institutions of different sizes. The minimum number of respondents in each category was as follows: very small schools—at least 5 teachers; small schools—7 teachers; medium schools—9 teachers; large schools—12 teachers; very large schools—15 teachers. This structure provided sufficient analytical density for each group and allowed comparisons not only between individual schools but also across categories defined by staff size.

The second stratification criterion was subject area/pedagogical profile. For each school, a minimum number of participants was planned within each major subject area to ensure balanced coverage across disciplines: Primary education (45), Bulgarian language and literature (30), Foreign languages (26), Mathematics (31), ICT/IT (30), Social sciences (32), Natural sciences (30). This systematic quota distribution ensured a transdisciplinary perspective, valid for interpretation and extrapolation across groups of teachers and schools. The initially planned teacher sample was n = 224, with the actual realisation rate reaching 98% (n = 220). The purposeful quota sampling combined all these stratification parameters, making the microsample both highly relevant and analytically flexible for qualitative analysis. The established structure allowed for an in-depth exploration of motivations, pedagogical practices, attitudes, and internal dynamics—both within individual schools and across different teacher profiles. In this way, the microsample functioned as an embedded analytical field, maintaining its connection with the nationally representative dataset while providing the depth and contextualisation necessary for embedded case analysis. The specific teachers selected for interviews were nominated by school management based on subject area, educational stage, and planned number of respondents, with the instruction to include teachers experienced in integrating digital technologies into classroom practice. In each school, a coordinator (usually a deputy principal or ICT coordinator) carried out the nomination, while the research team verified balance in terms of teaching experience and subject distribution, requesting additional candidates when needed. Systematic balancing across multiple demographic variables was limited, particularly in the 10 very small schools with teacher teams of only 8–10 members. The refusal rate was minimal, at approximately 2%.

2.4. Research Instruments

For the quantitative phase of the study, two instruments were used:

- SELFIE for Teachers questionnaire—an adapted version for the Bulgarian context of the SELFIE for Teachers questionnaire (Economou, 2023), developed by the European Commission as part of its initiatives for the digital transformation of education. The adaptation and approbation process followed all required methodological steps to ensure compatibility with the specific Bulgarian cultural and educational context—including forward and backward translation by two independent translators, iterative expert consultations with the research team, and reliability checks. The instrument

was modified into a questionnaire measuring teachers' self-assessment of digital competences according to the main domains of the DigCompEdu framework. In this study, only data from the "Assessment" subscale were used, this subscale represents one of the six core domains of the instrument and describes how teachers use digital technologies to plan and conduct assessment, collect and analyse learning data, provide timely feedback, and adapt teaching to learners' needs. The subscale demonstrated high internal consistency (3 items, Cronbach's Alpha = 0.870). This instrument was used in addressing RQ1 through an analysis of self-assessment related to e-assessment. This instrument also contributed to addressing RQ3 through an integrative analysis of data from all three instruments.

- SELFIE for Schools questionnaire—an adapted Bulgarian version of the SELFIE questionnaire (Self-reflection on Effective Learning by Fostering the Use of Innovative Educational Technologies, 2018–2019), developed by the European Commission for the institutional self-assessment of digital transformation in school environments, which is based on the DigCompOrg framework (European Commission—Joint Research Centre, 2018). To examine teachers' perspectives on digitalisation processes and the achievement of digital maturity within school organisations, the module with indicators for teaching staff (teachers from various educational stages) was used. The instrument comprises six key areas: leadership, infrastructure and equipment, continuing professional development, teaching and learning (including digital pedagogical competences), assessment practices, and students' digital competence. Each set of questions within these domains includes closed-ended items using a five-point Likert scale to express agreement, along with a "not applicable" option to ensure relevance across diverse educational contexts. The adaptation for the Bulgarian context preserved the original structure and wording, ensuring functional equivalence and comparability of the empirical data. This instrument was used to address RQ2 drawing on data from the "Assessment Practices" subscale of the adapted Bulgarian version (7 items, Cronbach's Alpha = 0.913), The results on this scale serve as indicators of whether, at the school level, digital assessment practices are systematically supported (through policies and procedures, available tools and platforms, professional development, exchange of good practices, and use of data for improvement) or are neglected and left to individual decisions. This instrument also contributed to addressing RQ3 through an integrative analysis of data from all three instruments.

For the qualitative phase, a semi-structured interview protocol was used. The interview questions for teachers were organised thematically into several main sections, covering the entire spectrum of digitalisation in the learning process—from the institutional context to specific classroom practices and visions for the future. Each thematic block included sub-questions designed to reveal both personal experiences and professional attitudes, needs, and examples from practice. The key domains of the interview included the following:

1. Integration of technologies in school: We explored access to digital resources, involvement of students and parents, institutional support, and attitudes towards digitalisation.
2. Experience in using digital technologies: We gathered information on sources and perceived usefulness of initial and continuing training, needs for further qualification, the role of professional communities, and support from school leadership and colleagues.
3. Role of technologies in teaching and learning: We addressed perceptions of the benefits and limits of technology use, its contribution to learning across subject areas, and the distribution of responsibilities for developing students' digital skills.
4. Integration of technologies in the classroom: This was the most extensive and practice-oriented section, including questions on purposes of technology use, types of digital

resources, adaptation and creation of digital learning content, work with specific student groups, and support for digital literacy.

The topic of e-assessment was explicitly incorporated into the fourth section, with questions designed to explore both the frequency and variety of electronic tools and approaches (tests, feedback platforms, digital portfolios, etc.) used for the assessment and tracking of students' individual and group progress. Aspects related to e-assessment also included questions on the use of electronic resources and platforms, task differentiation through technological means, feedback provision, and monitoring of students' progress and achievement—both in face-to-face and online learning contexts. Additional questions on preparedness for working with special groups and the role of technologies in adapted assessment further illuminated specific applications of e-assessment in diverse educational settings.

The interviews were conducted between December 2024 and February 2025 by 25 specially trained interviewers in an online environment (Zoom, BigBlueButton, Vedamo). Prior to each interview, participants were informed about the aims of the study, the procedure, and the main thematic areas covered in the interview. With the participants' consent, the conversations were recorded and transcribed using the HappyScribe platform (https://www.happyscribe.com/ accessed on 1 March 2026). The downloaded transcripts were subsequently reviewed and verified by the interviewers.

The use of this instrument contributed to addressing RQ2 through providing in-depth descriptions of specific experiences, challenges, digital strategies, and tools used for assessment. This instrument also contributed to addressing RQ3 through an integrative analysis of data from all three instruments.

2.5. Data Processing and Analysis

The quantitative data from the surveys were processed and analysed using SPSS version 23 software. The quantitative data were analysed using descriptive and comparative statistics, including the calculation of means, mode, standard deviation, and internal consistency of the scales.

Qualitative data were processed through thematic coding within the following analytical categories:

- Context of e-assessment implementation;
- Subject of assessment;
- Assessment strategies;
- Technologies and tools supporting e-assessment.

Overall, the procedure followed a deductive coding approach—the coding scheme was developed on the basis of theoretical assumptions and key elements identified in the academic literature on e-assessment. This approach enabled the comparison of empirical data with established conceptual frameworks. At the same time, inductive elements were applied—allowing for the emergence of new categories during analysis when data revealed unexpected themes or nuances (Saldaña, 2021; Corbin & Strauss, 2014).

2.6. Coding and Data Integration Procedures

The QDA Miner software version 2025.0.4 was used for the coding and processing of the qualitative data. The procedure followed several systematic stages:

- A coding scheme was created, based on the research objectives and the current body of literature.
- Systematic coding was applied to all interview transcripts, with text fragments labelled using appropriate codes according to their content.

- The coding and analysis of qualitative data were carried out in accordance with recognised research practices in the social sciences, aiming to minimise subjectivity and ensure reliability of results. To this end, pilot coding was conducted on 20 interviews to finalise and optimise the coding scheme. Each category was discussed in advance by two independent researchers, defined and recorded in the codebook to achieve clarity and internal consistency in coding (Corbin & Strauss, 2014). During the analysis, the main coder kept analytical memos documenting coding decisions, doubts, and clarifications (Creswell & Poth, 2016). These memos were subsequently discussed and debriefed by an external expert independent of the research team.
- QDA Miner was used not only for systematic coding but also for frequency extraction, visualisation of relationships, and co-occurrence searches between codes, which supported the validation and further objectification of analytical conclusions.

The final analytical stage integrated quantitative and qualitative results to identify alignments and discrepancies between self-assessed competences and declared practices (RQ3). Integration was achieved through several techniques: (a) Comparative distribution analysis—quantitative profiles derived from the scales of the two SELFIE instruments (SELFIE for Teachers and SELFIE for Schools) were compared with the frequency and nature of practices described in the interviews; (b) Cross-thematic analysis—qualitative codes referring to specific practices (e.g., e-tests, formative assessment) were related to quantitative self-assessments in the corresponding components; and (c) Co-occurrence analysis—using QDA Miner, the co-occurrence of themes across interviews was examined to identify links between institutional context and classroom practices. This integrative approach makes it possible not only to identify convergences, but also to reveal systematic inconsistencies and conceptual divergences.

2.7. Ethical Aspects of the Research Procedures

In accordance with ethical standards, all participants signed a written informed consent form, which clearly explained the objectives and procedures of the study, the voluntary nature of participation, and the right to withdraw at any time without negative consequences. The consent form explicitly stated that all collected data would be processed and analysed in anonymised form, with no possibility of identifying individual participants. It was also clearly indicated that the results may be used for the purposes of scientific publications, reports to the Ministry of Education and Science, and other analytical, expert, and academic materials aimed at improving educational practice, in full compliance with the principles of data protection and confidentiality.

3. Analysis of the Research Results

The results of the study are presented in accordance with the three research questions. First, the analysis focuses on teachers' self-assessment of their digital competences in the area of assessment (RQ1); next, it examines the institutional context and teachers' verbalised experiences with e-assessment (RQ2); and finally, it presents the integrative analysis of the alignments and discrepancies between self-assessment and practice (RQ3).

3.1. Self-Assessment of Digital Competences for E-Assessment (RQ1)

The answer to the first research question (RQ1), concerning how teachers from the analytical sample assess their digital competences related to assessment in teaching and learning, is based on data from the "Assessment" subscale of the SELFIE for Teachers tool.

The conceptual foundation of this domain lies in the understanding that digital tools both support established practices and open opportunities for new ones by facilitating data collection, student engagement, and reflection for teaching improvement. Structurally,

the subscale comprises three components/items: assessment strategies (this component addresses the idea that digital tools can support both formative and summative assessment); evidence analysis (this component concerns the potential of digital technologies to be used for collecting and interpreting data on learning processes and outcomes); and feedback and planning (this component is related to the idea of using digital solutions to provide and receive feedback and to plan follow-up actions aimed at improving teaching and learning).

The formulations of each item are arranged in order of increasing engagement with digital assessment and student involvement in the process, while self-assessment for each component is carried out using a scale based on the six-level (progressive/taxonomic) DigCompEdu model (see Table 2). In the Bulgarian version, based on SELFIE for Teachers, an additional category "Not applicable to me" was included (e.g., due to subject area, educational stage, or school context).

Table 2. Progressive self-assessment scale of digital pedagogical competence used in the SELFIE for Teachers instrument.

Level	Label	Description
A1	NEWCOMER	I am aware, I understand
A2	EXPLORER	I have tried, I have experimented
B1	INTEGRATOR	I use, I apply
B2	EXPERT	I analyse, I modify
C1	LEADER	I support, I lead, I engage, I motivate
C2	PIONEER	I initiate, I contribute

The descriptive and frequency analyses by competence levels within this domain were conducted on valid responses across the gradient of the scale (A1–C2), while the option "Not applicable to me" was calculated and reported as a separate (relative) share, respectively, as a distinct point in the analysis.

The descriptive analysis of teachers' responses to the items within the domain (see Table 3) shows that the mean values range from 1.75 to 2.01 (on a scale from 1 to 6), with the mode for all components/items being A1 (Level 1). This indicates that the most frequent self-assessed level is the basic level, associated with an understanding of the role of digital technologies in assessment. The standard deviations (1.13–1.16) reveal a distribution characterised by a clear concentration in the lower levels (A1–A2), alongside heterogeneity across the remaining competence levels.

Table 3. Descriptive indicators for the three components of the "Assessment" scale (excluding "Not applicable to me" responses from the total sample N = 574).

	Mean	Mode	Median	SD	Responses Excluding "Not Applicable"
Technologies in the implementation of different assessment strategies	2.01	1	2	1.16	540
The Analysis of evidence	1.83	1	1	1.13	542
Digital tools for feedback and planning	1.75	1	1	1.13	529
Assessment-scale—mean scores	1.86	1	1	1.14	1611

The analysis of the three components of the "Assessment" scale, based on the descriptive indicators, outlines a certain hierarchy: the aspect related to the use of technologies for implementing different assessment strategies shows the highest mean values. Against this background, the components "Evidence analysis" and "Digital feedback and planning" demonstrate lower results.

The frequency distribution across the different levels of the progressive competence scale (see Table 4) shows that most teachers self-assess at the initial levels (A1 and A2), which indicates a basic awareness and application of digital technologies in assessment. The intermediate level (B1) includes about one-fifth of participants, serving as an indicator of functional proficiency and independence in using digital tools for assessment purposes. The highest levels (B2, C1, C2) are represented by a small percentage, suggesting that only a limited number of teachers have reached an advanced or expert–leadership level in applying digital technologies within assessment processes.

Table 4. Percentage distribution of self-assessments by levels for the three components based on valid responses in the sample (n = 574).

Level	Technologies in the Implementation of Different Assessment Strategies	The Analysis of Evidence	Digital Tools for Feedback and Planning	Average Percentage
A1	45%	55%	62%	54%
A2	23%	21%	15%	19%
B1	22%	16%	16%	18%
B2	6%	5%	4%	5%
C1	2%	2%	3%	2%
C2	2%	1%	1%	1%
"Not applicable"	6%	6%	8%	6%

The comparative analysis of the individual components of the "Assessment" scale reveals several noteworthy findings. The component "Technologies in the implementation of different assessment strategies" stands out with the most favourable distribution across levels of digital competence compared to the other aspects analysed. 45% of teachers self-assess at the basic level (A1), indicating an understanding of the role of digital technologies in assessment, while 55% report a level of A2 or higher (A2–C2). The share of teachers who regularly apply digital technologies for formative and summative assessment (B1–C2) reaches 32%, while those demonstrating expert and leadership competences (B2–C2) constitute 9%[2].

The component "Evidence analysis" shows a stronger shift in self-assessments towards the lower levels. 55% of respondents rate their competence at the basic understanding level (A1), and 45% report A2 or higher, with only 25% indicating regular integration of digital tools for evidence analysis (B1–C2). The proportion of teachers at expert and leadership levels (B2–C2) is 9%.

Regarding the "Digital tools for feedback and planning" aspect, the results show an aggregation of self-assessments at the lowest competence levels. A total of 62% of teachers are positioned at the basic level (A1), indicating awareness of the potential of digital tools for providing feedback and planning improvements in teaching and learning, while 38% report a level of A2 or higher. Regular functional application (B1–C2) is reported by 24% of respondents, whereas expert and leadership competences (B2–C2) are the least represented, accounting for 8%, the lowest share across all components.

The percentage of teachers selecting "Not applicable to me" varies from 6% to 8% across components. This highlights the importance, in self-assessment studies of digital competences, of considering contextual factors such as subject area, educational stage, and the school's technological infrastructure. These low-to-moderate proportions indicate the presence of a distinct but not dominant group of teachers for whom the examined competence is not an integral part of their professional context.

The analysis of descriptive indicators and frequency distributions across competence levels in the three components of the "Assessment" scale reveals several key trends in teachers' self-assessments within the analytical sample:

- In all three components, the mode is A1, with percentages ranging from 45% for assessment strategies to 62% for feedback and planning. This indicates that the majority of teachers (aggregated mean of 54% across the entire scale) declare awareness and understanding of the potential of digital technologies, but not necessarily their practical application.
- The data show a clear hierarchy among competence levels across the three aspects: assessment strategies lead with the highest proportion at advanced levels (A2–C2: 55%), followed by analysis of evidence (A2–C2: 45%) and feedback and planning (A2–C2: 38%).
- Expert and leadership competences remain limited, with B2–C2 levels consistently below 10% across all components. This indicates that only a small proportion of teachers perceive themselves as experts or leaders in applying digital technologies for assessment purposes.
- Although still latent, there is evident potential for growth, as the combined categories on the scale show that between 38% and 55% of teachers have moved beyond the basic awareness level (A2–C2), forming a foundation for the further development of digital competences in this domain.

3.2. Institutional Context and Verbalised Experience with E-Assessment (RQ2)

In the next two sections, the paper first describes the institutional practices of digital assessment, as shown in the responses to the "Assessment Practices" scale from the SELFIE for Schools questionnaire, and then describes the analysis of the interview responses related to e-assessment.

3.2.1. Institutional Practices of Digital Assessment

This section presents quantitative data addressing the second research question, based on the "Assessment Practices" scale from the SELFIE for Schools instrument. This domain includes seven statements that measure the frequency and diversity of integrating digital technologies into assessment processes in the school environment. Teachers provided their self-assessments for each item on a five-point Likert scale, ranging from "strongly disagree" to "strongly agree", with an additional "not applicable" option for practices that were not relevant to their specific context.

The quantitative analysis encompasses self-reports from 655 teachers drawn from the analytical sample of 30 secondary schools. This approach allows for the exploration not only of the extent of digital technology integration in assessment, but also of the specific characteristics of its implementation and the potential barriers to its application. The analysed results are interpreted through three key quantitative indicators for each practice:

1. Cumulative percentage of agreement (sum of ratings 4 "agree" and 5 "strongly agree" on the Likert scale), reflecting the proportion of teachers supporting the respective digital practice.
2. Percentage of "not applicable" responses, indicating the scope of the practice in relation to teachers' profiles or subjects taught.
3. Mean value per item, representing the average level of integration of the respective digital practice within the real school environment.

Table 5 illustrates the results for the three indicators used across all seven items within the domain related to assessment practices in the SELFIE for Schools instrument.

Table 5. Quantitative indicators (cumulative % of agreement, % "not applicable," and descriptive statistics) for teachers' self-reports (n = 655) on the "Assessment Practices" scale (with scores of 0–5).

	Cumulative % of Consent	% "NA"	Mean	Mode	SD
The management of our school supports me in using digital technologies for assessment purposes (Support from the management)	64%	10%	3.6	4	1.51
I use digital technologies to assess students' skills (Assessing students' skills)	44%	13%	3.1	3	1.52
I use digital technology to provide timely feedback to students (student feedback)	43%	15%	3.0	3	1.56
I use digital technologies to enable students to provide feedback on other students' work (peer-to-peer feedback)	26%	25%	2.4	3	1.67
Enabling students to use digital technologies to document the progress of their learning (documenting progress)	31%	26%	2.4	0	1.69
I use available digital data about individual students to improve their learning process (digital data on learning progress)	52%	12%	3.2	4	1.51
The digital competences of students acquired informally are an element of the object of assessment in my subject (assessment of digital competences acquired in an informal way)	27%	28%	2.3	0	1.70
Assessment Practices—Average Scores			2.9	3	1.30

Regarding the first aspect of the "Assessment Practices" scale in the SELFIE for Schools instrument, which concerns institutional support, a high level of agreement is observed: 64% of teachers selected the two highest points on the Likert scale, confirming that their school leadership supports them in using digital technologies for assessment purposes. The mean score for this indicator is 3.6 (on a maximum of 5), with the most frequent response (Mo) being 4. Overall, these data indicate a strong perception of institutional support, which creates favourable conditions for introducing new digitally based assessment practices.

The application of digital tools for skill assessment and for providing timely feedback to students shows mean values of 3.1 and 3.0, respectively, with agreement levels around 44% for both practices. This suggests that teachers have already developed an understanding and a moderate level of integration of digital technologies in assessment. However, the findings indicate that their routine implementation in Bulgarian schools is not yet achieved. The shares of teachers who responded "somewhat agree" (ranging between 12% and 14%) suggest some ongoing activity in these two areas, though not yet widespread, and likely dependent on local school context and specific conditions.

The use of digital data for personalising learning and supporting the learning process received agreement from 51.5% of teachers, although a relatively high 12.1% selected "not applicable." The mean score of 3.2 may be interpreted as an indicator of confidence and positive attitudes among teachers who apply this practice to individualise learning. Nevertheless, despite this positively oriented group, the practice is not yet used by the majority of teachers.

The more innovative practices, such as peer-to-peer feedback through technology, self- and technology-assisted documentation of student progress, and especially the assessment of informally acquired digital competences, are characterised by significantly lower indicators, both in terms of mean scores (2.3–2.4) and agreement percentages (26–31%). A high share of respondents who marked these practices as "not applicable" (over 25%), possible explanations might include the following:

- Lack of sustainable pedagogical and methodological competence, and professional motivation to engage students as active participants in assessment through digital tools;
- Technological and infrastructural constraints in some schools, such as insufficient devices, lack of subscriptions or purchased software, or poor internet connectivity, etc.;
- Underdeveloped skills for using analytical data and digital artefacts as instruments for individualisation and formative assessment;
- Absence of sustainable policies and practices providing guidance for the validation and formal recognition of students' informally acquired digital competences.

The aggregated data across the entire domain "Assessment Practices" from SELFIE for Schools (M = 2.9; Mo = 3; Me = 3) indicate that school communities in Bulgaria are positioned between a positive attitude and the initial moderate steps in implementing digitally based assessment practices. A discrepancy is evident between the declared institutional (school) support and the actual adoption of more complex, pedagogically aligned digital assessment approaches/practices, suggesting that for many teachers, the process remains at the stage of initial experimentation.

In conclusion, based on the analysis of quantitative self-assessment data from Bulgarian teachers in this domain, it can be summarised that digitally based assessment in Bulgarian schools is in a transitional stage. It is characterised by the presence of some established practices, but the systematic adoption of more innovative approaches has not yet occurred. More in-depth evidence to verify the trends identified through the quantitative data should be sought in the qualitative interviews with teachers, where they elaborate on their concepts and practical experiences related to digitally supported assessment approaches.

3.2.2. Verbalised Experience and Practices—Qualitative Data from Semi-Structured Teacher Interviews

A total of 220 interviews were included in the analysis. Two types of interviews were developed: one for teachers of Informatics and Information Technologies (n = 30) and another for teachers of all other subjects (n = 191). The ICT teachers' interview included several additional questions, which are not analysed in the present paper. The thematic areas of the teacher interview covered the entire spectrum of digitalisation in the learning process—from the institutional context to specific classroom practices and visions for the future. Each thematic block included sub-questions aimed at exploring both personal experiences and professional attitudes, needs, and examples from practice. Special attention was devoted to self-reports concerning existing e-assessment practices (both formative and summative), focusing on preparation and implementation, with deliberate emphasis on their advantages and limitations. During the analytical coding, an inductively generated code emerged, reflecting the perceived opportunities and constraints of e-assessment.

Context of E-Assessment

Within the interviews, three aspects/factors of the institutional context in which digitalisation processes unfold were identified as potentially influencing teachers' e-assessment practices—management strategies related to digitalisation; teacher qualification and professional development in the field of educational technologies; and the technological infrastructure of the school.

Judging by the frequency of references made by respondents, the most significant factor for the context of digitalisation appears to be teachers' qualification and training in digital educational technologies (348 references), followed by technological infrastructure (301 references) and, finally, school management support for digitalisation (135 references).

Teacher Qualification

The importance of this topic within the studied context is evident from the fact that it was discussed 345 times, significantly more than other individual themes. This frequency allows for the outlining of a relatively complete picture of teachers' descriptions and evaluations regarding the quality of their qualification and the pathways for its development.

The data reveal two groups of teachers who evaluate differently the contribution of initial teacher training and continuous professional development (CPD) to the development of their digital competences in general and their e-assessment competences in particular.

A substantial group of the interviewed teachers had completed their initial training a long time ago, and their preparation in digital technologies is mainly connected to qualification courses and self-training. Statements such as "I graduated a long time ago. We had qualification courses, but mostly self-learning" are typical for this group.

It is noteworthy that these interviewees highly value the contribution of master's programmes specialising in digital educational technologies, offered by two Bulgarian universities, to the development of their digital skills.

By contrast, younger teachers indicate that they have developed a significant part of their competence during their initial university training, which allows them to work easily with new platforms and software: "Mainly from university lecturers, indeed, I gained considerable experience using these technologies because at the university I graduated from, they were very often applied during classes."

Regarding qualification courses, the most frequently mentioned are the training provided by SmartTest (a Bulgarian platform for test development)—explicitly cited by 12 teachers—and the training organised by publishing houses, mainly Klett and Prosveta—mentioned by 7 teachers; in total, 19 respondents out of 220 referred to these.

Overall, almost all interviewees who shared their experience on this topic acknowledged that there is a constant need for further qualification, yet none of the participants expressed specific intention or a perceived need for training in the field of e-assessment. Notably, the distribution of responses on this topic does not vary significantly depending on sample characteristics such as school size, location, or subject area taught.

Technological Infrastructure

Among the 301 statements related to technological infrastructure in schools, only a small number of negative evaluations of the digitalisation process were identified—six interviewees expressed such opinions. These negative assessments come from teachers working in schools of different sizes and locations and are largely associated with their evaluation of school leadership performance. Comments about difficulties in providing internet access or technological resources (hardware and software) for all students, particularly in rural areas and small settlements, are often accompanied by descriptions of the efforts teachers make to overcome the digital inequalities caused by lack of access. One teacher shared that this is not always possible without individual laptops for children who do not own devices.

The summarised results related to the level of technological provision in schools indicate that teachers perceive a significant link between their evaluation of school management and the state of the school's technological infrastructure (correlation coefficient = 0.517, link analysis Co-occurrence). A large proportion of the justifications provided by interviewees for their assessment of school management concern improvements in the technological base. According to teachers, the three main drivers for infrastructure development are: the recognised need for digitalisation in education, which has led to a shift in thinking among both managers and teachers; efforts to overcome challenges caused by the COVID-19 pandemic; and the implementation of STEM-related programmes. In this context, most

teachers share the view that the technological infrastructure is sufficiently developed to enable the use of technologies in teaching, including for e-assessment.

Management Strategies in the Field of Digitalisation

Teachers give high evaluations of the support provided by school management, both regarding the development of material infrastructure and the provision of professional qualification in the field of digitalisation and, more specifically, e-assessment. Nearly 60% of all interviewees (125 teachers) reported systematic and purposeful efforts by school leaders to respond to the challenges of digitalisation.

The results of this analysis are consistent with the percentage of respondents in the SELFIE for Schools survey concerning institutional support. The survey indicates a high level of agreement—64% of teachers confirmed that school leadership supports them in using digital technologies for assessment purposes, while only 7% expressed disagreement and 10% selected the "not applicable" option.

Teachers' interviews provide concrete examples of institutional support—ranging from regular surveys conducted by school principals to identify needs for technology and training, to direct communication practices between teachers and principals that led to effective solutions in this area. Typical responses include statements such as: "Yes, the school leadership fully supports us." Only two teachers refrained from giving an evaluation due to a recent change of school or leadership. The only exception to the overall positive trend was a low rating of leadership effectiveness expressed by a teacher from a rural secondary school, justified by insufficient material base and communication problems with the teachers.

In 18 cases, respondents specifically highlighted school management support for e-assessment. Teachers identify this support in two main directions: on the one hand, through initiatives for informing and subscribing to platforms and software products that provide tools for e-assessment, and on the other, through the organisation of training courses on how to use these platforms effectively. In the context of school management, the most frequently mentioned examples (12 references) were trainings and subscriptions to SmartTest, followed by Klett, Prosveta, Ucha.se, and Kahoot.

Based on this analysis, it can be summarised that, according to the interviewed teachers, the digitalisation context in the studied schools is shaped by the presence of strong managerial support, adequate teacher qualification, and well-developed technological infrastructure—all of which create a favourable environment for the integration of technologies in teaching and, more specifically, in e-assessment.

Aspects of E-Assessment in Their School Practice

The next two sections look at the place of e-assessment in teachers' practice, that is, what role it plays, and who actually conducts the assessment.

The Share of E-Assessment in the Overall Process of Student Evaluation

Although 68% of the interviewed teachers commented on the share of e-assessment in their overall assessment practice, due to a certain conceptual ambiguity, it is difficult to precisely determine the place of technology use within their assessment processes. For example, a primary school teacher claims that assessment is not applied with younger pupils, yet at the same time provides examples of using e-tests. In fact, according to national regulations, assessment in the primary stage (up to grade 3) is qualitative rather than quantitative and is expressed through a symbolic system of icons ("little figures"), each representing a qualitative level of achievement.

Such conceptual inconsistencies, which are not exceptional, complicate the interpretation of teachers' verbal self-reports. The co-occurrence analysis shows that 44 teachers who

described practices involving e-tests, quizzes, tasks, or projects simultaneously stated that they do not use e-assessment. Among primary school teachers, 20 respondents reported not using e-assessment. However, the qualitative analysis revealed that three of them currently use tests and quizzes, and nine had used them during the COVID-19 pandemic. Even more interesting are the findings among Bulgarian language and literature teachers. Of 18 teachers who claimed not to use e-assessment, six reported using tests, quizzes, and assignments during the pandemic, and nine still use them today for practice and preparation for external exams. This indicates that these teachers do not associate specific practices involving digital tools with the broader concept of e-assessment.

Against this background of theoretical and conceptual ambiguities, approximately 23% of the interviewed teachers explicitly stated that they use e-assessment, either exclusively or in combination with traditional (non-digital) approaches—roughly corresponding to the share of those who provided arguments in favour of its application. Meanwhile, 98 respondents (44%) reported that they do not currently use e-assessment in their practice. Most of them stated that they had experience during the pandemic but now consider e-assessment "inappropriate" or "inapplicable", primarily due to the specifics of their subject area or the age of their students (especially among primary teachers and teachers of Bulgarian language and natural sciences). It should also be noted that over 20% of interviewees did not address the topic at all.

The Subject of Assessment—Who Assesses?

The results concerning the three codes—teacher assessment, peer assessment, and self-assessment—reveal a strong attachment to classical models and traditional teacher–student roles in the assessment process. This conclusion is based on the fact that the topic was discussed 58 times, of which 44 references explicitly stated that the teacher is the sole assessor, while only 14 references emphasised self-assessment. There was no evidence of peer-assessment practices that would enable feedback exchange among students. This finding aligns with the quantitative results from the SELFIE for Schools data presented earlier, where peer-to-peer feedback practices scored among the lowest indicators (agreement rate of 26%). Only a small number of teachers are familiar with or express interest in such practices, and none of the interviewees described concrete peer-assessment examples.

Due to the specifics of different subject areas, it is noteworthy that teacher-led assessment is most widely endorsed among Informatics teachers (13 out of 30), while self-assessment is emphasised as a key pedagogical focus by Mathematics teachers (5 reported practices out of 31).

Goals and Strategies of Assessment

The interviews describe both practices for tracking students' learning progress and those focused on evaluating learning outcomes. The present analysis concentrates primarily on the available accounts related to two key strategies of digital assessment—formative and summative e-assessment.

Formative E-Assessment

Through the questions "Do you use technologies to support the assessment of students' achievements and progress? Give examples!" and "For what educational purposes do you most often use digital technologies?", the study explored the teachers' experiences and strategies related to e-assessment.

Formative assessment is often interpreted by teachers as a means of checking the current level of understanding of new content or as an opportunity for verifying/self-

verifying students' achievements, followed by feedback and analysis of typical errors with ways to overcome them.

In line with the definition proposed by Black and Wiliam (2009, p. 7), according to which "practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers to make decisions about the next steps in instruction that are likely to be better, or better founded, than the decisions they would have taken in the absence of the evidence that was elicited," the descriptions provided by 63 respondents (more than one quarter of all participants) can be classified as examples of formative e-assessment practices. A teacher from a large school explains:

> "...we often use phones during tests, or rather when we work on formative assessment and I want to measure something immediately—when we are solving our tasks, whether it's understood. Then I often use Google Forms to see the current picture."

This was the only instance in which the term "formative assessment" itself was explicitly used. In other cases, although teachers described strategies consistent with formative assessment, they did not use the term directly.

It is important to note that teachers' conceptualisations of formative assessment and its practical application vary considerably. The co-occurrence analysis shows that 23 of the 63 teachers whose practices can be classified as formative e-assessment also claimed not to use e-assessment, as discussed earlier. It is also interesting to note the teachers' expressed preference not to assign quantitative grades, but rather to analyse "what mistakes each student has made." For example, the e-test is not identified as a tool for formative or summative e-assessment but is instead described as an exercise for practising and checking students' knowledge. Some teachers have developed systems of "praise points" or pluses, which accumulate and, according to a predefined system, lead to a quantitative grade. Other examples of formative-oriented practices include game-based or competitive activities (e.g., digital crosswords or quizzes), where teachers use the results to draw conclusions about current learning progress.

According to 8 teachers (out of 220), such activities help reduce the stress associated with formal grading and serve as brainstorming and fun exercises, combined with identifying learning difficulties and providing feedback to overcome them. At the same time, almost half of all teachers clarified that while they no longer use such approaches they had applied numerous e-based practices during the COVID-19 pandemic. Their negative experiences with electronic assessment during that period appear to be a factor influencing their current reluctance to integrate technologies into assessment strategies. At present, various forms of feedback activities, games, and quizzes are popular, mainly used for reinforcement of learning, exam preparation for state matriculation tests, or as technological support in preparing classwork and tests.

Formative assessment, understood as monitoring learning progress, also emerges in teachers' accounts of using the electronic school diary introduced by the Ministry of Education, implemented in two national platforms, namely Shkolo and NEISPUO, mainly serving administrative functions. However, several of its assessment-related features are noteworthy for this study. Some of these functions can be considered implicit—for example, facilitating a large part of communication with parents, as well as the recording of grades and behavioural notes. For teachers, especially in smaller settlements, the electronic gradebook serves as a tool for assigning homework, organising individual work, consultations, recommendations, praise, and tracking statistics on student progress. Thus, a tool originally designed mainly to support administration and parent–teacher communication is now widely used by all teachers, and for some it has become a key

instrument supporting assessment practices. Moreover, as one teacher notes, parents insist that teachers record everything in the electronic gradebook—recommendations, grades, comments, and assignments.

Two additional practices described by the teachers deserve particular attention. The first involves the development of a series of practical tasks that students complete independently and then submit digitally in personal folders. Teachers assess these submissions, which allows them not only to diagnose learning gaps but also to monitor students' progress over time.

The second practice relates to the work of subject-based teacher teams (Methodical Associations). One teacher described designing digitalised tools for analysing students' entry and exit levels, along with guidelines for interpreting qualitative assessments: "Everything there is calculated as a percentage of knowledge acquired, how to draw conclusions and what measures should be planned to overcome the identified deficits."

Also noteworthy are the individual efforts of teachers to create digital assessment rubrics, to conduct face-to-face assessment of digitally developed products such as reports or presentations, and to design interactive learning resources used during in-person classes. One teacher shared that online e-tests available to teachers are often used as models upon which they either develop their own assessment tools or apply them directly in their own practice.

Although not always clearly conceptualised or verbalised by the respondents, elements of formative e-assessment are present in the practices of the studied schools. However, teachers who demonstrated such examples represent only a small proportion of the total sample. Interviewed teachers did not discuss in depth topics such as "the potential of technologies to optimise formative e-assessment" or "the potential of formative e-assessment to transform students' roles from objects to agents in assessing their own and peers' progress." The examples provided by the teachers are fragmentary and not clearly distinguished from general teaching methods.

Summative E-Assessment

Only three interviewees provided comments or examples of using technologies for summative assessment purposes. These teachers, representing three different subject areas, reported using Google Forms to design and conduct tests, classwork, and examinations. They also stated that grades for digitally developed projects are counted as mandatory term grades.

Teachers did not explicitly justify why they avoid e-assessment in summative contexts. One plausible contributing factor is that in Bulgaria, external assessments and state matriculation exams are still administered in paper format, which encourages teachers to prepare students for that mode. Another possible explanation relates to the low levels of teachers' digital professional competence in this domain, as revealed by the quantitative survey. As previously discussed, teachers' self-assessments on the item "Technologies in the implementation of different assessment strategies" were concentrated at the lower levels of expertise—A1 (awareness, understanding): 45%, A2 (tried occasionally): 23%, and B1 (using independently): 22%.

Technologies and Tools Supporting E-Assessment

Among the most frequently used tools for assessment are electronic tests, with a code frequency of 239, reported by more than half of the interviewed teachers (59%). It is also noteworthy that some teachers reported innovative practices involving the use of computer-based testing in their teaching. Teachers of science subjects in particular mentioned participating in projects that integrated e-testing as part of the learning process.

According to respondents, e-tests are primarily employed for formative assessment purposes. Teachers emphasised "the speed of communication", "time efficiency", opportunities for student self-assessment, and the alignment with national testing formats (used in external assessments and state exams) as key reasons for choosing this instrument. Most of the shared experiences referred to using testing platforms such as SmartTest and Google Forms, which allow for custom test creation, as well as to ready-made online tests available on Ucha.se or on the digital platforms of various textbook publishers. Teachers noted that SmartTest offers training courses and that the platform is being continuously upgraded and enriched with new functionalities.

Teachers highlighted two main limitations of the e-tests they use—the scope of learning objectives they address and the cognitive level of the tasks offered in ready-made versions across different platforms. One particularly interesting point raised by a teacher was: "Tests check knowledge and skills, mostly. But I need tasks that form knowledge, not only check it."

This statement illustrates an emerging awareness of the concept of "assessment as a learning episode", while also highlighting teachers' conceptual and technological difficulties in implementing it. A likely explanation is that many available digital testing tools still replicate traditional assessment formats, focused primarily on recall and factual knowledge, which are widely discussed among educators as a major limitation of test-based examination.

Teachers' attachment to traditional solutions may also explain the relatively low frequency of using other e-assessment tools: quizzes (15 mentions), assignments (10), projects (10), or platforms such as Khan Academy, Kahoot, Live Worksheets, etc. Furthermore, there were no references to electronic portfolios, although the paper-based portfolio was mentioned by several teachers as an actively used practice.

The findings regarding science teachers' individual practices are particularly noteworthy. Their opinions appear to be divided, as they represent both a large proportion of those who report not using e-assessment and simultaneously the largest group of teachers who do use e-tests. While the reasons behind this duality warrant a separate, more focused analysis, even at this level it is clear that, beyond subject-specific characteristics, teachers' decisions concerning e-assessment are likely shaped by a complex interplay of multiple contextual and pedagogical factors.

Arguments For and Against the Use of E-Assessment

For the majority of teachers, the advantages of e-assessment (mentioned by 45 participants) largely stem from the benefits of e-testing. Overall, these arguments align with findings reported in other studies (Alruwais et al., 2018; Peytcheva-Forsyth & Aleksieva, 2021; Sarıgoz, 2023) and can be summarised as follows:

- Faster and more effective communication of results and feedback to both students and parents (11 cases);
- Time efficiency in preparation and grading (18 cases);
- Increased engagement and enjoyment through digital assessment (7 cases);
- Visualisation of results (6 cases);
- Reduced paper use (2 cases).

In addition to these widely acknowledged benefits, several context-specific advantages were identified in this study:

- Personalisation of learning through assessment, as illustrated by one teacher's reflection:

  "For example, at the moment I am doing it with seventh-grade students who are preparing for the level exam in Bulgarian, and not with the whole class, but with

> 6, 7, 8 children who usually stay after classes to work a bit more, so they have no reason to lie to me and they know that it is important for them to see their gaps. And exactly then these electronic tests and on the nice screen, on which afterwards we look at their answers that appear in the system. It can be seen how little by little they appear, how the percentage of correct and incorrect answers changes, and afterwards we look with the students at each question one by one, analyse the knowledge, analyse the gaps. So I would say that in assessment I would rather use digital technologies selectively, not universally, not with the whole class, but with a selected group of students who want to."

- A higher level of objectivity in assessment is achieved, reducing suspicions of teacher bias: "Yes, yes, there they cannot blame the teacher."
- Higher quality of task presentation in the test through elements of visualisation and multimedia.

> "For the second year in a row, I have been an assessor for the seventh-grade matriculation exams, and we have discussed and analysed the problems that students and teachers face in the second module—again, the retelling of an unfamiliar text, in which students become acquainted with the content by listening to it twice. Before modern technologies appeared, this was done through a reader—the teacher would take on that role and read the text twice. And back then, there was a rather negative reaction from the children, who felt disadvantaged.
>
> Very often, for example, when creating tests, I use animated characters or edit images that I then include in a specific task."

The challenges related to the implementation of e-assessment and the reservations expressed by teachers in this regard were mentioned 66 times by 54 interviewees. Their objections can be summarised as follows:

- Prior negative experiences during the pandemic, associated with higher student results in e-tests compared to paper-based formats, raising doubts about the quality of the tools and the reliability of the platforms (11 respondents);
- Unsuitability of e-assessment for certain content areas (6 respondents);
- Displacement of handwriting, which hinders the development of fine motor skills and contradicts learning goals in Bulgarian language and literature (5 respondents);
- Digital inequality makes their use impossible (2 respondents);
- Issues with cheating and verification of authorship (6 respondents);
- Resistance from parents (3 respondents);
- Failure to develop skills needed for national external assessments, which are still conducted on paper (2 respondents);
- Technical infeasibility or high cost of platforms (5 respondents);
- Low level of students' digital competence (2 respondents);
- Concerns about negative health effects (2 respondents).

It is evident that, to a large extent, these concerns confirm the limitations identified in other studies (Pordanjani & Salehi, 2025, etc.), namely technical issues, problems with academic integrity, challenges related to accessibility and fairness, and inaccuracies in scoring and assessment. The only limitation not explicitly highlighted in the present study is the challenge of assessing group work—for example, in the context of collaborative projects and tasks.

The teachers' arguments are familiar and have long been discussed. It is evident that, in this context as well, the influence of subject-specific characteristics on how the opportunities and limitations of e-assessment are perceived and evaluated should be acknowledged. However, the impact of factors such as local infrastructure conditions,

the technical capabilities of platforms and software, and the long-standing issues related to preventing academic dishonesty should not be underestimated. While solutions to these problems have been actively explored in higher education, including within the Bulgarian context, they have not yet been adequately adapted or applied to the secondary education level.

The presented data allow several key conclusions to be drawn. Teachers' conceptualisations and practices related to e-assessment in Bulgarian secondary education take place in a context of declared strong institutional support, access to professional development opportunities—largely adequate to teachers' diverse needs—and generally well-evaluated school digital infrastructure. These factors together provide a sufficient foundation for the implementation of e-assessment. However, in a small number of cases, predominantly in schools located in smaller settlements, problems persist, reflecting existing digital inequalities. These are also the regions where a clear connection is observed between teachers' perceived lack of leadership support and the unsatisfactory state of technological provision.

Some of the activities related to assessment, defined in the DigCompEdu framework as "to enable learners to evaluate and interpret the results of formative, summative, self- and peer-assessments" (Punie & Redecker, 2017, p. 66), are rarely implemented in practice according to the interviewed teachers. Similar to findings from other studies (Børte et al., 2023), this research also highlights the persistent challenges in defining and operationalising assessment—formative assessment in particular. These challenges partly explain the experience-based, instrumental use of such assessment without a clear conceptual understanding of its pedagogical foundations. Although not explicitly stated, there remains a certain attachment to traditional assessment models in terms of format, purpose, and the conventional roles of teacher as evaluator and student as evaluated. Consequently, practices involving the use of technologies for purposeful self-assessment are limited, and no examples of peer assessment have been identified. This situation reflects a broader tendency, also observed in other studies, whereby technologies are adapted to existing and well-established models of assessment rather than being employed to enhance the effectiveness of current practices or to create innovative ones.

3.3. Integrative Analysis: Self-Assessment of E-Assessment Competences and Reported Practices (RQ3)

The analysis of the collected data reveals a multifaceted picture of e-assessment practices in Bulgarian secondary education by integrating quantitative self-assessments and qualitative self-reports of teachers' practices. The triangulation approach seeks to identify both consistencies and discrepancies between the two types of data collected—quantitative (teachers' self-assessments based on standardised scales) and qualitative (teachers' narratives and self-descriptions in interviews). The analysis seeks to deepen the description where the qualitative data supports the quantitative data, and also to explore areas where there are observed divergences. The conclusions emerging from this triangulation unfold along several key lines.

First, the quantitative data from SELFIE for Teachers (n = 574) demonstrate a strong accumulation of teachers' self-assessments at the initial competence levels in the domain of digital assessment. The mode is A1 across all three components of the Assessment subscale, with an aggregated average of 54% of teachers situated at this basic level. The share of respondents above A1 ranges from 38% ("Feedback and Planning") to 55% ("Assessment Strategies"), while the advanced and expert levels (B2–C2) are below 10%. These findings align with the qualitative narratives: 98 respondents (44%) explicitly stated that they currently do not use e-assessment, although many referred to prior experience during the COVID-19 period. The convergence between the two data sources (quantitative self-assessments and qualitative narratives) confirms a predominantly basic level of competence,

characterised by an awareness of the potential of e-assessment but without consistent or sustainable practical application in teaching practice.

Second, a clear conceptual inconsistency emerges regarding teachers' understanding of what constitutes e-assessment. A thematic cross-analysis between two codes: (1) use of e-tests/quizzes/tasks and (2) non-use of e-assessment—reveals a paradox: 44 teachers describe concrete practices involving digital testing, quizzes, or assignments while simultaneously claiming not to use e-assessment. Among Bulgarian language teachers, 18 declared e-assessment as inapplicable, yet 9 reported using digital tests for national exam preparation. Similarly, 20 primary school teachers denied using e-assessment, although 12 mentioned digital quizzes or tasks that they conceptualised as practice or revision, not as assessment. This terminological gap calls into question the validity of the quantitative self-assessments—teachers are likely to systematically underestimate their competencies due to a lack of conceptual clarity regarding the boundaries of the term. The widespread use of electronic gradebooks (reported by over 57% of interviewees) is another example: teachers predominantly perceive them as administrative tools, despite their inherent assessment and feedback functions, which partly explains the low mean score (1.75) on the "Digital Feedback and Planning" component.

Third, regarding the institutional context, there is strong alignment between quantitative and qualitative data. The quantitative data from SELFIE for Schools (indicate 64% agreement regarding managerial support, a finding that is corroborated by approximately 60% positive evaluations in the interviews (125 out of 221 respondents). The co-occurrence analysis reveals a relatively strong association (coefficient 0.517) between teachers' evaluations of school leadership efforts to improve infrastructure in response to pandemic-related challenges and the actual state of technological infrastructure. This level of co-occurrence in the qualitatively coded data indicates a significant overlap between the two themes. The qualitative observations provide a contextual explanation for this relationship through examples of institutional efforts to improve infrastructure and participation in programmes such as STEM, which stem from strategic management decisions. However, a notable discrepancy emerges in actual practices. While 44% of teachers report using technologies for skill assessment and 43% for timely feedback, only 25% (63 teachers) described practices consistent with formative assessment principles (Black & Wiliam, 1998, 2009). Innovative approaches show drastically lower levels in both datasets—quantitative and qualitative: peer assessment as a practice aggregates only 26% agreement in the quantitative self-assessments of teachers, while the interviews contain no concrete examples of its implementation. A similar pattern is observed in relation to "progress documentation", which gathers 31% agreement in the positive self-assessments of teachers and only sporadic qualitative self-descriptions of such practices. Moreover, electronic portfolios are not mentioned at all in the qualitative interviews.

Fourth, in light of DigCompEdu guidelines for integrating digital technologies into formative and summative assessment, the quantitative data show that 55% of teachers rate themselves above the basic level (A1) on the "Assessment Strategies" component. Nevertheless, the qualitative analysis reveals a significant deficit both in the understanding and in the application of key concepts related to formative and digital summative assessment: only one teacher explicitly uses the term "formative assessment", and clear examples of digital summative assessment are identified in only three cases. In the analysis of the tools used, 59% of teachers reported employing e-tests, including Smart Test (12 teachers), publisher platforms (7 teachers), and Kahoot. However, in all these cases, the descriptions emphasise the use of digital resources mainly for "practice," "fun," or "preparation for national assessments," rather than as an integral part of pedagogical strategies in the sense outlined by DigCompEdu. Altogether, this indicates that although self-assessed digital competence in

assessment appears relatively high, there is little evidence of genuine transformation of teaching practices through digital tools—suggesting that the deficit lies in both conceptual understanding and practical implementation of innovative assessment approaches.

Not least, a discrepancy is also observed regarding teachers' qualifications for e-assessment. While the quantitative results do not provide direct information about teachers' self-assessment of their preparation in this area, the qualitative analysis shows that only 19 out of 220 interviewees (9%) mention participation in specialised courses on e-assessment, most of which focus on developing technical skills for using specific software or platforms. In parallel, 64% of surveyed teachers report receiving institutional support from school leadership for the integration of digital technologies in assessment; however, this support most often concerns technological and infrastructural provision rather than the development of pedagogical or methodological competences. Based on this imbalance between the reported institutional support and the actual content of professional qualification, it can be concluded that even when favourable school conditions exist—such as adequate infrastructure or administrative assistance—they seldom translate into the genuine development and consolidation of teachers' e-assessment competences and practices.

In conclusion, the triangulated analysis reveals a consistent pattern across quantitative and qualitative data: teachers demonstrate basic digital competence in e-assessment and operate within supportive institutional contexts with adequate technological and administrative support. However, significant discrepancies between self-perceived competence and actual practice persist, stemming from terminological ambiguity, limited pedagogical understanding, and context-driven constraints. The data clearly indicate that digital tools are most often used for routine and administrative tasks, while formative and innovative assessment practices remain limited and are rarely integrated into teachers' everyday practice. Pedagogical preparation remains limited, as specialised courses on e-assessment are few and primarily focused on the technical mastery of specific tools and platforms that support e-assessment, rather than on its pedagogical or conceptual foundations. These trends reveal a fragmented and pedagogically underdeveloped integration of digital technologies in assessment, which limits the potential for developing more innovative and sustainable practices within the teaching and learning process.

4. Discussion and Conclusions

The findings of the study in relation to the research questions are as follows:

RQ1. *How do secondary school teachers assess their competences in e-assessment?*

The majority of teachers declare awareness and understanding of the potential of digital technologies for assessment, but not necessarily their practical application.

Of the three aspects of e-assessment competence indicated in the survey, 'assessment strategies' had the greatest numbers above the level of awareness (A2-C2), at 55%, followed by 'analysis of evidence' (45%), and the lowest was 'feedback and planning' (38%).

Only a small proportion of teachers perceive themselves as experts or leaders in applying digital technologies for assessment purposes.

There is potential for growth, as the combined categories on the scale show that between 38% and 55% of teachers have moved beyond the basic awareness level, forming a foundation for the further development of digital competences in this domain.

RQ2. *How do secondary school teachers verbalise and describe their experience with e-assessment?*

Teachers' conceptualisations and practices related to e-assessment in Bulgarian secondary education take place in a context of declared strong institutional support, access to professional development opportunities—largely adequate to teachers' diverse needs—and generally well-evaluated school digital infrastructure. These factors together provide a

sufficient foundation for the implementation of e-assessment. However, in a small number of cases, predominantly in schools located in smaller settlements, problems persist, reflecting existing digital inequalities. These are also the regions where a clear connection is observed between teachers' perceived lack of leadership support and the unsatisfactory state of technological provision.

Some of the activities related to assessment, defined in the DigCompEdu framework, such as "to enable learners to evaluate and interpret the results of formative, summative, self- and peer-assessments", are rarely implemented in practice. There were persistent challenges in defining and operationalising assessment—formative assessment in particular. These challenges partly explain the experience-based, instrumental use of such assessment without a clear conceptual understanding of its pedagogical foundations. There remains a certain attachment to traditional assessment models in terms of format, purpose, and the conventional roles of teacher as evaluator and student as evaluated. Consequently, practices involving the use of technologies for purposeful self-assessment are limited, and no examples of peer assessment have been identified.

RQ3. *To what extent, and what is the nature of the alignment between teachers' self-assessed digital competences and their declared practices and experiences in e-assessment?*

Teachers demonstrate basic digital competence in e-assessment and operate within supportive institutional contexts with adequate technological and administrative support. However, significant discrepancies between self-perceived competence and actual practice persist, stemming from terminological ambiguity, limited pedagogical understanding, and context-driven constraints. Digital tools are most often used for routine and administrative tasks, while formative and innovative assessment practices remain limited and are rarely integrated into teachers' everyday practice. Pedagogical preparation remains limited, as specialised courses on e-assessment are few and primarily focused on the technical mastery of specific tools and platforms that support e-assessment, rather than on its pedagogical or conceptual foundations. These trends reveal a fragmented and pedagogically underdeveloped integration of digital technologies in assessment, which limits the potential for developing more innovative and sustainable practices within the teaching and learning process.

We next discuss the relationship of our findings to the literature that we discussed earlier in the paper.

The level and form of implementation reflects a tendency, also observed in other studies, whereby technologies are adapted to existing and well-established models of assessment rather than being employed to enhance the effectiveness of current practices or to create innovative ones (Børte et al., 2023; Looney, 2019; Ridgway et al., 2004).

The level and form of implementation reflects a tendency, also observed in other studies, whereby technologies are adapted to existing and well-established models of assessment rather than being employed to enhance the effectiveness of current practices or to create innovative ones (Børte et al., 2023; Looney, 2019; Ridgway et al., 2004; Peytcheva-Forsyth & Aleksieva, 2021). For example, on the basis of a systematic review, Børte et al. (2023) refer to studies indicating that a substantial proportion of teachers continue to work in paper-based formats even when tasks are submitted digitally, merely "transferring" their conventional assignments into digital form without exploiting the affordances of technology, particularly with regard to feedback. Ridgway et al. (2004) describe cases in which students employ technologies to support various learning strategies, yet these tools are not integrated into assessment practices. Similarly, Looney (2019) highlights research suggesting that technologies tend to preserve and even reinforce pre-existing pedagogical approaches rather than transforming them. These conclusions are further corroborated by

Peytcheva-Forsyth and Aleksieva (2021), who observe that "most of the teachers transferred their experience and approaches to students' assessment from face-to-face to the online environment without adaptation and modification to the specifics of the latter."

For the majority of teachers, the advantages of e-assessment largely stem from the benefits of e-testing. Overall, these arguments align with findings reported in other studies (Alruwais et al., 2018; Peytcheva-Forsyth & Aleksieva, 2021; Sarıgoz, 2023). In comparative terms with other studies, we may accept the summary provided by Peytcheva-Forsyth and Aleksieva (2021) that the advantages and limitations are relatively well researched and that, overall, the results obtained here coincide with the findings reported in other studies (Alruwais et al., 2018; Sarıgoz, 2023). As a result of their analysis of the research, Alruwais et al. (2018) indicate that, among other factors, the main advantages outlined are the rapid receipt of results, the opportunities for easy feedback, and the saving of time for both learners and teachers. The data from the study by Sarıgoz (2023) again draw attention to time independence and the practicality of preparation and assessment.

The obstacles to implementation of e-assessment identified—technical issues, problems with academic integrity, challenges related to accessibility and fairness, and inaccuracies in scoring and assessment—confirm the limitations identified in other studies (Peytcheva-Forsyth & Aleksieva, 2021; Pordanjani & Salehi, 2025, Ridgway et al., 2004). In their study of students' views on e-assessment, Peytcheva-Forsyth and Aleksieva (2021) indicate that problems related to infrastructure and accessibility emerge as possible disadvantages. Pordanjani and Salehi (2025) identify ten key categories of limitations, among which the same issues are highlighted—technical reliability, academic integrity, unequal access, and others.

The persistent challenges in defining and operationalising assessment—formative assessment in particular—echoes the findings from other studies (Børte et al., 2023). The systematic review conducted by Børte et al. (2023) in this field not only makes it possible to identify substantial problems in defining the concept but also highlights the subsequent difficulties in describing and studying existing practice. In the present study, not only are the effects of these theoretical challenges on teachers' conceptualisations outlined, but they are projected onto the actual practice of electronic formative assessment.

The present study has a number of limitations that need to be taken into account in seeking to generalise from these findings. First, the data are based on self-assessment and practices self-reported by teachers (SELFIE for Teachers for competences and interviews for practices), which introduces a potential risk of bias due to social desirability. The declared practices may differ from the actual ones, as the study does not include direct classroom observations or data on the effectiveness of the described practices. Second, the cross-sectional design of the study does not allow for the tracking of changes over time. Third, the qualitative sample consists of teachers with experience in integrating technologies into their practice. While this focus is logical for exploring e-assessment, it limits the representation of perspectives from teachers who entirely avoid technology use. Fourth, systematic balancing of the sample was limited in small schools (with up to 8–10 teachers). Despite these limitations, the combination of a representative quantitative framework and in-depth qualitative data provides a balanced and comprehensive view of e-assessment within the Bulgarian educational context.

The findings of this study suggest several directions for future research that could further advance understanding of teachers' e-assessment competences in secondary education.

First, longitudinal research is needed to examine how teachers' e-assessment competences develop over time, particularly in relation to targeted professional development and sustained institutional support. Such studies could explore pathways of progression across DigCompEdu levels and identify conditions that enable movement from basic

or exploratory uses of digital assessment towards more integrated and pedagogically grounded practices.

Second, comparative research across subjects, school types, and educational systems could help to clarify how contextual and disciplinary factors influence the adoption of e-assessment. Particular attention should be given to subject cultures and assessment traditions that may constrain or enable innovative uses of digital tools.

Finally, further research is needed on teachers' capacities to interpret and pedagogically use digital assessment data, including learning analytics and AI-supported tools, as well as on the role of school leadership and organisational culture in supporting sustainable e-assessment practices.

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Notes

1 https://joint-research-centre.ec.europa.eu/digcompedu_en (accessed on 1 March 2026)

2 In some of the totals reported in this section a small rounding discrepancy of 1 arises because individual values were rounded before summation.

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