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Research Insights
Изследователски проникновения

DIGITALISATION OF SCIENCE EDUCATION AS SEEN BY BULGARIAN TEACHERS

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Abstract. This paper presents the results of a survey conducted among 39 science teachers from a nationally representative subsample of 30 schools. The research design combines qualitative and quantitative methods of data collection and analysis. A Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies (SELFIE) questionnaire for schools based on the DigCompOrg framework of the European Commission is used to explore factors influencing the integration of digital technologies (DT) in teaching, learning, and assessment, and science teachers' attitudes toward DT. Results indicate generally positive attitudes toward digitalisation and support by school management for the efficient implementation of digital technologies in science education. Teachers report frequent use of DT for lesson preparation, communication, and access to educational resources; however, technology-supported assessment practices remain underdeveloped across all school types. Results reveal a clear digital divide between teachers in rural areas and those in large regional cities, who benefit from a betterdeveloped learning environment with resources for integrating digital technologies, have greater opportunities to participate in appropriate training courses, and experience stronger support from school staff. Correlation analyses highlight that school management is a key factor influencing the quality of infrastructure, teacher training, and students' digital competencies.

Keywords: digital technologies; digitalization; science teachers; DigCompOrg; SELFIE; self-assessment

1. Introduction

One of the key competences required for successful integration into social life is digital competence – a set of knowledge, skills, and attitudes that enable the creative, confident, and critical use of information technologies and systems[1]. It is developed in schools both through specialised subjects and through the application of innovative approaches to teaching and learning. An important factor in achieving educational goals is the ability of teachers to integrate digital technologies (DT) effectively into the educational environment. This integration supports and facilitates teaching and learning processes, encourages independent work, and enhances the objectivity of assessment.

Some researchers (Bocconi et al., 2022) identify well-developed digital infrastructure and teachers' positive attitudes towards digitalisation as the main factors for the effective use of DT in schools. The degree of development of the digital environment (the digital capacity of the school) is defined as the extent to which culture, policies, infrastructure, as well as the digital competences of students, teachers, and administrative staff, support the effective integration of technologies into teaching and learning (Costa et al., 2021).

A commonly cited reason for the lack of motivation and positive attitudes towards digitalisation is teachers' insufficient computer skills, which hinder the integration of technologies into their instructional practices. Teachers should be willing to experiment, not be afraid of failure, and sometimes learn from their students (Zhang et al., 2020). Factors influencing teachers' professional preparation in terms of digital technology skills include participation in both shortand long-term training programmes rather than one-off courses (Kong et al., 2020), professional communication and peer support within the school community, and the exchange of practices among colleagues.

Various approaches exist to foster teachers' digital competences. One approach focuses on teamwork led by a teacher-leader who already has developed strong digital skills (Sherwood et al., 2021), typically a science teacher or a supervisor of a STEM laboratory. A second approach involves external educational providers who collaborate with school administrations and are tasked with teacher training. A third approach is a joint development of curricula with external providers who, together with teachers, develop teaching materials using digital resources.

An essential prerequisite for the successful digitalisation of the learning process is the preparation of students to participate in lessons involving DT. Students tend to use technologies more outside of school than in school, which suggests a digital divide in terms of their parents' financial and social opportunities (Kampylis & Sala, 2023). This results in unequal opportunities for engagement in technology-enhanced learning processes and poses challenges for teachers in selecting appropriate technologies for instruction. Researchers have noted (Fernández Miravete & Prendes Espinosa, 2022) that teachers often fail to acknowledge the digital skills students acquire in out-of-school contexts, leading to mismatches with learners' individual educational needs.

This article presents part of the findings of the large-scale research project of the Sofia University Marking Momentum for Innovation and Technological Transfer (SUMMIT), which investigates the degree of digitalisation in Bulgarian secondary schools. The aim is to examine the current state of digitalisation in science education from the teachers' viewpoint, with a vision to improve science education in schools.

The study is based on self-assessments of science teachers (physics, biology, chemistry) about their own digital skills and their views on the state of digital learning, including its technical provision. The main research questions (RQ) are:

RQ1: What are science teachers' attitudes towards the digitalisation of the educational process in secondary schools?

RQ2: To what extent does the school environment (technological and organisational infrastructure) support digital transformation, according to science teachers' perceptions?

Digital competence has become a priority in educational policy, prompting the European Commission (EC) to develop frameworks and tools designed for entire institutions. The EC's Joint Research Centre (JRC) published in 2015 a European framework for digitally-competent educational organisations (DigCompOrg) framework, a reference model for "digitally competent educational organisations".[2] DigCompOrg is intended for all levels of education – from preschool education through upper secondary (K-12) to higher education – guiding them towards the effective integration of technologies into teaching, learning, and the management of educational institutions.

The conceptual foundation of the framework lies in the understanding that the impact of DT, content, and processes extends across all educational sectors (schools, universities, as well as non-formal and self-directed learning). It affects all components of these sectors (e.g., curriculum updates, teaching and learning practices, assessment, and teachers' continuous professional development) and involves all stakeholders in the educational process (teachers, students, school leaders, etc.)[2].

The DigCompOrg framework comprises seven key elements (leadership and governance practices; teaching and learning practices; professional development; assessment practices; content and curricula; collaboration and networking; infrastructure and sector-specific practices/elements) and 15 sub-elements common to all educational sectors. It also allows for the inclusion of sectorspecific elements and sub-elements. For each of the DigCompOrg elements and sub-elements, a set of descriptors has been developed (74 in total), which are interconnected and interdependent. DigCompOrg provides a comprehensive and overarching conceptual framework that encompasses all aspects of the systematic integration of digital learning into educational organisations across all educational sectors. It can be adapted to the specific contexts in which educational organisations, intermediaries, or project designers operate (Mizova et al., 2025).

The DigCompOrg framework forms the basis of the European Union's SELFIE (Selfreflection on Effective Learning by Fostering the use of Innovative Educational technologies)[3]. This instrument provides information on how DT is changing the teaching model and what attitudes, knowledge, use, and difficulties are observed among teachers working in a digital environment.

There are a number of publications related to the use of the SELFIE tool, based on DigCompOrg. Fernández Miravete & Prendes Espinosa (2021) applied SELFIE to survey students, teachers, and school leaders in secondary schools. Similarly Athanatou & Prendes Espinosa (2023) developed a questionnaire inspired by SELFIE / DigCompOrg for preschool and secondary school teachers (up to grade 12^{th}). These studies provide quantitative results for each dimension, often complemented by focus groups or interviews to contextualise the data. Panesi et al. (2020) analysed results collected through SELFIE from 31,912 respondents from 201 primary and secondary schools to examine their views on digital infrastructure, employing all aspects of the DigCompOrg framework. Jeladze & Pata (2018) show that the data generated by the SELFIE self-reflection helps schools to better understand their progress, highlighting significant differences in digital competence levels between different schools.

A common application of DigCompOrg is to guide schools in developing a digital strategy or an improvement plan for their digital environment. For example, Fernández Miravete & Prendes Espinosa (2021) reported that their school has applied self-assessment based on DigCompOrg to create a school-wide digital strategy, including the definition of objectives and mechanisms for evaluation. Their analysis identified priority actions such as allocating time for teachers to develop digital skills, promoting digital collaborative assessment, and increasing leadership engagement. A follow-up study (2018 – 2022) by the same authors showed measurable progress in the areas targeted by the strategy. Similarly, another study combined DigCompOrg data with a decisionmaking model based on survey results to propose a cyclical action model for improving school digitalisation (Athanatou & Prendes Espinosa, 2023).

It can be argued that DigCompOrg is becoming a conceptual model that promotes systemic change applicable in any context, seeking greater digital efficiency (Đurek et al., 2017). Research also shows that scholars can use this concept for their own purposes: to focus attention on pedagogical models of DT education in schools (Fedeli, 2017), to prepare plans for implementing digital technologies in teaching,[4] to identify specific educational areas requiring improvement (Malach & Kostoloányová, 2017), and to develop models for evaluating learning (Campelj et al., 2019). Beyond the school context, Broek & Buiskool (2020) applied SELFIE in non-formal and informal learning settings, thereby highlighting the potential of the tool to be used beyond formal education.

Monitoring changes over time in digital pedagogical competences, measured within the same samples across two or more consecutive years using the same instrument, can help to identify trends and inform actions aimed at improving results in different dimensions of the measurement (Peytcheva-Forsyth & Mizova, 2025). This would help institutions develop effective strategies and policies to overcome the difficulties and negative aspects of the digitalisation of education at its various stages.

2. Method

2.1. Instruments

The research design combines qualitative and quantitative methods of data collection and analysis. The SUMMIT project included standardised teacher surveys, interviews, questionnaires, and classroom observations (Aleksieva et al., 2025). This work analyses only the results of the SELFIE survey based on the DigCompOrg framework and related to science teachers. SPSS Statistics 23 software was used for data processing.

The instrument includes 56 items (54 multiple-choice and two open-ended), organized into six areas: *Infrastructure and Equipment* (10 items), *School Management* (8 items), *Continuing Professional Development* – Part 1 (3 items) and Part 2 (8 items and 1 open-ended question), *Teaching and Learning*: Part 1 (*Teachers' Digital Competences:* 4 items and 1 open-ended question) and Part 2 (*Practices*: 6 items), *Assessment Practices* (7 items), and *Students' Digital Competence* (8 items). Each item is rated on a 5-point Likert scale (from "strongly disagree" to "strongly agree"), with a "not applicable" option (0) for maximum adaptability to different educational contexts.

The adaptation of the tool to Bulgarian conditions was carried out in accordance with the original structure and wording, ensuring functional equivalence and comparability of the empirical data collected with international studies using SELFIE. The consistency check of the 8 subscales in the tool shows high levels of internal consistency, with Cronbach's alpha coefficients ranging from $\alpha = 0.743$ to $\alpha = 0.913$. The highest reliability was demonstrated by the *Digital Competence of Students* area ($\alpha = 0.913$), followed by *Assessment Practices* ($\alpha = 0.906$). All areas show values above the acceptable threshold of 0.70, which confirms the psychometric adequacy of the instrument for use in Bulgarian educational contexts.

2.2. Sample

The total number of units in the general population is 1,967 schools. The sample size was calculated using a standard formula for proportions in a finite population with a confidence interval of 95%, a maximum acceptable sampling error of 4.6% and $p = 0.5$ (assuming maximum variability). This leads to a minimum of 359 schools, ensuring statistical representativeness. The selection of these 359 schools was made on the basis of predefined stratification criteria that reflect key characteristics of the school system. A two-stage/two-level, stratified, cluster sampling model was applied, in which each school represents a separate cluster. The first stage involves stratification according to the following four criteria: a) Administrative region – all 28 regions of the country; b) Type of settlement – village, town, regional city; c) Type of school – primary, lower secondary, specialised upper secondary, secondary, and other d) School size – small (up to 100 students), medium (101 – 300 students), and large (over 300 students).

Within the research phase of the project, to study the digitalization of Bulgarian school education through a mixed design (quantitative-qualitative methods), a subsample of 30 schools was formed. It represents a purposefully extracted subset of the already established nationally representative sample of 359 schools. This sample of 30 schools was constructed in such a way as to preserve the structural logic of the nationally representative initial sample. This allows for comparability of the results while maintaining the focus on the contextualization of the research problem, achieving research depth, and ensuring analytical flexibility.

The present study is based on data from a survey conducted with 39 science teachers who are part of a representative sample from the selected 30 schools. The selection follows a proportional model based on school size (operationalized for the qualitative research design by the number of teachers and the subject taught), so as to ensure representation in the subsample of all educational stages and subjects taught.

The questionnaire was distributed to the school coordinator, who in turn forwarded the link to the selected teachers. Data collection took place in October 2024. The distribution of the surveyed science teachers by various characteristics is presented in Table 1.

Table 1. Demographic Characteristics of Respondents (N = 39)

Gender	**Male**			**Female**	
	12.8%			87.2%	
Age, years	**< 30**	**31 – 40**	**41 – 50**	**51 – 60**	**> 60**
	2.5%	2.5%	35.9%	46%	13%
Educational level	**Bachelor**			**Master**	
	12.8%			87.2%	
School location	**Rural**	**Small town**		Large regional city	
	25.6%	15.4%		59.0%	
Teaching level	Lower secondary level	Upper secondary level		Both lower and upper secondary levels	
	46.1%	38.5%		15.4%	
Teaching experience, years	**< 10**	**11 – 20**	**21 – 30**	**> 30**	
	25.6%	7.7%	41.0%	25.6%	

The sample of 39 teachers reflects the demographic characteristics of physics, chemistry, and biology teachers in the general population: science teachers are predominantly women over the age of 50, working mainly in large cities, most of them having a master's degree. Furthermore, they are unevenly distributed across the educational stages at which they teach – lower secondary and upper secondary.

3. Results

3.1. Teachers' responses to the six questionnaire areas

Area I, *Infrastructure and Equipment*, provides information on the availability of adequate, reliable, and secure infrastructure such as equipment, software, information resources, Internet connection, technical support, or physical space.

It is a positive fact that 62% of teachers categorically state that their school has created an appropriate technological infrastructure to support the integration of DT in the process of teaching and learning. However, nearly one-third of respondents (33%) only partially agree with this statement and believe that there is still work to be done. Overall, teachers express a positive opinion about the opportunities provided by the school to use digital devices for teaching purposes (87%) and the provision of a good internet connection for teaching and learning purposes (87%), as well as good technical support in case of problems (71%). It is also positive that 67% of teachers are confident in the data protection systems used in their schools. A very large proportion of teachers (88%) report that their school provides digital devices that students can use when needed. In this area, however, attention should be paid to the responses of a relatively high percentage of teachers (51%) stating that students who need special support do not have access to specialised DT at school. A similar percentage of teachers also note the lack of online libraries with educational and teaching materials.

Area II, *School Management*, concerns teachers' beliefs on the role of school leadership in integrating DT throughout the school and their effective application in teaching and learning. The majority of teachers state that their school has developed a strategy in the field of DT, but more than a quarter (28%) respond negatively to this statement. It is also a good sign that a significant proportion of teachers are involved in the development of such a strategic document.

Most teachers in this survey area also express a positive opinion about: (a) the support provided by school management for trying out new ways of teaching supported by DT (79% strongly agree and 15% partly agree); (b) monitoring progress in teaching with the help of DT (83%); and (c) discussing the advantages and disadvantages of technologies in the process of teaching and learning (88%). Teachers also have a predominantly positive opinion about the opportunities they are given to explore teaching methods using technology (67%). However, one third (33%) state that their school does not have such practices or that this does not apply to them. The large share of teachers (around 78%) who claim that their school applies copyright and licensing rules when using DT for teaching and learning purposes is encouraging. The rest of the respondents say that this is not applicable or that there is no such practice in their school.

Area III *Continuing professional development* (*CPD*), Part I, focuses on the extent to which the school facilitates and invests in the teachers' CPD and encourages it to support the achievement of better learning outcomes through the development and integration of new teaching and learning approaches based on DT. According to the majority (78%) of teachers, the school management discusses with them the need for CPD in the field of DT, provides them with opportunities to participate in such activities, as well as in the exchange of experience within the school. The remaining teachers note that they do not receive such support or that this is not applicable to their school.

Area III *CPD*, Part II, is related to teachers' participation in various CPD activities involving DT. It is noteworthy that the majority of teachers (nearly 80%) have attended face-to-face courses, online training, webinars, and on-the-job training carried out by the information technology teacher. Participation in online professional communities, educational visits to other schools, and participation in courses and programmes for academic degrees are not noted as common practices. About 58% of teachers respond negatively to these questions. Science education is based on the collection and analysis of data from empirical research. The rapid development of DT makes it possible to visualize and conduct some of the observations and experiments using digital devices and resources. Searching for and systematising reliable and trustworthy information, processing data, presenting it in different ways: tables, diagrams, charts, various images, is particularly important for natural sciences and is part of the formation of key competences. It is expected that digitalisation will support science education and facilitate the work of both teachers and students, which in turn may lead to better achievements in science education (Manaseh, 2025; Memiş et al., 2023).

In this regard, the results in Area IV *Teaching and Learning* are interesting. Here, the items

are divided into two parts. The first part concerns teachers' digital competence. A great share of all teachers (87%) state that they search for and use digital resources, while the remaining 13% partially carry out such activities. The percentage of those who claim to create digital resources in support of their teaching work is also very high (84%). One-third of teachers respond to the statement "I use a virtual learning environment when working with students" with a completely negative response or "this is not applicable." Almost all teachers say they use DT to communicate on school-related issues.

The second part of area IV focuses on the practical application of DT in the learning process. Noteworthy are the teachers' categorical responses that they use DT to support the individualisation of learning, as well as for freely accessible educational resources. There is some variation in the teachers' responses to the remaining items. About 34% of respondents do not use technology to encourage students' creative skills, nor do not involve students in various activities based on DT.

The percentage of teachers who do not take advantage of students' skills in preparing digital learning activities is also significant – approximately 25%. However, overall, the positive responses prevail in the aspects considered. A large share of the teachers surveyed (82%) show a quite high level of confidence in using DT to prepare lessons through editing, as well as to create a variety of digital resources (presentations, images, videos), and 79% state they use a variety of devices and resources. Teachers' assessment of the role of DT in communicating with parents is extremely positive (97%).

Over 82% of teachers consider the use of available educational platforms – Ucha.se[5] Academico[6], Shkolo[7], Mozaweb[8], Microsoft Teams[9], Digital Backpack[10] etc., to be particularly useful for teaching purposes. To the question: "What percentage of teaching time have you used DT in class over the last 3 months?" 36% answered: "3/4 of teaching time", 31% – half of the lesson. Lower percentages represent the remaining answers.

Area V *Assessment Practices* refers to measures that schools can take to gradually shift the balance from traditional assessment to personalized, student-centered, DT-based assessment activities. Regular assessment of student progress and high-quality, adequate, and timely feedback are key factors in the learning process and have one of the most significant impacts on student achievement. Appropriate and meaningful feedback from teachers is a necessary element of assessment. Descriptive feedback, which includes analytical questions and constructive comments, provides students with information they can use to direct their efforts in the right direction and is much more useful to them than numerical grades. Learning in an electronic environment allows for the use of different ways of assessing and developing self-assessment skills, for example, tracking one's own progress upon completion of certain activities; using specific criteria to record the quality of their work upon completion; using expert feedback to check their work through trackers, surveys, and other tools.

In the survey, 56% of teachers stated categorically that they receive the necessary support from school management in using technology for assessment purposes, while 26% said that this support is partial It should be noted, however, that almost 18% of respondents stated that they do not receive such support. The positive responses from teachers (over 50%) in this area are related to their confidence in using technology to assess student skills, provide timely feedback, and use available student data to improve their learning process. However, the survey results also draw attention to other findings. Almost 50% of respondents consider it inapplicable in their practice or disagree with the statement "I give students the opportunity to use DT to document their learning progress." Almost the same percentage of teachers do not assess students' digital competences acquired informally.

Area VI *Digital Competence of Students* refers to the set of skills, knowledge, and attitudes that enable students to use DT confidently, creatively, and critically. Regarding the statement: "The school management ensures the development of students' digital skills in all subjects", 56% of teachers strongly agree, and 23% partially agree. However, it cannot be ignored that 21% disagree or answer that this does not apply to their school. There is consensus in the answers to all other questions in this area. Over 80% of teachers say that students at their school learn how to behave safely and responsibly in the online environment. Teachers are almost unanimous in their belief that their students are taught to check whether the internet information they have found is reliable and accurate, and to respect copyright. There is some hesitation regarding the opportunities provided to students to learn how to create digital content at school and solve technical problems when using DT: only 29% of teachers partially agree with this.

3.2. Results from the descriptive statistics of the six thematic areas of the questionnaire SELFIE

Data from the descriptive statistics for the areas described above are presented in Table 2.

Table 2. Descriptive statistics for SELFIE thematic areas

Area	Mean	Standard Deviation	Coefficient of Variance, %
I. Infrastructure and Equipment	3.50	0.77	22.0
II. School Management	3.47	1.00	28.8
III. Continuing Professional Development	3.46	0.96	27.7
IV. Teaching and Learning	3.56	0.75	21.1
V. Assessment Practices	2.95	1.38	46.8
VI. Students' Digital Competence	3.86	0.69	17.9

The highest average value is found in the *Digital Competence of Students* area, and the lowest in *Assessment Practices* (Table 2).

The largest standard deviation is in *Assessment Practices*, which, combined with the low average value, results in a very high coefficient of variation of 46.8%. This shows that there are teachers with more than average experience in assessment, but their number is not large (low average value), and most teachers do not report using digital assessment techniques in their practice.

3.3. Correlation and factor analysis

Looking for significant relationships between the six areas, the following further research questions were asked:

1. How strong is the correlation between the answers in the individual areas of the questionnaire?

2. Is there a statistically significant difference in teachers' responses depending on the settlement in which they teach?

The null hypothesis H_0 for the first additional research question states: There is no significant linear correlation between any area and any of the others. Since the variables are rankscaled (1, 2, 3, 4, 5) and the distribution is unknown, Spearman's rank-order correlation coefficient (r_s) was applied.

The strength of the correlations of each thematic area with the others is presented in Table 3.

Table 3. Correlation analysis of the six areas of the questionnaire (p < 0.01)

Area	**Nonparametric Correlations (Spearman's)**					
	I. Infrastructure and Equipment	II.School Management	III.Continuing Professional Development	IV.Teaching and Learning	V. Assessment Practices	VI. Students' Digital Competence
I. Infrastructure and Equipment		r_s = 0.877**	r_s = 0.747**	r_s = 0.462	r_s = 0.549*	r_s = 0.637*
II. School Management			r_s = 0.806**	r_s = 0.531*	r_s = 0.620*	r_s = 0.760**
III. Continuing Professional Development				r_s = 0.463	r_s = 0.531*	r_s = 0.633*
IV. Teaching and Learning					r_s = 0.837**	r_s = 0.621*
V. Assessment Practices						r_s = 0.629*
VI. Students' Digital Competence						

Notes: The symbol * indicates a significant correlation, and ** – a strong correlation.

The strongest correlation is found between *School Management*, *Infrastructure and Equipment*, and *Continuing Professional Development* areas.

It can be assumed that school management is emerging as a key factor that directly influences the creation of a digital learning environment and supports teachers in participating in professional development courses.

A strong correlation is also apparent between the *Teaching and Learning* and *Assessment Practices* areas, with the assumption that the relationship is unidirectional – teachers who use DT in their practice are more likely to integrate them into assessment.

The strong correlation between *School Management* and *Students' Digital Competence* areas is somewhat surprising. The explanation may lie in the direct strong link between school management and digital infrastructure. The following causal relationship can be assumed: good school management → good infrastructure →good students' digital literacy.

The area of *Students' digital competence* has a strong relation with *School management* and a significant correlation with all other areas. This confirms the conclusion that well-developed infrastructure, teacher training, the implementation of DT in teaching and learning, and a variety of assessment practices are prerequisites for the development of students' digital literacy. These conclusions are also confirmed by other studies on students' self-assessment of digital competences and the learning environment factor related to the development of school infrastructure: "…students' perceived learning environment has a significant effect on their self-perceived digital and sustainability competencies, both in terms of generic and profession-specific competencies." (Goropečnik et al., 2025). The correlation between the other pairs of areas is moderate.

For the second research question, the null hypothesis H_0 states: There is no statistically significant difference in the distribution of responses of the surveyed teachers based on their school settlement (village, small town, large town/city). Since the data are rank-scaled and the distribution is unknown, the nonparametric Kruskal–Wallis test for independent samples was employed (Appendix 1).

The results of the nonparametric test indicate a statistically significant difference ($p < 0.05$) in the distribution of teachers' responses between rural areas and large regional cities, as well as between small towns and large regional cities across all areas of the questionnaire, except for the V *Assessment Practices* area (Appendix 1).

There is no statistically significant difference between schools in villages and small towns across all areas of the survey. Only for area V *Assessment Practices* is there no statistically significant difference in the distribution of responses by settlement type (village, small town, large regional city). This suggests that digital technology-supported assessment in science education is the least developed, irrespective of settlement type.

4. Discussion

The findings lend themselves to a logical interpretation. Schools in large regional centres tend to have greater financial resources, which in turn predetermine better material, technical and technological infrastructure in terms of DT. At the administrative and managerial level, these schools prioritise the integration of technologies into teaching and the development of digital competencies among teachers and students. Despite national strategies and policies, schools in villages and small towns lag in the digitalisation process. Possible reasons include insufficient technological infrastructure, underqualified ICT staff, insufficient digital competence among teachers, students and parents, and shortcomings in school management.

According to the surveyed science teachers, infrastructure and equipment are key to the digitalisation of education, influencing other factors and potentially causing some schools to fall behind. When good infrastructure is already in place, teachers are motivated to use new technologies, including digital ones, which is confirmed by other studies: "This high level of engagement suggests that teachers are generally open to innovation and their practices, both in terms of pedagogical approaches and the integration of technology into the learning process." (Granda-Piñán, 2025, p. 564).

The relationship between school management and infrastructure is self-evident. The conclusion is clear: schools with better management tend to have better infrastructure. This, in turn, is also a prerequisite for the continuing professional development of teaching staff, for the application of DT in the educational environment, which influences teaching and learning methods, and for collaboration between them. Although the majority of teachers report support from school management for their participation in courses, webinars, or online conferences, there is a lack of practice exchange via online professional communities with other teachers or school visits. A substantial proportion of teachers consider this to be poorly represented or inapplicable to their school. Similar findings have been reported in other studies (Castaño Muñoz et al., 2021).

Another conclusion that can be drawn is that efforts are generally focused primarily on teaching and learning strategies and approaches, while technology-supported assessment is not a priority, which is confirmed by other studies mentioned above. This reduces the objectivity of assessment and also weakens students' opportunities to apply digital resources for monitoring and evaluating their knowledge and skills.

4.1. Limitations and future research

The reliability of the study may have been affected by the small sample size of science teachers. It is a sub-sample of a larger sample for the SUMMIT project, which involved teachers of all subjects, and reflects the characteristics of the sample selected for the purposes of this study. Another limitation is that the conclusions are based solely on the quantitative analysis of the teacher survey. However, the tool used covers various aspects of the potential of DT for developing digitally competent educational organizations. It provides information about teachers' knowledge of DT and their attitudes towards it, its use, and the difficulties in its implementation.

It should be noted that the survey is a reflection-based tool that captures teachers' attitudes and perceptions of digitalisation in education at the specific moment of the study. Responses may also be influenced by other factors not related to sustained opinion and behaviour. It is necessary to combine it with qualitative approaches that have already been carried out with the sample, but due to the amount of data, they will be reported in other articles. Similar research limitations have been noted by Goropečnik et al. (2025). The findings of the study may lead to changes in the management and teaching model. The results will be compared with those from qualitative studies accompanying the survey, such as observation and interviews with science teachers from the sample studied.

5. Conclusions and recommendations

This study largely enabled the main research questions to be answered. Regarding RQ1, respondents strongly share a positive attitude toward digitalisation and all the processes that accompany it. This conclusion is supported by the active participation of teachers in CPD and the strong support from school management in experimentation, analysis of individual progress, and partnerships with other institutions to adopt new ways of teaching and learning with the support of DT.

The survey shows that the school environment supports digital transformation in secondary schools (RQ2). The majority of teachers work in an environment with a technological infrastructure that supports teaching and learning with DT integration. Most of the schools surveyed have a clearly defined digitalisation strategy developed jointly with school administration and science teachers.

A "digital gap" between schools in terms of location (village, small town, and large regional city) was found. This leads to inequality in the development of students' digital competences in large cities and smaller settlements. Work at school, not just the informal use of computers, smartphones, and other devices, is of primary importance for the formation of students' digital skills. There is a clear need for the development of effective digitalisation strategies, especially at regional and local school level, adapted to the respective schools and learning environments to bridge the gap between DT in rural areas on the one hand and large cities on the other.

The teacher training courses mainly focus on teaching and learning. However, the DT's implementation in the assessment area was rated lowest by teachers among other areas. A longitudinal study confirms that DT-based assessment practices need improvement (Fernández Miravete & Prendes Espinosa, 2022). Therefore, it is recommended to encourage DT-based assessment CPD activities.

Educational institutions have to implement active policies on school management, as this is the determining factor for the development of all other areas, as shown by the study. DT are factors that enable significant change in learning and teaching practices, but they do not guarantee it. A sustainable and multifaceted systemic approach is needed, including investment in infrastructure and professional development for teachers, changes in curricula, rethinking the assessment of students and teachers, encouraging collaboration, and integrating all of this into an environment that provides good leadership and quality control.

Appendix 1

Test of differences between means: Kruskal – Wallis Test (df = 1)

	Village / Small town	**Village / Large regional city**	**Small town / Large regional city**
I. Infrastructure and Equipment	Chi-Square = 0.004 p = 0.951 $p > 0.05$ H_0 accepted	Chi-Square = 5.336 p=0.021 $p < 0.05$ **H_0 rejecte**d	Chi-Square = 4.180 p = 0.041 $p < 0.05$ **H_0 rejected**
II. School Management	Chi-Square = 0.060 p = 0.806 $p > 0.05$ H_0 accepted	Chi-Square = 4.754 p=0.029 $p < 0.05$ **H_0 rejected**	Chi-Square = 4.963 p = 0.035 $p < 0.05$ **H_0 rejected**
III. Continuing Professional Development	Chi-Square = 0.135 p = 0.713 $p > 0.05$ H_0 accepted	Chi-Square = 6.219 p=0.013 $p < 0.05$ **H_0 rejected**	Chi-Square = 5.317 p=0.021 $p < 0.05$ **H_0 rejected**
IV. Teaching and Learning	Chi-Square = 0.542 p = 0.462 $p > 0.05$ H_0 accepted	Chi-Square = 5.773 p=0.016 $p < 0.05$ **H_0 rejected**	Chi-Square = 7.387 p=0.007 $p < 0.05$ **H_0 rejected**
V. Assessment Practices	Chi-Square = 0.244 p = 0.621 $p > 0.05$ H_0 accepted	Chi-Square = 3.103 p = 0.078 $p > 0.05$ H_0 accepted	Chi-Square = 1.281 p = 0.258 $p > 0.05$ H_0 accepted

VI. Students' Digital Competence	Chi-Square = 0.034 p = 0.854 $p > 0.05$ H_0 accepted	Chi-Square = 5.263 p=0.022 $p < 0.05$ **H_0 rejected**	Chi-Square = 5.781 p=0.015 $p < 0.05$ **H_0 rejected**

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