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Strategies for inclusive digital education: problem/project-based learning, cooperative learning, and service learning for students with special educational needs

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Introduction: Inclusive digital education is a growing field that aims to provide equitable learning opportunities for all students, including those with special educational needs (SEN). This study investigates the effectiveness of three pedagogical methods - problem/project-based learning (PBL), cooperative learning (CL), and service learning (SL) - in promoting inclusive digital education.

Methods: We adopted a quantitative approach, collecting data through a structured questionnaire administered to nine media education and pedagogy experts from Italy and Austria.

Results: Results showed that PBL, CL, and SL are generally effective but require differentiated implementation approaches to maximize inclusivity. Practical implementation in the inclusive context of PBL requires promoting student reflection and self-assessment adapted to students' individual needs; in CL, group projects supported by digital collaboration tools (e.g., Google Docs) facilitate structured dialogue, peer collaboration, and shared responsibility, thereby increasing engagement; in SL, linking learning to real-world practice and designing experiences that reflect students' abilities and interests emerge as crucial, especially for students with SEN.

Discussion: The implications of these findings suggest that educators should adopt flexible and adaptive strategies to successfully implement PBL, CL, and SL to ensure that they meet the diverse needs of students in digital environments. Limitations of the study and recommendations for future investigations are discussed to further develop this area of research.

KEYWORDS

digital learning, inclusive education, problem/project-based learning, cooperative learning, service learning

1 Introduction

Inclusive education, as defined by the United Nations (2006), highlights the right of all students to participate in mainstream education and the inherent right of every student to participate fully in educational life (Krämer et al., 2021; Long and Guo, 2023). This fundamental principle extends seamlessly into the digital sphere, where strategic information and

communication technology (ICT) is critical in shaping the methodologies underpinning open and distance learning (Kumar Basak et al., 2018; Hassan and Mirza, 2020). In response to the growing need for equitable and accessible education (Boyle and Allen, 2023), ICT has taken on a central role in the evolution of educational practices. Globally, policies such as India's National Education Policy (Ministry of Education, Government of India, 2020) and the European Union's Digital Education Action Plan (European Commission, Directorate-General for Education, Youth, Sport and Culture, 2023) point to the importance of inclusive teaching strategies that use ICT to overcome physical and cultural barriers. Digital learning tools effectively address diverse students' needs, facilitating access to personalized feedback (Maier and Klotz, 2022), thus fostering the development of self-regulation skills that are essential for academic success (Neuenschwander et al., 2012; Berger et al., 2021; DiStefano et al., 2021). Students with special educational needs require additional support in a digitally supported learning environment regarding their self-regulation skills, motivation, and technical abilities (Börnert-Ringleb et al., 2021); and teachers play a key role in implementing explicit instructions for them (Pit-ten Cate et al., 2018; Stalmach et al., 2023). In a recent investigation (Stalmach et al., 2024), education experts identified problem/project-based learning, cooperative learning, and service learning as the most effective and inclusive methods out of fourteen options. The current study focuses on the optimal implementation of these methods.

Problem/project-based learning (PBL) is a student-centered approach that focuses on real problems (Rehman et al., 2023), helps students see the implications of the concepts they are learning (Krajcik and Shin, 2014), and fosters high-quality group process (Kokotsaki et al., 2016). Integrating digital technologies into PBL environments increases students' critical thinking, enthusiasm, and engagement (Basilotta Gómez-Pablos et al., 2017). Digital technologies facilitate educational experiences for students with specific accessibility needs (Haleem et al., 2022) and allow all students to engage in projects, create, explore, and communicate (Kim et al., 2016). In addition, interactive digital media, such as online discussion forums (Du et al., 2022), provide new opportunities for students to collaborate and learn from each other. Although PBL may not lead to extensive knowledge acquisition, students tend to retain what they learn more effectively through this method (Dochy et al., 2003), as PBL enables understanding rather than memorization (Hattie, 2009); for example, a recent study from Kazakhstan showed that problem/project-based learning can positively influence students' skills in solving geometric construction problems (Tursynkulova et al., 2023). Digitally supported PBL has also been shown to be effective at the university level, adhering to key principles such as collaborative knowledge construction and rapid access to information facilitated by ICT in academic environments (Fischer et al., 2003; Beers et al., 2005).

Cooperative learning (CL), a teaching method that promotes effective collaboration (Gillies, 2016), improves academic achievement, social relationships, and motivation while supporting social integration processes (Hank et al., 2023). Designing CL to create conditions that foster positive interactions can effectively promote social integration in everyday classroom settings (Weber and Huber, 2020). With specific adaptations and intensive CL sessions, students can universally benefit from peer influence (Hank and Huber, 2024). In small groups, they can improve academic performance, problem-solving skills, social relationships (Parker, 1985), and increase motivation (Tran, 2019). Technology can facilitate the learning process by providing resource-sharing opportunities and optimized group setup and management (Barneva et al., 2018). However, an integrative approach to evaluating the success of computer-supported collaborative learning (CSCL) is critical. Research consistently highlights the benefits of three strategies in promoting effective and inclusive collaborative learning: accountable talk, dialogic teaching, and exploratory talk.

Michaels et al. (2008) define accountable talk as a form of classroom discourse that promotes equity, characterized by three dimensions: accountability to the learning community, accepted standards of argumentation, and knowledge. In addition, Fernández-Villardón et al. (2020) highlight the role of dialogue and interaction in promoting the social development of students with special educational needs. Activities, such as presentations, support individual accountability leading to improved communicative competence (Puji and Barratt, 2018). Positive resource interdependence and individual accountability improve academic performance (Sarfo and Elen, 2011), which prevents free riding and social loafing in collaborative learning environments (Laal et al., 2013). Specific strategies such as setting expectations for communication (Michaels et al., 2008), requiring students to provide evidence in their discussions (Alexander, 2010), or providing waiting time (Richardson, 2010) can encourage student participation and thereby promote accountability for knowledge.

Dialogic teaching is an interactive dialogue among students that stresses the power of discussion to improve students' learning and problem-solving abilities (Kim and Wilkinson, 2019). Gillies (2020) highlights its central role in promoting dialogue and interaction in the classroom, underlining the important contribution of teachers in creating an engaging learning environment. Michaels et al. (2008) and Ardasheva et al. (2016) underline the importance of reasoned participation and fair discourse in fostering quality classroom interactions and expanding students' learning opportunities. Navarro-Mateu et al. (2021) further suggest that dialogic learning environments, facilitated by responsible talk, can enhance inclusion for students with special educational needs. Gillies (2016, 2020) highlights the use of multiple discourses and the importance of teachers challenging and scaffolding students' thinking. Webb (2009) also highlights the role of teacher talk and classroom norms in fostering beneficial group dialogue. Groenke and Paulus (2007) point to the role of teacher questioning in fostering dialogic literary inquiry in computer-mediated communication. The strategic use of online discussion forums, guided by the teacher, could improve students' understanding and completion of group assignments (Ali et al., 2016).

Exploratory talk is a form of dialogue that promotes cognitive change and contributes to learning (Barnes, 2008). It addresses language issues in English as a Second Language - ESL classrooms (Boblett, 2018) and enhances cognitive challenges in collaborative group work (Patterson, 2018). Despite its potential, exploratory talk is often underutilised, with teacher talk dominating classroom interactions (Khong et al., 2019). Technologies may support it, increasing student empowerment and engagement (Kerawalla et al., 2023). Exploratory talk can be a powerful means of facilitating collaborative learning, but its practical implementation requires changing classroom dynamics and using assistive technology. Patterson (2018) and Kerawalla et al. (2013) underscored the importance of exploratory talk in collaborative group work, with the latter highlighting the role of the teacher in modeling and guiding student engagement. Fleming (2008) provided practical insights into using online discussions and assessments to promote collaborative learning, suggesting using rubrics for assessment, helping students pay close attention to what others are saying, and providing opportunities for reflection.

Service learning (SL), as outlined by Salam et al. (2019), is the integration of academic content with community service, allowing students to apply their learning in real-world settings and enhancing their interpersonal skills (Rimm-Kaufman et al., 2021). It can be supported by research projects or collaborations with local organisations (Salam et al., 2019). Service learning also can have a positive impact on student learning and retention. According to Garwood et al. (2023), service learning has the potential to help students with disabilities develop academic and life skills. This approach increases learning and engagement (Warren, 2012), providing networking opportunities for students to connect with professionals and organisations in their field and promoting personal growth, cognitive development, and a sense of civic responsibility; however, its practical implementation requires a significant time commitment and may present technical challenges (Salam et al., 2019).

1.1 Research questions

This study examines how digital adaptations of traditional educational approaches - PBL, CL and SL - can be optimized to promote inclusion in digitized educational contexts, particularly for students with special educational needs. By focusing on their effectiveness in meeting the diverse needs of learners, the research highlights how these methods can be used to create inclusive and equitable learning environments in the digital age.

This study aimed to address three main research questions:

- How can problem/project-based learning be effectively implemented in inclusive digital educational environments?
- What tools and strategies are most effective in promoting collaborative learning experiences through cooperative learning for students with special needs?
- How can service learning be integrated into curricula to enhance the engagement and learning of students with special needs?

Each question is supported by sub-questions specific to the teaching methods:

For PBL: How do teacher guidance and collaborative activities influence its effectiveness in inclusive settings?

For CL: Which digital tools best facilitate peer collaboration and dialogic teaching in inclusive classrooms?

For SL: What role do alignment with academic goals and structured reflection play in achieving meaningful learning outcomes?

2 Materials and methods

2.1 Participants and procedure

Nine experts in media education and pedagogy participated in our study (8 from Italy and 1 from Austria) by answering a structured questionnaire that specifically addressed problem/project-based learning, cooperative learning, and service learning. The selection procedure for identifying experts was aimed at identifying researchers and professors with significant publications and leadership roles in educational organizations, societies or associations, or editorial positions in relevant, highly ranked academic journals. The identification process included a review of journals, conference proceedings, and books.

Formal invitations outlining the study's objectives were sent to the selected individuals, requesting their confirmation to participate. The data collection period spanned from May to June 2023.

To ensure a careful selection of our experts, we have applied the following criteria:

i) Minimum publication threshold: experts were required to have published at least three papers in the last 3 years that specifically addressed pandemic and post-pandemic issues. The selection criteria prioritized not only their academic contributions, but also their expertise in providing actionable insights into digital and inclusive education practices. This approach ensured that their feedback was both well-rounded and practical, based on their first-hand experience of the challenges of digital education.
ii) Professional roles: all participants held positions at public universities in Italy or Austria for a minimum of 3 years and were actively involved in research leadership roles.

2.2 Data collection

The questionnaire in this study was developed to evaluate digital learning methods with a focus on problem/project-based learning, cooperative learning, and service learning. Its purpose was to evaluate the effectiveness and explore potential improvements for these methods. The questionnaire, structured into distinct sections, explored key areas including engagement, tools, challenges, and outcomes. Anchored in established research methodologies, this systematic approach played a key role in developing an effective and impactful tool (Taherdoost, 2022). The design included closed-ended questions, utilizing multiple-choice and Likert scale formats, to gather structured quantitative data efficiently (Al-Rukban, 2006). Additionally, slider questions employing a 0–100 scale were included, offering deeper insights compared to traditional Likert scales (Roster et al., 2015). This comprehensive approach was designed to gain a detailed and granular understanding of expert judgments (Funke and Reips, 2012).

2.2.1 Validation process

To ensure the validity and reliability of the questionnaire, a pilot test was conducted with a subset of two experts outside the primary sample. This process allowed adjustments to be made to improve clarity and consistency. In addition, two independent academic researchers reviewed the questionnaire to ensure that it was consistent with the objectives of the study. Further revisions were made based on feedback from both the pilot test and the expert review.

The final version of the questionnaire was distributed via the Qualtrics platform, a widely used survey administration tool (Qualtrics, 2023). Each expert received a personalised email invitation with a unique survey link, ensuring data confidentiality and integrity. Participants' responses were automatically collected and securely stored on the Qualtrics platform, ensuring standardised, efficient data collection and enhancing the reliability and replicability of the study. The use of Qualtrics also streamlined data aggregation, minimized manual errors, and supported a consistent methodology that could be applied across different educational contexts.

2.3 Data analysis

The data collected through the Qualtrics platform was analysed quantitatively to address the research objectives. Although the sample size was small, appropriate statistical methods were applied to ensure the findings' reliability and relevance.

2.3.1 Statistical methods

Normality test: The Shapiro–Wilk test was used to verify the normal distribution of the data. This step was crucial in determining the appropriateness of parametric tests, such as *t*-tests, despite the limited sample size.

One-sample t-tests: One-sample t-tests were used to compare expert ratings of specific features of each teaching method against a hypothesised mean of 50. This approach allowed the identification of features that were rated higher or lower than the expected standard.

Descriptive statistics: Means and standard deviations were calculated to rank the tools and strategies within each method, providing an overview of their relative effectiveness as perceived by the experts.

Beyond method-specific assessments, the analysis also examined how the examined teaching methods could be integrated into existing curricula, with a focus on their potential to enhance the engagement and learning of students with special needs.

2.3.2 Method-specific applications

PBL: The analysis focused on features such as teacher guidance, the role of assessment tools, and the integration of clear learning objectives within inclusive digital contexts.

CL: The analysis focused on tools that facilitate collaboration, alongside strategies such as dialogic teaching and exploratory talk to foster inclusivity in digital learning environments.

SL: The analysis assessed strategies for curricular integration, including alignment with academic goals and the role of structured reflection in promoting inclusivity.

3 Results

The experts rated cooperative learning as the most known method, with the knowledge being assessed as "very well" by 3 out of 9 experts and by 5 as "well" on a 5-level scale, with the maximal option being "very well." The least known method is service learning, with the knowledge rated as "very poor" by 3 experts. Knowledge of problem/project-based learning was rated as 'average' by four experts and 'good' by three, suggesting a reasonable overall level of familiarity.

3.1 Problem/project-based learning

3.1.1 Evaluation of features that can contribute to the successful implementation of digital and inclusive PBL

The Shapiro–Wilk test was conducted to assess the normality of the data, confirming normal distribution. For PBL, the data were normally distributed for *clear learning goal* ($W = 0.915$, $p = 0.389$), *real world scenarios* ($W = 0.921$, $p = 0.405$), *group activities* ($W = 0.884$, $p = 0.171$), *teachers' guidance* ($W = 0.880$, 0.156), *teachers' feedback* ($W = 0.837$, $p = 0.054$), *metacognition* ($W = 0.897$, $p = 0.274$), and *resources and support for teachers* ($W = 0.948$, $p = 0.667$).

The effective implementation of PBL in digital and inclusive educational environments requires a comprehensive examination of key components (Table 1).

According to experts' opinions, PBL should be designed with clear learning goals and outcomes, integrating authentic and practical contexts into curricula. PBL also requires collaboration, and teamwork, which may be supported by provision of opportunities for students to work together in groups. According to experts' evaluations, teacher guidance and feedback significantly contribute to the success of PBL projects, helping students stay on track and meet project milestones. PBL also requires resources, both in terms of technology and in terms of professional development and support for teachers.

3.1.2 Competencies teachers need to help students achieve their learning goals with PBL

The experts, who possess varying levels of knowledge in PBL, were given up to three response choices to assess each of the specified competencies among the teachers. The specified competencies include collaboration skills, content knowledge, creativity and innovation, facilitation skills, and technology skills. Cumulative choices made by the experts provide an overview of the competencies that were identified as important for effective PBL implementation (Table 2). The total scores indicate the number of times each competence was chosen by the experts.

The most chosen teachers' competence was "facilitation skills," offering insights into the collective emphasis placed on these abilities deemed crucial for successful PBL.

TABLE 1 Statistical data evaluating various features contributing to implementing digital and inclusive PBL.

	N	Mean	SD	*t*	df	*P*
1. Clear learning goals	8	75.88	9.94	7.37	7	< 0.001
2. Real-world scenarios	9	74.78	18.26	4.07	8	0.004
3. Group activities	9	72.89	23.35	2.94	8	0.019
4. Teachers' guidance	9	76.56	25.60	3.11	8	0.014
5. Teachers' feedback	9	70.22	31.15	1.95	8	0.087
6. Metacognition	8	81.88	18.04	5.00	7	0.002
7. Resources and support for teachers	9	75.00	20.35	3.69	8	0.006

The table presents a one-sample t-test to determine the significance of each feature's mean score compared to a hypothetical mean of 50.

TABLE 2 Evaluation of teachers' competencies for effective Project-Based Learning (PBL) by experts.

	Level of knowledge				
Teachers' competencies	Poor	Average	Well	Very well	Total
Collaboration skills	1	0	2	1	4
Content knowledge	0	3	1	0	4
Creativity and innovation	1	1	1	1	4
Facilitation skills	1	4	3	1	9
Technology skills	0	2	1	0	3
Total	3	10	8	3	24

3.1.3 Evaluation of tools to enhance learning outcomes in digital and inclusive PBL

The Shapiro–Wilk test was conducted to assess the normality of the data, confirming normal distribution despite the small sample size. The data were normally distributed for *rubrics* ($W = 0.881$, $p = 0.160$), *self-assessment* ($W = 0.896$, $p = 0.228$), *peer-evaluation* ($W = 0.940$, $p = 0.577$), *portfolios* ($W = 0.966$, $p = 0.862$), and *observations* ($W = 0.944$, $p = 0.621$).

The following results show how the examined tools such as rubrics, self-assessment, peer review, portfolios, and observations can aid progress within digital and inclusive PBL environments (Table 3).

In the context of PBL, self-assessment was deemed best, and portfolios were assessed as less effective.

3.2 Cooperative learning

3.2.1 Ranking of the tools used for promoting cooperative learning in inclusive environments

The tools to support cooperative learning in inclusive settings were ranked according to their mean scores, with lower scores indicating higher preference. Google Docs was the most preferred tool, achieving the highest ranking with a mean score of 1.50 (SD = 0.54). Padlet followed with a mean score of 2.13 (SD = 2.03). Edmodo came in third with a mean score of 4.25 (SD = 1.28). Flipgrid came next with a mean score of 4.50 (SD = 1.85). Kahoot ranked fifth with a mean score of 4.75 (SD = 1.98). Nearpod had a mean score of 5.75 (SD = 1.04), placing it in sixth place. Seasaw followed closely with a mean score of 5.88 (SD = 1.46). Finally, Slack was the least preferred tool with a mean score of 7.25 (SD = 1.39).

3.2.2 Strategies for promoting cooperative learning in inclusive environments

Each expert could choose up to three options (Table 4).

Group projects and real-time collaboration emerged as the top-rated options for promoting collaboration among students with special educational needs in digital environments. These findings underscore the significance of active participation and shared responsibilities, which are crucial in fostering a strong sense of teamwork and engagement among students.

TABLE 3 Statistical insights into the effectiveness of additional features in facilitating digital and inclusive PBL.

	N	Mean	SD	T	df	*p*
1. Rubrics	9	72.56	20.01	3.38	8	0.010
2. Self-assessment	9	83.33	15.66	6.39	8	< 0.001
3. Peer-evaluation	9	79.78	17.22	5.19	8	< 0.001
4. Portfolios	9	71.11	19.75	3.21	8	0.012
5. Observations	9	76.78	17.58	4.57	8	0.002

A one-sample t-test is conducted to determine the significance of each feature's mean score compared to a hypothetical mean of 50.

TABLE 4 The choices made by experts among four collaborative learning strategies, and their level of knowledge of each method.

	Level of knowledge			
Strategies	Average	Well	Very well	Total
Group project	1	3	2	6
Peer-review	0	3	1	4
Real-time collaboration	0	3	2	5
Discussion forum	1	1	0	2
Total	2	5	10	17

TABLE 5 Contingency table of the choices made by experts according to their level of knowledge of the method regarding the most inclusive activities.

	Level of knowledge			
Activities	Average	Well	Very well	Total
A	1	3	1	5
B	1	1	2	4
C	0	1	0	1
D	0	2	1	3
E	1	5	1	7
Total	3	12	5	20

A Group project that requires defining common goals, dividing tasks, and sharing responsibility. B Individual activities followed by small group discussions led by a moderator, allowing students to compare the solutions they have found. C Reading of didactic material followed by group learning activities such as problem-solving. D Role-playing games that require students to work together to achieve a common goal. E Small group discussion on specific topics, guided by a moderator, that requires the comparison of ideas and collaboration to reach a shared solution.

3.2.3 Activities for promoting cooperative learning in inclusive environments

Delving into activities encouraging collaboration, each expert could choose up to three options (as shown in Table 5).

Notably, experts with an average level of knowledge collectively chose Activity B and Activity E, totaling three selections. Those with a well-established knowledge level exhibited diverse preferences, favoring Activity B. The experts' evaluations highlight the importance of small group discussions in promoting collaboration among students with special educational needs. Such activities were acknowledged for stimulating critical thinking, and fostering cooperation.

3.2.4 Evaluation of strategies teachers can use to promote inclusive and effective accountable talk

In the context of cooperative learning, the Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests for *norms* ($W = 0.912$, $p = 0.330$), *open-ended questions* ($W = 0.946$, $p = 0.650$), *providing wait time* ($W = 0.891$, $p = 0.205$), *provide evidence* ($W = 0.887$, $p = 0.186$), *dialogue journals* ($W = 0.912$, $p = 0.333$), *students led discussions* ($W = 0.947$, $p = 0.662$), *small group discussion* ($W = 0.861$, $p = 0.098$), and *feedback and scaffolding* ($W = 0.881$, $p = 0.162$).

The analysis of strategies aimed at fostering Accountable Talk within inclusive digital learning contexts has yielded significant results based on expert evaluations (Table 6).

These insights underscore the importance of strategic approaches to enhance communication and collaboration among students in inclusive settings. Among the strategies investigated, "Providing feedback and scaffolding" contributes to positive communicative outcomes. Conversely, strategies like using open-ended questions while exhibiting potential may warrant further exploration or consideration of alternative approaches.

3.2.5 Evaluation of strategies/tools teachers can use to promote inclusive and effective dialogic teaching

In the context of cooperative learning, the Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests for *online forums* ($W = 0.943$, $p = 0.640$), *collaborative writing platforms* ($W = 0.889$, $p = 0.197$), *social media* ($W = 0.963$, $p = 0.825$), and *online polling/surveys* ($W = 0.988$, $p = 0.992$).

Collaborative writing platforms demonstrated a positive effect, emphasizing their role in fostering interactive and engaging teaching practices. Online polling or survey tools also exhibited a noteworthy impact, showcasing their efficacy in promoting dialogic teaching strategies (Table 7). However, social media did not show a statistically significant impact, suggesting the need for alternative approaches. Further exploration and consideration of alternative approaches are needed to ensure effective implementation in inclusive digital learning environments.

3.2.6 Evaluation of strategies/tools teachers can use to promote inclusive and effective exploratory talk

In the context of cooperative learning, the Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests for *encouraging students to ask questions* ($W = 0.907$, $p = 0.298$), *answer open-ended questions* ($W = 0.918$, $p = 0.377$), *use prompts* ($W = 0.933$, $p = 0.506$), *students' reflection* ($W = 0.945$, $p = 0.633$), *conferencing tools* ($W = 0.938$, $p = 0.563$), *online discussion forums* ($W = 0.898$, $p = 0.242$), *collaborative docs* ($W = 0.980$, $p = 0.966$), and *real-time feedback tools* ($W = 0.920$, $p = 0.393$).

The values that provide insights into the average effectiveness and variability of each strategy/tool in fostering Exploratory Talk, showed that students' reflection and real-time feedback tools were deemed most effective (Table 8).

3.3 Service learning

This analysis investigates the efficacy of integrating service learning strategies into existing curricula to enhance learning and engagement for students with special needs in inclusive settings. Utilizing a one-sample *t*-test, we assessed the impact of SL experiences

TABLE 6 Key statistics for different strategies teachers use to encourage accountable talk in the classroom.

	N	Mean	SD	*t*	df	*p*
1. Norms	9	73.89	18.84	3.80	8	0.005
2. Open-ended questions	9	66.00	27.96	1.72	8	0.124
3. Providing wait time	9	76.33	24.02	3.29	8	0.011
4. Provide evidence	9	77.56	19.44	4.25	8	0.003
5. Dialogue journals	9	70.89	20.49	3.06	8	0.016
6. Students led discussions	9	71.89	21.81	3.01	8	0.017
7. Small group discussion	9	71.89	21.92	3.00	8	0.017
8. Feedback and scaffolding	9	90.44	10.31	11.77	8	< 0.001

This table summarizes the results of one-sample t-tests for the same AT strategies. The tests assess whether the means significantly differ from 50.

TABLE 7 Descriptive statistics for various strategies/tools teachers use to promote inclusive and effective dialogic teaching.

	N	Mean	SD	t	df	p
1. Online forums	8	64.13	16.06	2.49	7	0.042
2. Coll. writing platforms	9	73.00	19.74	3.50	8	0.008
3. Social media	9	56.22	27.48	0.68	8	0.516
4. Online polling/surveys	9	68.89	19.23	2.95	8	0.019

This table displays the results of one-sample *t*-tests to assess the significance of mean differences for different strategies/tools. The alternative hypothesis for each test is that the mean differs from 50.

TABLE 8 Descriptive statistics for various strategies/tools employed by teachers to promote inclusive and effective exploratory talk.

	N	Mean	SD	t	df	p
1. Encourage students to ask questions	9	72.44	15.38	4.38	8	0.002
2. Answer open-ended questions	9	71.67	18.30	3.55	8	0.007
3. Use prompts	9	75.44	20.75	3.68	8	0.006
4. Students' reflection	9	80.22	16.07	5.64	8	< .001
5. Conferencing tools	9	68.78	19.05	2.96	8	0.018
6. Online discussion forums	9	55.44	25.88	0.63	8	0.545
7. Collaborative docs	9	74.78	15.60	4.77	8	0.001
8. Real-time feedback tools	9	77.11	14.09	5.77	8	< .001

For the Student *t*-test, location difference estimate is given by the sample mean difference *d*. The alternative hypothesis for each test is that the mean was different from 50.

TABLE 9 Descriptive statistics evaluating strategies to enhance learning and engagement for special needs students with service learning.

	N	Mean	SD	t	df	*p*
1. Alignment	8	70.13	19.64	2.90	7	0.023
2. Reflection and discussion	8	77.50	20.26	3.84	7	0.006
3. Shared purpose	8	72.63	25.34	2.53	7	0.040
4. Learning assessment	8	71.75	28.34	2.17	7	0.067

This table provides the results of a one-sample t-test examining the significance of each strategy's mean score compared to a hypothetical mean of 50.

TABLE 10 Descriptive statistics evaluating types of service learning experiences that promote academic success in students with SEN.

	N	Mean	SD	t	df	*p*
1. Critical thinking and problem-solving	8	81.25	18.46	4.79	7	0.002
2. Collaboration and teamwork	8	77.38	21.20	3.65	7	0.008
3. Project management and decision-making	8	73.63	25.86	2.58	7	0.036
4. Mentorship/tutoring	8	70.75	20.47	2.87	7	0.024

This table provides the results of a one-sample t-test examining the significance of each SL experience's mean score in comparison to a hypothetical mean of 50.

on academic success, aiming to identify effective strategies while addressing potential challenges.

3.3.1 Evaluation of strategies that can be integrated into existing curricula to enhance special needs student's learning and engagement

In the context of SL, the Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests for *alignment* ($W = 0.860$, $p = 0.119$), *reflection and discussion* ($W = 0.895$, $p = 0.261$), *shared purpose* ($W = 0.897$, $p = 0.274$), and *learning assessment* ($W = 0.864$, $p = 0.132$).

Reflection and discussion were deemed to be effective in enhancing student engagement. Regarding learning assessment, although marginally above the conventional significance level of 0.05, the *p*-value suggests a trend, hinting at its potential impact on student engagement (Table 9).

These results underscore the varied effectiveness of distinct SL strategies in bolstering student engagement, providing valuable insights for educators and curriculum designers. The alternative hypothesis, positing a mean different from 50, is supported across multiple dimensions, indicating the potential significance of SL interventions in enhancing the educational experience.

3.3.2 Evaluation of types of SL experiences that promote academic success in students with special needs

The Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests also for *critical thinking and problem-solving* ($W = 0.907$, $p = 0.332$), *collaboration and teamwork* ($W = 0.854$, $p = 0.104$), *project management and decision making* ($W = 0.912$, $p = 0.369$), and *mentorship/tutoring* ($W = 0.852$, $p = 0.099$).

These results show the influence of various service learning experiences on academic success for students with SEN (Table 10).

The results collectively suggest that specific SL experiences, particularly those emphasizing critical thinking, collaboration, project management, and mentorship/tutoring, significantly promote academic success for students with special needs.

3.3.3 Evaluation of strategies to address potential drawbacks or challenges in SL

The Shapiro–Wilk test results supported the normality assumption, validating the use of one-sample t-tests also for *time constraints* ($W = 0.991$, $p = 0.996$), *appropriate opportunities* ($W = 0.940$, $p = 0.615$), and *effective impact* ($W = 0.885$, $p = 0.209$).

TABLE 11 Descriptive statistics evaluating strategies to address potential drawbacks or challenges in service learning with special needs students.

	N	Mean	SD	*t*	df	*p*
1. Time constraints	8	70.63	12.40	4.71	7	0.002
2. Appropriate opportunities	8	78.50	18.04	4.47	7	0.003
3. Effective impact	8	71.25	24.04	2.50	7	0.041

This table displays the results of a one-sample t-test assessing the significance of each strategy's mean score compared to a hypothetical mean of 50.

The results of the one-sample *t*-test measure the effectiveness of strategies to address potential drawbacks or challenges in service learning to maximize benefits for students with special needs (Table 11).

These results underscore the importance of targeted strategies in mitigating challenges associated with time constraints, providing appropriate opportunities, and ensuring an effective impact on service learning for students with special needs.

4 Discussion

Equal access to digital resources for all students and understanding the specific needs of teachers are essential in developing strategies to ensure the successful implementation of digital methods (Val and López-Bueno, 2024). To conceptualize the integration of these approaches into inclusive digital learning, we propose the Inclusive Digital Learning Model (Figure 1). This model shows how PBL, CL, and SL complement each other in promoting inclusion, engagement, and effective use of digital tools. Each method offers unique contributions - PBL focuses on real-world problem solving, CL promotes collaboration and structured peer interaction, and SL integrates community service with reflective practice. The overlaps within the model show their common principles and synergies and demonstrate their collective potential to create accessible, engaging, and inclusive learning environments, particularly for students with special educational needs. The insights from experts' assessments offer valuable guidance on effective teaching methods and strategies for inclusive digital learning through cooperative, problem/project-based, and service learning, fostering engagement, collaboration, critical thinking, and real-world application of knowledge in digital learning environments.

The Venn diagram visualizes the unique and common elements of PBL, CL, and SL, highlighting their interrelated roles in promoting inclusive digital education.

4.1 Problem/project-based learning

The findings highlight several key elements that contribute significantly to the success of PBL implementation, including the importance of clear learning goals, engagement with real-world scenarios, collaboration, teacher scaffolding, aligned assessment, the promotion of metacognitive skills, and the essential need for resources and support.

4.1.1 Clear learning goals and real-world scenarios

The study underscores the need for teachers and educators to design PBL projects with explicit learning objectives, providing students with a roadmap for achieving their goals. Students understand what is expected of them and can better organize their efforts when goals are clearly defined. Explicit learning objectives support transparency and accountability within the learning process, fostering self-regulation (Jönsson and Prins, 2019) and motivation. Integrating real-world scenarios into PBL projects is a key factor in enhancing their effectiveness, highlighting the significance of contextual relevance and the practical application of knowledge. This approach offers students valuable opportunities to apply their skills in authentic settings.

4.1.2 Collaboration

The study underscores the significance of collaboration and group activities in PBL. Educators play a critical role in creating opportunities for collaboration within PBL settings, designing tasks and projects that necessitate teamwork, provide guidance on effective collaboration strategies, and create a supportive atmosphere. Additionally, they can facilitate reflection on the collaborative process, helping students recognize the value of teamwork, identify areas for improvement in their collaborative skills, and encourage meaningful communication between group members (Zhang et al., 2023). It emphasizes the social nature of learning and the importance of interpersonal skills in the context of PBL.

4.1.3 Teacher guidance and aligned assessment

Teacher guidance and feedback emerge as critical elements in the success of PBL projects. Providing support to help students stay on track significantly influences project outcomes. Teachers should focus on effective scaffolding, providing timely and constructive feedback to enhance the learning experience and ensure the successful completion of PBL projects. The study also highlights the importance of assessment aligned with learning goals, which makes students more likely to engage in learning activities (Ozan and Kıncal, 2018) and leads to a deeper understanding and retention of concepts.

4.1.4 Promotion of metacognitive skills

Encouraging the development of metacognitive skills in the PBL context has been shown to have a significant impact on self-regulation. Educators should incorporate activities that prompt students to reflect on their learning process, thereby encouraging self-directed and reflective practices. This finding confirms that PBL goes beyond content delivery and actively engages students in thinking about how they learn.

4.1.5 Need for resources and support

Adequate resources are critical to creating an environment conducive to engaging PBL experiences. The evaluation of teacher competencies reveals the importance of collaboration, content knowledge, creativity and innovation, facilitation skills, and

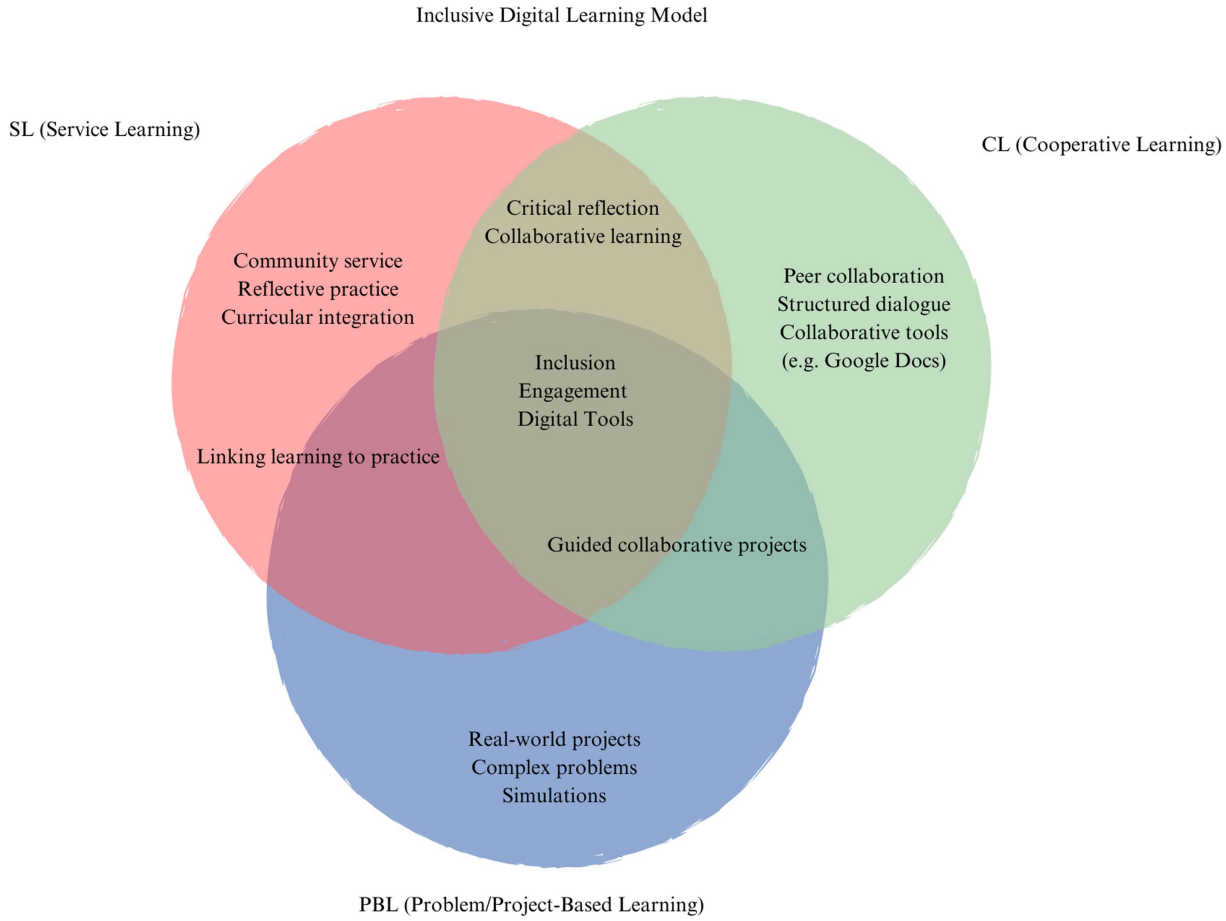

FIGURE 1
Inclusive digital learning model.

technology skills. The evaluation of assessment tools suggests that rubrics, self-assessments, peer assessments, portfolios, and observations effectively measure student progress in digital and inclusive PBL. Teachers can use these tools to provide comprehensive and varied feedback that addresses different learning styles and preferences, which are key factors in PBL success (Table 12).

4.2 Cooperative learning

Our panel of experts evaluated various tools and platforms for promoting inclusive and effective cooperative learning. Google Docs emerged as the top choice, reflecting its widespread acceptance and preference among experts. For students with special needs, group projects and real-time collaboration were identified as the most effective strategies for fostering teamwork and engagement. These findings highlight the importance of active participation, shared responsibility, and structured teamwork in creating a positive learning environment for students with special needs in digital contexts. In addition, the experts underscored the value of small-group discussions focused on specific topics as a key activity to foster collaboration.

4.2.1 Accountable talk

Our evaluation of strategies for promoting Accountable Talk revealed different impactful approaches. Establishing clear norms and expectations for communication, allowing sufficient wait time, and encouraging students to provide evidence were identified as highly effective strategies. Encouraging students to support their statements with facts, examples, or logical reasoning enables them to develop critical thinking skills and learn how to evaluate information in an effective way (Alsaleh, 2020).

4.2.2 Dialogic teaching

Dialogic Teaching, designed to foster interactive and inclusive teaching practices, may yield varying levels of impact depending on the tools employed. Collaborative writing platforms and online polling or survey tools were identified as highly effective, whereas the use of social media showed limited influence.

4.2.3 Exploratory talk

In Exploratory Talk, strategies such as encouraging active listening, posing open-ended questions, using prompts, providing opportunities for reflection, and leveraging conferencing tools were identified as effective in promoting interactive and inclusive teaching practices. These findings underscore the importance of creating a

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TABLE 12 PBL implementation guidelines for students with special educational needs.

Guidelines	Strategies
Clear learning objectives	Define explicit, achievable project objectives aligned with academic standards.
Contextual relevance	Integrate real-world scenarios in projects to enhance interest and practical application.
Collaboration	Include group activities to promote teamwork and social interaction.
Teacher facilitation skills	Develop facilitation skills to guide and support students effectively.
Teacher support	Provide continuous guidance and constructive feedback to support students with special needs during projects.
Aligned assessments	Design assessments closely aligned with learning objectives, offering constructive feedback.
Individualized assessments	Customize assessments to meet the diverse learning needs of students.
Metacognitive assessments	Include assessments encouraging metacognitive skill development, prompting students with special needs to reflect on their learning.
Technology integration	Use assistive technologies for assessments, ensuring students with special needs can effectively demonstrate understanding.
Rubrics for assessment	Implement rubrics outlining specific criteria and expectations, providing clear guidelines for performance assessment.
Self-assessments and portfolios	Incorporate self-assessment tools and portfolio assessments, allowing students with special needs to monitor progress and showcase results.

supportive, structured environment that encourages students to explore and discuss ideas collaboratively.

Our research provides insights into the effective implementation of cooperative learning in digital contexts and offers practical recommendations for educators (Table 13). The variety of strategies and tools evaluated underscores the importance of customizing approaches to meet the specific needs of students.

4.3 Service learning

The results of this study provide insights into the effectiveness of integrating service-learning strategies into existing curricula for students with special needs in inclusive settings (Table 14). The analysis of strategies to enhance learning and engagement for students with special needs revealed positive effects across multiple dimensions. Alignment strategies that stress the connection between academic content and community service were found to be successful in promoting student engagement.

TABLE 13 Cooperative learning implementation guidelines for students with special educational needs.

Guidelines	Strategies
Online platform	Utilize Google Docs as the preferred platform for promoting inclusive and effective cooperative learning.
Promote collaboration among SEN students	Implement group projects and real-time collaboration as the most effective strategies for promoting collaboration among students with special needs.
Foster relationship	Lead interaction, critical thinking, and cooperation among students with special needs through small group discussions on specific topics.
Accountable talk	Establish communication norms within the online environment. Provide wait time for thoughtful responses. Encourage students to provide evidence to support their contributions.
Dialogic teaching	Opt for collaborative writing platforms and online polling or survey tools.
Exploratory talk	Encourage active listening. Pose open-ended questions. Use prompts. Provide opportunities for reflection. Leverage conferencing tools for interactive discussions.
Accessible content	Ensure that all learning materials and content are accessible to students with different learning needs. Use multimedia content to cater to diverse learning styles.

4.3.1 Reflection and discussion

Reflection and discussion components have been identified as important drivers of student engagement. Incorporating opportunities for students to reflect on their service experiences and engage in meaningful discussions fosters a deeper understanding of the material and promotes interpersonal skills, thereby enhancing cognitive and personal development. Students can gain insight into themselves, their communities, and societal issues, leading to empathy, self-awareness, and a sense of social responsibility.

4.3.2 Collaboration

Collaboration and teamwork emerged as important factors in academic success. This finding is consistent with the broader literature emphasizing the importance of social skills and collaborative learning experiences for students with special needs. Project management or decision-making components within SL experiences also showed a statistically significant positive impact on academic success.

4.3.3 Challenges

The study also examined different strategies to address potential drawbacks or challenges in SL for students with special needs. Time constraints emerged as a significant challenge, and the solutions to address this issue were shown to be effective. This finding underscores the importance of providing individualized opportunities that meet

TABLE 14 Service learning implementation guidelines for students with special educational needs.

Guidelines	Strategies
Service-integrated academic projects	Design academic projects that align with real-world service opportunities, allowing students to apply classroom knowledge in community contexts, and reinforcing learning through practical application.
Structured reflection sessions	Incorporate regular reflection sessions before, during, and after service activities, providing structured opportunities for students to reflect on their experiences.
Establishing common goals	Foster a shared sense of purpose and commitment among students by establishing common goals and objectives for service projects, promoting collective effort towards meaningful outcomes.
Adaptive assessment	Implement assessment methods tailored to accommodate diverse learning needs, ensuring that they effectively measure students' progress while providing the necessary support for students with special needs.
Problem-based service learning	Design service projects that present students with real-world challenges, requiring critical thinking and problem-solving skills.
Collaborative service projects	Focus on collaborative learning experiences within service projects that promote teamwork, communication, and social skills development through group activities and cooperative problem-solving tasks.
Peer mentorship	Establish peer mentorship programs within service experiences, pairing students with mentors or tutors to provide personalized support, guidance, and academic assistance, enhancing learning outcomes and fostering positive relationships.
Individualized Learning plans	Develop individualized learning plans for students with special needs within service learning activities, ensuring that projects and tasks are aligned with their learning goals, abilities, and interests.
Time management	Offer training sessions on time management skills to help students effectively plan, organize, and prioritize tasks during service activities, maximizing productivity and minimizing stress.
Tailored opportunities	Provide diverse participation options and accommodations for special needs students within service projects, ensuring that activities are tailored to their individual needs, preferences, and abilities.
Outcome-oriented project design	Design service projects with clear objectives and measurable outcomes, regularly evaluating progress and impact to ensure that students' efforts contribute to tangible and intangible benefits for both the community and themselves.

the diverse needs of students to ensure their worthwhile participation in service learning experiences.

4.4 Children with special educational needs and digital technologies

Students with special needs exhibit diverse abilities and challenges, and their educational needs vary widely. For instance, students with physical disabilities may require adaptive technology and accessible learning environments to participate effectively (Fernández-Batanero et al., 2022), while students with cognitive disabilities may benefit from more structured, repetitive, or visually-assisted learning methods. Similarly, students with social or emotional challenges may require more individualized attention. These varying needs highlight the importance of customizing pedagogical approaches, including PBL, CL, and SL, to ensure that all students can benefit from the learning process. PBL focuses on real-world problems and encourages critical thinking and self-directed learning. For children with special educational needs, this approach can foster a sense of autonomy and accomplishment as they work through challenges at their own pace. Digital tools can provide multimedia resources (e.g., videos, interactive simulations, visual aids) that support different learning preferences, simplify complex concepts in a more accessible way, and also support the creativity of students with special needs (Zhang et al., 2024). CL emphasizes collaboration and peer interaction, which might help children with special educational needs develop social skills, improve communication, and derive value from personalized peer support (Seitz et al., 2023). In a digital environment, tools such as collaborative platforms, group chats, and virtual breakout rooms allow students to work together to accommodate different learning styles and abilities, ensuring that all students are encouraged to participate actively (Llorent et al., 2024).

SL combines community service with academic learning, allowing children with special needs to apply their knowledge in real-world contexts while contributing to their communities. In digital environments, service learning projects can be designed to allow remote participation (Bringle and Clayton, 2020), ensuring that also students with physical or learning disabilities can engage. Virtual service projects or online collaborations can foster their sense of purpose, enthusiasm, and inclusion, helping them feel connected to their peers (Mebert et al., 2020). For instance, features like closed captions and subtitles enhance accessibility, particularly for individuals with hearing impairments or language barriers. In addition, multilingual support, such as sign language interpreters, empowers students to contribute effectively. Prioritizing these inclusive elements ensures that activities are accessible to all participants (Doran et al., 2024).

Digital technologies play a key role in supporting inclusive education for students with special needs and encouraging their engagement. In PBL, assistive technologies such as interactive simulations and multimedia platforms enhance inclusivity. In collaborative learning, digital tools such as Google Docs create flexible, real-time environments that allow students to actively participate regardless of physical location or specific needs (Barneva et al., 2018). Similarly, virtual service learning leverages online community projects to enable students with mobility impairments to participate in service learning experiences (Bringle and Clayton, 2020).

4.4.1 Service learning and self-confidence development in a child with autism - a fictional case study

4.4.1.1 Background

Pawel, from a small city in Austria, a 10-year-old with autism, struggled with social interactions, and had low self-confidence. To help him build self-esteem, his teachers introduced a service learning project where students created care packages for elderly residents in a local nursing home. The project involved gathering materials, assembling the packages, and delivering them, providing Pawel with a real-world task.

4.4.1.2 Service learning experience

Pawel's teacher, Ms. Flower assigned him the task of organizing the care packages alongside a small group of classmates. Although Pawel was initially hesitant to work with others, Ms. Flower provided him with a structured plan and clear expectations, which helped him feel more comfortable.

Over time, Pawel's involvement in the project gradually increased his engagement. He was proud of his role, particularly in ensuring that each care package was carefully assembled. Through his contributions, Pawel felt a sense of accomplishment that had been hard to achieve in previous school activities. Initially, Pawel was anxious about meeting new people and speaking to the elderly residents. However, his teacher and classmates offered encouragement, and Pawel took the opportunity to practice social skills, such as introducing himself. He felt valued for his contributions, which were recognized both by his peers and the recipients of the care packages; he also began to initiate conversations with his peers, particularly those he had worked closely with during the project. The experience showed him that he could play an important role in his community, even in situations that require social interaction and communication—areas he had previously found challenging.

The project's real-world context, structured support, and positive social interactions made Pawel feel valued and improved his social skills. As a result, Pawel's experience highlights the potential of service learning to foster social development in children with autism, making it a powerful tool for inclusion (see also Silveira-Zaldivar et al., 2021).

4.5 Barriers to PBL, CL, and SL in digital inclusion

The effectiveness of PBL, CL, and SL in inclusive digital education is affected by technology and teacher training challenges. Limited access to digital tools and inaccessible platforms can hinder participation, especially for students with special needs (Björnsdóttir et al., 2024). Teachers often lack the training to effectively adapt these methods for diverse learners, including differentiating instruction and assessing progress. In addition, time constraints, a competitive mindset among some teachers, strict curriculum requirements, and limited resources (Andrews et al., 2019) make it difficult to implement flexible practices. The digital transformation of education supports inclusivity by making learning materials accessible to students of all abilities. However, to use digital resources effectively, teachers need to acquire new competencies (Ng et al., 2023), and to teach inclusively, they also need to have confidence in their abilities and a sense of self-efficacy (Woodcock et al., 2023). A study of international students in China found that teachers were more satisfied with digital learning than students (Li et al., 2021), suggesting that while teachers may find digital tools effective in delivering content, students may face challenges, highlighting the importance of adapting instructions to student's needs.

When effectively implemented by teachers, digital technologies not only increase accessibility and inclusivity but also promote critical thinking, social interaction, and self-regulation among students with special educational needs (Stalmach et al., 2023).

5 Conclusion

Integrating CL, PBL, and SL into digital education environments may serve as a cornerstone for achieving the goals of inclusive education. CL, which focuses on group interaction and shared responsibilities, promotes a sense of community within the digital classroom. PBL, on the other hand, introduces real-world scenarios, encouraging students to engage with complex issues. It enhances their critical thinking skills and aligns with the principles of self-regulated learning as students take charge of their learning journey. SL, which links academic content with community service, goes beyond traditional classroom boundaries. In the educational digital ecosystem, this approach provides students with opportunities to engage with real-world challenges. It helps them develop self-management skills as they plan tasks and choose roles to accomplish their goals (Merritt et al., 2021).

The collective integration of CL, PBL, and SL into digital learning environments creates a holistic educational experience. These methods contribute synergistically to students' academic, social, and emotional development in the digital era, underlining the importance of a well-rounded, inclusive approach in a digitally enhanced learning environment. Teachers should prioritize culturally responsive teaching approaches, flexible course designs, and comprehensive support services to mitigate challenges such as technological constraints. In addition, policymakers must address systemic issues by investing in digital infrastructure and ensuring equitable access to technology and Internet resources for all students and school staff. Beyond the immediate context, these findings provide a basis for developing global standards for inclusive digital education, with implications for various disciplines. For instance, in areas with limited Internet access, teachers and educators could adopt culturally responsive practices by incorporating local knowledge, using flexible course designs with offline materials, and providing devices or workshops as support.

This study offers practical implications for implementing PBL, CL, and SL in different educational contexts, addressing common challenges such as time constraints and technological accessibility. In addition, using digital platforms with accessibility features ensures that students with different special educational needs are included in collaborative and reflective activities. These recommendations highlight the need for educators to be creative in adapting methods to their specific contexts. In addition, policymakers have a critical role to play in supporting this integration by prioritizing investments in inclusive digital infrastructures and providing professional development programs that enable teachers to implement these strategies effectively. To illustrate the practical integration of PBL, CL, and SL, we have included in Annex 2 a detailed framework of activities based on the Inclusive Digital Learning Model (Figure 1). This framework shows how these approaches can be combined to address real-world challenges while promoting collaboration, digital literacy, and social responsibility among students.

5.1 Limitations and further research

It should be noted that due to the small group size, complex statistical analysis could not be done. The results may be different with a larger study group (Serdar et al., 2021). The study's reliance upon a small sample of experts limits the generalizability of the results. However, the structured approach and targeted selection criteria ensured that the findings were reliable and relevant in the context of inclusive digital education. Future research could expand the sample size and use advanced statistical methods, such as multivariate analysis or structural equation modelling, to explore deeper relationships between pedagogical methods and outcomes.

The study is limited to experts from specific cultural and institutional contexts. Therefore, the generalizability of the study's findings, i.e., the extent to which they apply to other settings, is also limited. This limitation is due to potential differences in cultures and professional practices across regions or institutional structures that may influence the phenomena under study.

Other regions may have different educational priorities, technological infrastructures, or pedagogical approaches that could lead to different challenges and opportunities for integrating digital learning. In addition, institutional structures, such as the availability of resources or government policies on education, may vary widely, potentially affecting the adoption of digital tools.

Consequently, while the results of the study may provide useful insights into the specific contexts studied, they may not fully reflect the differences that might emerge from professionals in other settings. This should be taken into account when interpreting the findings, particularly when discussing how these findings might be applied in different cultural and institutional contexts.

Furthermore, cultural and political differences between Italy and Austria may affect the implementation of PBL, CL, and SL for students with special educational needs. In Italy, regional differences in inclusive education policies (Ianes et al., 2020) and digital access may hinder effective implementation. However, Italian teachers work within a well-established tradition of inclusive education (Auer, 2023; Sahli Lozano et al., 2024). In Austria, teaching in inclusive settings is often shaped by a narrow interpretation of inclusive education that focuses primarily on students with disabilities (Buchner and Proyer, 2019). These differences highlight the need for context-specific approaches to digital education that consider each country's policies, culture, and resources.

The questionnaire options were defined *a priori*, limiting the scope within which experts could provide responses. The overly rigid structure of the survey could influence the data collected (Queirós et al., 2017), and the response options may not cover all possible perspectives.

Future efforts could focus on the development of comprehensive educational training programs that combine digital literacy with inclusive teaching practices adapted to diverse learning environments. In addition, the research could explore the long-term effects of integrating cooperative, problem/project-based, and service-learning methods on student outcomes, particularly in promoting inclusivity in rapidly evolving digital learning ecosystems.

This article presents the perspectives of experts, but future studies could also consider the viewpoints of educators and students. The perspectives of teachers and students likely differ (Tao et al., 2023), highlighting the need for future quantitative studies to validate and extend the criteria identified in this investigation. The article relies solely on expert opinions and neglects teachers' perspectives on implementing these methods or students experiencing the learning process. This omission limits the practical relevance of the study. However, this approach was intentional in our study design, as we sought to gather insights from experts who have extensive knowledge and experience in the field. We recognize the value of including the perspectives of teachers and students in future research to further enrich the applicability and humanistic dimension of the study.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

PD'E: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Visualization, Writing – original draft. AS: Resources, Writing – review & editing, Investigation, Visualization. SS: Writing – review & editing, Funding acquisition, Supervision. GC: Formal analysis, Supervision, Writing – review & editing, Funding acquisition.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2024.1447489/full#supplementary-material

References

Alexander, R. J. (2010). Speaking but not listening? Accountable talk in an unaccountable context. *Lit* 44, 103–111. doi: 10.1111/j.1741-4369.2010.00562.x

Ali, M. F., Tahir, L. M., and Said, M. N. H. B. M. (2016). Facilitating learners' online discussions in completing group assignments. In 2016 IEEE Conference on e-Learning, e-Management and e-Services (IC3e) (pp. 102–106).

Al-Rukban, M. O. (2006). Guidelines for the construction of multiple choice questions tests. *J. Fam. Community Med.* 13, 125–133. doi: 10.4103/2230-8229.97543

Alsaleh, N. J. (2020). Teaching critical thinking skills: literature review. *Turk. Online J. Educ. Technol.* 19, 21–39.

Andrews, D., Walton, E., and Osman, R. (2019). Constraints to the implementation of inclusive teaching: a cultural historical activity theory approach. *Int. J. Incl. Educ.* 25, 1508–1523. doi: 10.1080/13603116.2019.1620880

Ardasheva, Y., Howell, P., and Vidrio Magaña, M. (2016). Accessing the classroom discourse community through accountable talk: English learners' voices. *TESOL J.* 7, 667–699. doi: 10.1002/tesj.237

Auer, P. (2023). "On the inclusiveness of the education system in a multination state from the perspective of primary school children and teachers' values" in International perspectives on inclusive education: In the light of educational justice. eds. S. Seitz, P. Auer and R. Bellacicco (Leverkusen: Verlag Barbara Budrich), 119–140.

Barnes, D. R. (2008). "Exploratory talk for learning", in exploring talk in school: Inspired by the work of Douglas Barnes. Cham: SAGE Publications Ltd.

Barneva, R. P., Gelsomini, F., Kanev, K., and Bottoni, P. (2018). Tangible technology-enhanced learning for improvement of student collaboration. *J. Educ. Technol. Syst.* 46, 284–302. doi: 10.1177/0047239517736875

Basilotta Gómez-Pablos, V., Martín del Pozo, M., and García-Valcárcel Muñoz-Repiso, A. (2017). Project-based learning (PBL) through the incorporation of digital technologies: an evaluation based on the experience of serving teachers. *Comput. Human Behav.* 68, 501–512. doi: 10.1016/j.chb.2016.11.056

Beers, P. J., Boshuizen, H., Kirschner, P., and Gijselaers, W. (2005). Computer support for knowledge construction in collaborative learning environments. *Comput. Human Behav.* 21, 623–643. doi: 10.1016/j.chb.2004.10.036

Berger, F., Schreiner, C., Hagleitner, W., Jesacher-Rößler, L., Roßnagl, S., and Kraler, C. (2021). Predicting coping with self-regulated distance learning in times of COVID-19: evidence from a longitudinal study. *Front. Psychol.* 12:701255. doi: 10.3389/fpsyg.2021.701255

Björnsdóttir, K., Snæfríðar, G. H., and Gunnarsdóttir, E. D. (2024). The digital exclusion of people with intellectual disabilities during the COVID-19 pandemic. *Scand. J. Disabil. Res.* 26, 505–517. doi: 10.16993/sjdr.1131

Boblett, N. (2018). Doing exploratory talk in the language classroom: a sequential account. *Hacettepe Univ. J. Educ.* 33, 1–17. doi: 10.16986/HUJE.2018038806

Börnert-Ringleb, M., Casale, G., and Hillenbrand, C. (2021). What predicts teachers' use of digital learning in Germany? Examining the obstacles and conditions of digital learning in special education. *Eur. J. Spec. Needs Educ.* 36, 80–97. doi: 10.1080/08856257.2021.1872847

Boyle, C., and Allen, K.-A. (2023). "Understanding the issues in inclusive education: working towards equitable and accessible education for all students" in Research for inclusive quality education. eds. C. Boyle and K. A. Allen (Berlin: Springer), 1–9.

Bringle, R. G., and Clayton, P. H. (2020). Integrating service learning and digital technologies: examining the challenge and the promise. *RIED* 23, 43–65. doi: 10.5944/ried.23.1.25386

Buchner, T., and Proyer, M. (2019). From special to inclusive education policies in Austria – developments and implications for schools and teacher education. *Eur. J. Teach. Educ.* 43, 83–94. doi: 10.1080/02619768.2019.1691992

DiStefano, R., Grenell, A., Palmer, A. R., Houlihan, K., Masten, A. S., and Carlson, S. M. (2021). Self-regulation as promotive for academic achievement in young children across risk contexts. *Cogn. Dev.* 58:101050. doi: 10.1016/j.cogdev.2021.101050

Dochy, F., Segers, M. S. R., van den Bossche, P. G., and Gijbels, D. (2003). Effects of problem-based learning: a meta-analysis. *Learn. Instr.* 13, 533–568. doi: 10.1016/S0959-4752(02)00025-7

Doran, A. L., Dutch, V., Warren, B., Watson, R. A., Murphy, K., Aldis, A., et al. (2024). Planning virtual and hybrid events: steps to improve inclusion and accessibility. *Geosci. Commun.* 7, 227–244. doi: 10.5194/gc-7-227-2024

Du, Z., Wang, F., Wang, S., and Xiao, X. (2022). Enhancing learner participation in online discussion forums in massive open online courses: the role of mandatory participation. *Front. Psychol.* 13:819640. doi: 10.3389/fpsyg.2022.819640

European Commission, Directorate-General for Education, Youth, Sport and Culture (2023). Digital education action plan 2021–2027 – Improving the provision of digital skills in education and training: Publications Office of the European Union. Available at: https://data.europa.eu/doi/10.2766/149764

Fernández-Batanero, J. M., Montenegro-Rueda, M., Fernández-Cerero, J., and García-Martínez, I. (2022). Assistive technology for the inclusion of students with disabilities: a systematic review. *Tech. Research Dev.* 70, 1911–1930. doi: 10.1007/s11423-022-10127-7

Fernández-Villardón, A., Alvarez, P., Ugalde, L., and Tellado, I. (2020). Fostering the social development of children with special educational needs or disabilities (SEND) through dialogue and interaction: a literature review. *Soc. Sci.* 9:97. doi: 10.3390/socsci9060097

Fischer, F., Troendle, P., and Mandl, H. (2003). Using the internet to improve university education: problem-oriented web-based learning with MUNICS. *Interact. Learn. Environ.* 11, 193–214. doi: 10.1076/ilee.11.3.193.16546

Fleming, D. L. (2008). Using best practices in online discussion and assessment to enhance collaborative learning. *Coll. Teach. Methods Styles J.* 4, 21–40. doi: 10.19030/ctms.v4i10.5573

Funke, F., and Reips, U.-D. (2012). Why semantic differentials in web-based research should be made from visual analogue scales and not from 5-point scales. *Field Methods* 24, 310–327. doi: 10.1177/1525822X12444061

Garwood, J. D., Peltier, C., Ciullo, S., Wissinger, D., McKenna, J. W., Giangreco, M. F., et al. (2023). The experiences of students with disabilities actually doing service learning: a systematic review. *J. Exp. Educ.* 46, 5–31. doi: 10.1177/10538259221109374

Gillies, R. M. (2016). Cooperative learning: review of research and practice. *Aust. J. Teach. Educ.* 41, 39–54. doi: 10.14221/ajte.2016v41n3.3

Gillies, R. M. (2020). Dialogic teaching during cooperative inquiry-based science: a case study of a year 6 classroom. *Educ. Sci.* 10:328. doi: 10.3390/educsci10110328

Groenke, S. L., and Paulus, T. M. (2007). The role of teacher questioning in promoting dialogic literary inquiry in computer-mediated communication. *J. Res. Technol. Educ.* 40, 141–164. doi: 10.1080/15391523.2007.10782502

Haleem, A., Javaid, M., Qadri, M. A., and Suman, R. (2022). Understanding the role of digital technologies in education: a review. *Sust. Oper. Comput.* 3, 275–285. doi: 10.1016/j.susoc.2022.05.004

Hank, C., and Huber, C. (2024). Do peers influence the development of individuals' social skills? The potential of cooperative learning and social learning in elementary schools. *Int. J. Appl. Posit. Psychol.* 9, 747–773. doi: 10.1007/s41042-024-00151-8

Hank, C., Weber, S., and Huber, C. (2023). Die Rolle des Kooperativen Lernens bei der Förderung sozialer integration: Eine Interventionsstudie [the role of cooperative learning in promoting social integration: an intervention-study]. *Unterrichtswiss* 52, 391–416. doi: 10.1007/s42010-023-00174-1

Hassan, M. M., and Mirza, T. (2020). Information and communication technology (ICT) in the distance education system: an overview. *IOSR J. Res. Method Educ.* 10, 38–42. doi: 10.9790/7388-1006053842

Hattie, J. A. C. (2009). Visible learning: A synthesis of over 800 Meta-analyses relating to achievement. Abingdon: Routledge.

Ianes, D., Demo, H., and Dell'Anna, S. (2020). Inclusive education in Italy: historical steps, positive developments, and challenges. *Prospects* 49, 249–263. doi: 10.1007/s11125-020-09509-7

Jönsson, A., and Prins, F. (2019). Editorial: transparency in assessment—exploring the influence of explicit assessment criteria. *Front. Educ.* 3:119. doi: 10.3389/feduc.2018.00119

Kerawalla, L., Petrou, M., and Scanlon, E. (2013). Talk factory: supporting 'exploratory talk' around an interactive whiteboard in primary school science plenaries. *Technol. Pedagogy Educ.* 22, 89–102. doi: 10.1080/1475939X.2012.745049

Kerawalla, L., Chudasama, M., and Messer, D. J. (2023). "We can make our words powerful": students' perspectives about using talk factory, a classroom technology to support exploratory talk. *English Educ.* 57, 28–44. doi: 10.1080/04250494.2022.2135431

Khong, T. D. H., Saito, E., and Gillies, R. (2019). Key issues in productive classroom talk and interventions. *Educ. Rev.* 71, 334–349. doi: 10.1080/00131911.2017.1410105

Kim, M.-Y., and Wilkinson, I. A. G. (2019). What is dialogic teaching? Constructing, deconstructing, and reconstructing a pedagogy of classroom talk. *Learn. Cult. Soc. Inter.* 21, 70–86. doi: 10.1016/j.lcsi.2019.02.003

Kim, H. J., Park, J. H., Yoo, S., and Kim, H. (2016). Fostering creativity in tablet-based interactive classrooms. *Educ. Technol. Soc.* 19, 207–220.

Kokotsaki, D., Menzies, V., and Wiggins, A. (2016). Project-based learning: a review of the literature. *Improv. Sch.* 19, 267–277. doi: 10.1177/1365480216659733

Krajcik, J., and Shin, N. (2014). "Project-based learning" in The Cambridge handbook of the learning sciences. ed. R. Sawyer (Cambridge: Cambridge University Press), 275–297.

Krämer, S., Möller, J., and Zimmermann, F. (2021). Inclusive education of students with general learning difficulties: a meta-analysis. *Rev. Educ. Res.* 91, 432–478. doi: 10.3102/0034654321998072

Kumar Basak, S., Wotto, M., and Bélanger, P. (2018). M-learning and D-learning: Conceptual definition and comparative analysis. *E-Learning Digital Media* 15, 191–216. doi: 10.1177/2042753018785180

Laal, M., Geranpaye, L., and Daemi, M. (2013). Individual accountability in collaborative learning. *Procedia Soc.* 93, 286–289. doi: 10.1016/j.sbspro.2013.09.191

Li, W., Gillies, R., He, M., Wu, C., Liu, S., Gong, Z., et al. (2021). Barriers and facilitators to online medical and nursing education during the COVID-19 pandemic: perspectives from international students from low- and middle-income countries and their teaching staff. *Hum. Resour. Health* 19:64. doi: 10.1186/s12960-021-00609-9

Llorent, V. J., Núñez-Flores, M., and Kaakinen, M. (2024). Inclusive education by teachers to the development of the social and emotional competencies of their students in secondary education. *Learn. Instr.* 91:101892. doi: 10.1016/j.learninstruc.2024.101892

Long, T., and Guo, J. (2023). Moving beyond inclusion to belonging. *Int. J. Environ. Res. Public Health* 20:6907. doi: 10.3390/ijerph20206907

Maier, U., and Klotz, C. (2022). Personalized feedback in digital learning environments: classification framework and literature review. *Comput. Educ.* 3:100080. doi: 10.1016/j.caeai.2022.100080

Mebert, L., Barnes, R., Dalley, J., Gawarecki, L., Ghazi-Nezami, F., Shafer, G., et al. (2020). Fostering student engagement through a real-world, collaborative project across disciplines and institutions. *High. Educ. Pedagog.* 5, 30–51. doi: 10.1080/23752696.2020.1750306

Merritt, E., Harkins, T., and Rimm-Kaufman, S. (2021). Empowering elementary students through environmental service-learning. *Clearing*, 8–11.

Michaels, S., O'Connor, C., and Resnick, L. B. (2008). Deliberative discourse idealized and realized: accountable talk in the classroom and in civic life. *Stud. Philos. Educ.* 27, 283–297. doi: 10.1007/s11217-007-9071-1

Ministry of Education, Government of India. (2020). National Education Policy 2020. Available at: https://www.education.gov.in/nep/about-nep (Accessed May 19, 2024).

Navarro-Mateu, D., Gómez-Domínguez, T., Padrós Cuxart, M., and Roca-Campos, E. (2021). Dialogic learning environments that enhance instrumental learning and inclusion of students with special needs in secondary education. *Front. Psychol.* 12:662650. doi: 10.3389/fpsyg.2021.662650

Neuenschwander, R., Röthlisberger, M., Cimeli, P., and Roebers, C. M. (2012). How do different aspects of self-regulation predict successful adaptation to school? *J. Exp. Child Psychol.* 113, 353–371. doi: 10.1016/j.jecp.2012.07.004

Ng, D. T. K., Leung, J. K. L., Su, J., Ng, R. C. W., and Chu, S. K. W. (2023). Teachers' AI digital competencies and twenty-first century skills in the post-pandemic world. *Educ. Techn. Res. Dev.* 71, 137–161. doi: 10.1007/s11423-023-10203-6

Ozan, C., and Kıncal, R. Y. (2018). The effects of formative assessment on academic achievement, attitudes toward the lesson, and self-regulation skills. *Educ. Sci.* 18, 85–118. doi: 10.12738/estp.2018.1.0216

Parker, R. E. (1985). Small-group cooperative learning-improving academic, social gains in the classroom. *NASSP Bull.* 69, 48–57. doi: 10.1177/019263658506947908

Patterson, E. W. (2018). Exploratory talk in the early years: analysing exploratory talk in collaborative group activities involving younger learners. *Education* 46, 264–276. doi: 10.1080/03004279.2016.1243141

Pit-ten Cate, I. M., Markova, M., Krischler, M., and Krolak-Schwerdt, S. (2018). Promoting inclusive education: the role of teachers' competence and attitudes. *Insights Learn. Disab.* 15, 49–63.

Puji, A., and Barratt, L. (2018). Individual accountability in cooperative learning in EFL classrooms: more opportunities for peer interaction. *J. AsiaTEFL* 15, 1–16. doi: 10.18823/asiatefl.2018.15.1.1.1

Qualtrics, XM Software (2023). Available at: https://www.qualtrics.com (Accessed May 18, 2023).

Queirós, A., Faria, D., and Almeida, F. (2017). Strengths and limitations of qualitative and quantitative research methods. *Eur. J. Educ. Stud.* 3, 369–387. doi: 10.5281/zenodo.887089

Rehman, N., Zhang, W., Mahmood, A., Fareed, M. Z., and Batool, S. (2023). Fostering twenty-first century skills among primary school students through math project-based learning. *Humanit. Soc. Sci. Commun.* 10:424. doi: 10.1057/s41599-023-01914-5

Richardson, A. E. (2010). Exploring text through student discussions: accountable talk in the middle school classroom. *The Eng. J.* 100, 83–88. doi: 10.2307/20787697

Rimm-Kaufman, S. E., Merritt, E. G., Lapan, C., DeCoster, J., Hunt, A., and Bowers, N. (2021). Can service-learning boost science achievement, civic engagement, and social skills? A randomized controlled trial of connect science. *J. Appl. Dev. Psychol.* 74:101236. doi: 10.1016/j.appdev.2020.101236

Roster, C. A., Lucianetti, L., and Albaum, G. (2015). Exploring slider vs. categorical response formats in web-based surveys. *J. Res. Pract.* 11:1.

Sahli Lozano, C., Wüthrich, S., Setz, F., Romano, A., and Petruccioli, R. (2024). A look across the borders: Swiss vs. Italian future special education teachers' perspectives on inclusive education. *J. Res. Spec. Educ. Needs* 1, 1–15. doi: 10.1111/1471-3802.12734

Salam, M., Awang Iskandar, D. N., Ibrahim, D. H. A., and Farooq, M. S. (2019). Service learning in higher education: a systematic literature review. *Asia Pac. Educ. Rev.* 20, 573–593. doi: 10.1007/s12564-019-09580-6

Sarfo, F. K., and Elen, J. (2011). Investigating the impact of positive resource interdependence and individual accountability on students' academic performance in cooperative learning. *Electron. J. Res. Educ. Psychol.* 9, 73–94.

Seitz, S., Auer, P., and Bellacicco, R. (2023). "Introduction — in the light of educational justice: international perspectives on inclusion" in International perspectives on inclusive education. In the light of educational justice. eds. S. Seitz, P. Auer and R. Bellacicco (Opladen, New York: Verlag Barbara Budrich).

Serdar, C. C., Cihan, M., Yücel, D., and Serdar, M. A. (2021). Sample size, power and effect size revisited: simplified and practical approaches in pre-clinical, clinical and laboratory studies. *Biochem. Med.* 31:010502, 27–53. doi: 10.11613/BM.2021.010502

Silveira-Zaldivar, T., Özerk, G., and Özerk, K. (2021). Developing social skills and social competence in children with autism. *Int. Electr. J. Element. Educ.* 13, 341–363. doi: 10.26822/iejee.2021.195

Stalmach, A., D'Elia, P., Di Sano, S., and Casale, G. (2023). Digital learning and self-regulation in students with special educational needs: a systematic review of current research and future directions. *Educ. Sci.* 13:1051. doi: 10.3390/educsci13101051

Stalmach, A., D'Elia, P., Di Sano, S., and Casale, G. (2024). Digital methods to promote inclusive and effective learning in schools: a mixed methods research study. *Open Educ. Stud.* 6:20240023. doi: 10.1515/edu-2024-0023

Taherdoost, H. (2022). Designing a questionnaire for a research paper: a comprehensive guide to design and develop an effective questionnaire. *Asian J. Manag. Sci.* 11, 8–16. doi: 10.51983/ajms-2022.11.1.3087

Tao, L., Yang, Y., Ma, X., Fu, L., and Liu, S. (2023). Teachers' and students' perspectives on the needs of community practice teachers: a cross-sectional study. *BMC Med. Educ.* 23:486. doi: 10.1186/s12909-023-04456-1

Tran, V. D. (2019). Does cooperative learning increase students' motivation in learning? *Int. J. High. Educ.* 8, 12–20. doi: 10.5430/ijhe.v8n5p12

Tursynkulova, E., Madiyarov, N., Sultanbek, T., and Duysebayeva, P. (2023). The effect of problem-based learning on cognitive skills in solving geometric construction problems: a case study in Kazakhstan. *Front. Educ.* 8:1284305. doi: 10.3389/feduc.2023.1284305

United Nations (2006). Convention on the rights of persons with disabilities. *Treaty Series* 2515:3.

Val, S., and López-Bueno, H. (2024). Analysis of digital teacher education: key aspects for bridging the digital divide and improving the teaching–learning process. *Educ. Sci.* 14:321. doi: 10.3390/educsci14030321

Warren, J. L. (2012). Does service-learning increase student learning?: a Meta-analysis. *Michigan J. Commun. Serv. Learn.* 18, 56–61.

Webb, N. (2009). The teacher's role in promoting collaborative dialogue in the classroom. *Br. J. Educ. Psychol.* 79, 1–28. doi: 10.1348/000709908X380772

Weber, S., and Huber, C. (2020). Förderung sozialer integration durch Kooperatives Lernen – Ein systematisches review [improved social integration as a result of cooperative learning – a systematic review]. *Empirische Sonderpädagogik* 12, 257–278. doi: 10.25656/01:21611

Woodcock, S., Hitches, E., and Manning, A. (2023). "'The hardest part is…': teacher self-efficacy and inclusive practice. *Int. J. Educ. Res. Open* 5:100289. doi: 10.1016/j.ijedro.2023.100289

Zhang, R., Shi, J., and Zhang, J. (2023). Research on the quality of collaboration in project-based learning based on group awareness. *Sustain. For.* 15:11901. doi: 10.3390/su151511901

Zhang, Q., Shi, B., Liu, Y., Liang, Z., and Qi, L. (2024). The impact of educational digitalization on the creativity of students with special needs: the role of study crafting and creative self-efficacy. *Human. Soc. Sci. Commun.* 11:754. doi: 10.1057/s41599-024-03232-w