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FROM AI KNOWLEDGE TO INCLUSIVE PRACTICE: HOW SMARTED SUPPORTS TEACHER LEARNING AND INCLUSIVE EDUCATION

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ABSTRACT

This paper will analyze how the three interrelated intellectual outputs from the Erasmus+ SmartEd project can facilitate AI-related knowledge among teachers. To conduct a qualitative document analysis, the three intellectual outputs, namely the Teacher Training Program: AI Integration for Inclusive Education (IO1); the Adaptive Learning Modules: Tailored AI Solutions for Diverse Learners (IO2); and the SmartEd AI Learning Platform and its virtual-piloting report (IO3) were analyzed against the following five dimensions: AI basics and critical literacy; pedagogical application and instructional design; inclusion, differentiation and accessibility; ethics, human agency and responsible use; and reflection, collaboration and continuing professional learning. The findings reveal a coherent developmental pathway. Firstly, IO1 prepares the teacher participants for understanding AI concepts, ethical issues and pedagogy in terms of seven modules with a variety of structured activities including tool exploring, case analysis, collaborative work, self-assessment and reflection. Secondly, IO2 turns this conceptual knowledge into practice by using 70 adaptive activities related to different subjects. Thirdly, IO3 provides flexible and self-paced access to the learning material that will be useful beyond one training session. The evidence base to support the perceived relevance of the material is provided through descriptive evidence obtained through a seven-country virtual piloting with 206 teachers. During the virtual piloting, 91.7% of respondents evaluated the platform as high regarding the promotion of understanding of AI in inclusive education, 92.2% regarding the practical applicability, 93.2% regarding confidence and readiness and 94.2% regarding facilitating inclusive and differentiated methods. Thus, this study revealed the transferable professional-learning model of developing AI literacy, designing instruction, applying AI in an inclusive manner and developing reflectively. However, the evidence is perception-based only and cannot prove any causal effect on practice or learning outcomes.

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INTRODUCTION

Integrating artificial intelligence is now common in lesson preparation, content creation, assessments, feedback, accessibility and student support. The educational utility of AI tools cannot, however, be assumed based on the availability of these instruments. Teachers need to possess enough conceptual knowledge to understand the capabilities of AI-based systems, pedagogical knowledge to integrate them in line with learning objectives and ethical competence to secure human autonomy, privacy, equity and participation. Accordingly, recent international frameworks define teacher AI competence as a multifaceted professional attribute rather than a single technical one (European Commission, 2026; Miao and Cukurova, 2024). The importance of professional learning is even greater in inclusive education. AI can serve to facilitate personalization, multimodal communication, language help, adaptive feedback and new ways of participating in learning. Simultaneously, issues related to interface accessibility, bias in data, lack of transparency and uneven access may reproduce or even aggravate exclusion (Li *et al*., 2025; Melo-López *et al*., 2025). Thus, the design of AI-enhanced instruction in inclusive education should start from recognizing the variability of learners and eliminating unnecessary barriers, not reducing everything to automation. Professional development of

teachers is more likely to affect their practice when it is coherent, content-oriented, active, sustained and contextually situated (Desimone, 2009; Guskey, 2002). In relation to AI-related professional learning, these criteria imply moving from core concepts to tool testing, designing instruction, reflection on consequences and practice adaptation. Systematic reviews indicate that teachers commonly appreciate practical and context-relevant training but often have concerns about limited time, lack of follow-up, the need for ethical guidance and lack of examples from their discipline (Aljemely, 2024; Brandão *et al*., 2024; Tan *et al*., 2025). SmartEd – AI Integration in Schools (2024-1-LT01-KA220-SCH-000244021) was developed as a European response to this need. Its three intellectual outputs were designed as interconnected resources: a teacher-training programme on AI integration for inclusive education (IO1), adaptive learning modules offering tailored AI solutions for diverse learners (IO2), and an AI learning platform that reorganises the training content for flexible digital access and professional learning (IO3). Rather than presenting these outputs as a catalogue of project products, the present article analyses the educational logic connecting them.

The purpose of the study is to examine how the SmartEd outputs support the development of teachers' AI knowledge and professional competence and how inclusive education is embedded across their structure, content and implementation. The study addresses three research questions: (1) How do IO1–IO3 support teachers' AI knowledge and pedagogical competence? (2) How are inclusion, differentiation and accessibility embedded across the outputs? and (3) How do the outputs form a coherent pathway from professional learning to inclusive classroom practice?

CONCEPTUAL BACKGROUND

Teacher AI competence and professional learning: Teacher AI competence combines technological understanding with pedagogical reasoning, professional judgement and ethical responsibility. The UNESCO AI Competency Framework for Teachers organises competence around a human-centred mindset, ethics, AI foundations and applications, AI pedagogy and AI for professional learning, with progression from acquisition to deeper application and creation (Miao and Cukurova, 2024). Similarly, the European Commission's ethical guidelines ask educators to examine purpose, transparency, data use, fairness, agency and accountability when deploying AI and data in teaching (European Commission, 2026). These frameworks position teachers as informed decision-makers, not passive users of commercial tools. This approach builds upon existing frameworks of digital competencies of teachers. DigCompEdu places importance on the professionals' engagement in work; digital resources; teaching and learning; assessment; empowerment of learners and the promotion of learners' digital competencies (Redecker and Punie, 2017). Similarly, the technological pedagogical content knowledge framework claims that technology integration depends on the intersection between technology, pedagogy and content and not on technology skills alone (Mishra and Koehler, 2006). In the case of AI, professional development should include interpreting system functionalities, choosing appropriate tools based on a sound pedagogical rationale, adjusting these tools to students' needs and assessing their impact. The design of professional development is also critical in achieving these goals. According to Desimone (2009), the following characteristics can be considered crucial in order to achieve teacher learning and change: content focus; active learning; coherence; duration and collective participation. Moreover, Guskey (2002) highlights that continuous change depends on the experience of enhanced practice and results gained by teachers. Training limited to demonstration activities may lead to increased awareness but will unlikely contribute to transferring skills. Experimentation, analysis, classroom-related tasks, assessment and reflection are needed to go beyond theoretical knowledge of AI and apply it meaningfully.

Inclusive pedagogy, learner variability and AI: Inclusive pedagogy does not assume that the accommodation for one group of learners should be provided independently of their access to learning opportunities, but tries to increase what is typically provided for all participants, taking into account their differences in participation and support (Florian and Black-Hawkins, 2011). The principle of Multiple Means of Engagement, Representation and Action or Expression of UDL implies a similar approach with the larger goal of learner agency and elimination of barriers (CAST, 2024). AI may be used to achieve these goals through the provision of alternative explanations, variation in linguistic complexity, translation, multimodal presentations, scaffolded exercises and diverse responses. However, personalization is not necessarily inclusion. Personalization may reduce opportunities for learning, provide incorrect categorizations of the students or shift the responsibility of pedagogical choices to the AI system. Reviews of the recent literature highlight both accessibility features of AI and persistent issues of potential biases, data protection problems, lack of teachers' readiness, and under-researched impact on disabled learners (Li *et al*., 2025; Melo-López *et al*., 2025).

MATERIALS AND METHODS

Study design and document corpus: The research methodology involved qualitative document analysis within the project-based case study approach. This method is suitable for researching the ways in which educational ideas, concepts and mechanisms of implementation are portrayed in interrelated programme materials (Bowen, 2009). The main corpus included the full English versions of the three intellectual outputs of the SmartEd project and its virtual-piloting report.

IO1: Teacher Training Program: AI Integration for Inclusive Education consists of seven modules including an introduction to AI in education, inclusive education fundamentals, adaptation of AI applications for learners with special needs, differentiated instruction based on AI, responsible and ethical AI use, collaborative learning through AI and evaluation and reflection. Each of the modules has ten structured activities including objectives, learning outcomes, materials, guided procedures and assessment/reflection activities. IO2: Adaptive Learning Modules: Tailored AI Solutions for Diverse Learners has seven cross-curricular modules and more than 70 activities.IO3 comprises the SmartEd AI Learning Platform and its modular audiovisual learning resources. The virtual pilot report provides aggregate descriptive feedback on the platform from 206 educators in seven partner countries.

Analytical procedure: A directed coding framework was developed from the study questions and the conceptual literature. The analysis examined explicit objectives, learning

outcomes, activity structures, adaptation guidance, assessment prompts and mechanisms for continued learning. Five dimensions were applied across the corpus: (a) AI foundations and critical literacy; (b) pedagogical application and instructional design; (c) inclusion, differentiation and accessibility; (d) ethics, human agency and responsible use; and (e) reflection, collaboration and continuing professional learning. Coding focused on the function of each output and on the progression created by their combined use. Repeated reading and constant comparison were used to refine the categories and identify cross-output patterns.

Table 1. Analytical framework applied to the SmartEd outputs

Dimension — indicative evidence and professional-learning function
AI foundations and critical literacy — Concepts, capabilities, limitations and tool evaluation; builds informed understanding and professional judgement.
Pedagogical application — Lesson design, subject examples, scaffolding and assessment; connects AI use to learning goals and classroom decisions.
Inclusion, differentiation and accessibility — Learner variability, adaptations, multimodality and special educational needs; removes barriers and expands participation.
Ethics and human agency — Privacy, bias, transparency, equitable access and teacher oversight; supports responsible and accountable use.
Reflection and continuing learning — Self-assessment, collaboration, feedback and modular access; sustains professional growth and iterative improvement.

Use of virtual-pilot evidence: The pilot report served as evidence but was not considered proof of the learners' progress. The percentages were stated descriptively using the overall report of the project. In order to make interpretation easy, the proportion that rated the responses 4 or 5 was added to each other. There was no personal data involved, there were no analyses done and no cause-and-effect relationship was established. The evidence was the perception of the teachers after the platform was utilized.

Reflexivity and ethical considerations: The authors participated in the SmartEd project activities and the development of its content. In this role, the authors had comprehensive contextual understanding, while at the same time there was a possibility of interpretative bias. To counterbalance this potential bias, the researcher made a clear distinction between intentions behind the design and perceptions that emerged during the pilot stage, used negative feedback, and restricted the scope of conclusion to the information available in the project materials.

RESULTS

IO1: Building AI knowledge, pedagogical readiness and critical agency: IO1 provides the conceptual basis of the SmartEd path. Its evolution begins with artificial intelligence basic concepts and its usage in education and then moves on to inclusive education, accommodations, differentiated instruction, ethics, collaboration, and assessment. The order here matters: teachers start from learning how to understand AI systems and their limitations before proceeding to the evaluation of the potential usage of such systems in pedagogy and inclusivity. AI is always seen in terms of a tool complementing rather than replacing the work of a teacher. The professional learning design puts active learning before exposition. It involves case studies, explorations of the tools, collaborative discussions, lesson redesign, scenario assessment, and self-assessment. Teachers have to evaluate advantages and limitations of the approaches, compare tools, predict obstacles, adapt resources, and justify choices made. Forms for reflection and confidence evaluations provide an ongoing opportunity for the evaluation of knowledge acquisition. The process helps to transition from declarative knowledge – knowledge about AI, to conditional and procedural knowledge – knowledge why, when and how to use AI. Inclusion is introduced as a central organising principle. The modules address diverse cognitive, linguistic, sensory, physical and developmental needs; differentiation of content, process and product; accessible and multimodal resources; and the adaptation of AI tools to individual goals. Ethical content extends the inclusive orientation by examining privacy, bias, fairness, transparency and equitable access. The programme therefore links professional competence to responsibility: teachers are expected to evaluate not only whether an AI application works, but also for whom it works, under what conditions and with what possible consequences.

IO2: Translating professional knowledge into adaptive classroom design: IO2 implements knowledge obtained from IO1. The seven subject-oriented modules in IO2 – interactive learning adventures, adaptive math, personalized language learning, inclusive sciences, social studies, arts and personal development – have over 70 activities. The modules include objectives, outcomes, resources, methods, assessment, and adaptations. Thus, the modules shorten the gap between general professional knowledge and classroom planning. Activities demonstrate a number of mechanisms of inclusive design that recur. Information can be presented in text, image, audio, symbol, simulation and interaction forms. The task can be simplified, extended, or broken into smaller steps. The learner's response can be made by writing, speaking, making visual product, performing role play, or working in collaboration. Artificial intelligence is used for language adaptation, generating ideas, giving feedback, visualization, and adaptive practice, while the teacher is in charge of selecting, verifying and adapting information.

Customized language learning is one of the examples of how logic of output is implemented in practice. This module uses AI-assisted language adaptation, multimodal prompts, scaffolding of production and alternative response mode to accommodate different learning styles and levels of proficiency. The same logic is followed in designing other subjects' lessons. IO2 also supports professional development by functioning as a repertoire rather than a fixed script. Teachers can adapt activity templates to their own subjects, learner profiles and local conditions. The resource therefore provides worked examples of technological-pedagogical reasoning: it makes visible how an AI capability can be connected to a learning objective, a form of scaffolding and a method of assessment.

IO3: Flexible access, consolidation and continuing professional learning: IO3 converts the instructional materials into a modularized digital learning tool. This tool provides the opportunity for studying independently, accessing the materials continuously, and engaging selectively with modules relevant to professionals' needs. As per the feedback from the

pilot test, it is observed that the clear structure, mobile-friendly design, and no need for signing up were appreciated by the participants. This is important from the perspective of the continuing professional development, since teachers have the possibility to return to the resources in the course of planning and can use the tool not only during training. Moreover, IO3 incorporates the sequence of professional learning from the project. Concepts, examples from the classroom, and reflective practice are provided within one digital tool, providing the possibility for teachers with different experience in using AI tools to start their journey from the convenient point. According to the feedback from the pilot, 26.2% of the respondents did not use AI tools before and wanted to learn more about them, while 36.9% frequently used them.

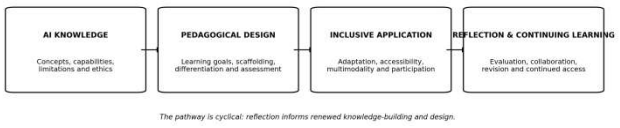
Table 2. Selected virtual-pilot indicators (N = 206)

Indicator — Rating 5 / Ratings 4-5
Relevance to professional needs — 65.5% / 87.8%
Understanding AI for inclusive education — 73.3% / 91.7%
Practical applicability — 72.3% / 92.2%
Confidence in using AI tools — 74.8% / 93.2%
Readiness to integrate AI — 73.3% / 93.2%
Inclusive and differentiated methods — 74.3% / 94.2%
Recommendation to other educators — 85.0% / 95.7%
Overall satisfaction — 85.9% / 95.6%

The strongest ratings concerned the dimensions most directly related to professional transfer. Ratings of 4 or 5 were given by 91.7% of respondents for understanding AI in inclusive education, 92.2% for practical applicability, 93.2% for confidence, 93.2% for readiness to integrate AI and 94.2% for using inclusive and differentiated methods. Module 3, Adaptation of AI Tools, was the most frequently identified as valuable (59.2%), followed by collaborative learning (56.3%) and effective use of multimedia (51.9%). Open responses highlighted organisation, practical relevance, ease of mobile access and value for beginners. Suggestions for improvement included more classroom cases, additional interactive exercises, shorter versions of some materials, follow-up training and examples from different subjects.

A coherent pathway from knowledge to inclusive practice: The cross-document analysis describes a four-step process of professional development. IO1 produces awareness and readiness. IO2 provides worked designs that allow teachers to implement and adjust this awareness. IO3 provides flexibility for access and usage. The processes of reflection and evaluation occur throughout these three steps, bringing together the experience and future professional development.

Figure 1. SmartEd professional-learning pathway



The four stages connect AI knowledge, pedagogical design, inclusive application, and reflection and continuing professional development. The process is more cyclic in nature than it is linear. The teacher may start off with a problem within the class, refer to IO2, return to IO1 to get some theoretical or moral perspective, and then use IO3 for further study. The biggest strength of this model comes from its synthesis of knowledge, design, implementation, and reflection. Rather than being something added at the end, inclusion is a standard used in the selection of tools, instructional modification, participant involvement, and evaluation throughout the pathway.

DISCUSSION

The results reveal that the outputs of SmartEd facilitate professional learning because they combine three components that are often considered in isolation in AI initiatives: literacy in concepts, instructional design, and pedagogy that includes inclusiveness. Such an approach resonates with competence frameworks that combine AI, pedagogy, ethics, and professional learning (Miao and Cukurova, 2024). It is also similar to the TPACK principle according to which technology becomes meaningful in education through the connection with pedagogy and content (Mishra and Koehler, 2006). IO1 offers more depth and progression than a simple introduction to the use of tools; it focuses on limitations, ethical issues, special educational needs, differentiation, collaboration, and reflection. IO1 includes ten activities for each module, allowing active learning, joint discussions and self-assessment. These qualities are in line with features of successful professional development programs (Desimone, 2009). The suggested long period of implementation is more consistent than one-off awareness workshop, but there is no available documentation about the completion of the entire course by all participants.

IO2 serves as the main approach for professional transfer. It is common that teachers see lack of relevant and ready-to-use examples as a challenge to using AI (Aljemely, 2024; Brandão *et al*., 2024). The adaptive modules provide examples related to a specific subject matter: examples of relevant scenarios, materials, assessments, and adaptations. These modules become pedagogical examples that demonstrate how AI may be used for some educational purpose without excluding the responsibility of the teacher for the curriculum, for accurate information and learner well-being. It is possible to achieve the full potential of inclusive contribution of SmartEd only by taking into account all the outputs. IO1 provides explicit knowledge about inclusion and the needs of special education; IO2 takes into account multimodality, scaffolding, and other alternatives for participation in regular lessons; and IO3 increases the number of learning opportunities for teachers. In this way, the project fits into inclusive pedagogy and UDL by focusing on extending the repertoire of options rather than designing a new curriculum (CAST, 2024; Florian and Black-Hawkins, 2011). These pilot results provide some supportive, but constrained, evidence. High ratings of practical utility, self-confidence, preparedness, and methods involving inclusivity imply that teachers viewed the platform as professionally valuable. It is evident that the popularity of the modules devoted to adaptation, collaboration, and multimedia is another indication of the importance for the participants of material that pertained directly to classroom inclusion. Nevertheless, high satisfaction does not mean actual professional competency or implementation. In addition, the results correspond to the assumption that the outputs create conditions for professional learning; there is no evidence of changed practice of teachers or increased student engagement or performance.

One more strength of this approach has to do with its sustainability. Taking into consideration the rapidly changing landscape of the use of artificial intelligence in teaching and

learning practices, the risk is too high that any static training becomes obsolete. A digital structure allows for changes and updates and provides permanent access. On the other hand, sustainability would require proper governance since resources have to be reviewed periodically for accuracy, privacy, accessibility, and relevance.

RECOMMENDATIONS

- First, future use of the SmartEd outputs should combine self-paced platform study with facilitated professional learning. Short school-based learning cycles could ask teachers to study one module, adapt one activity, test it in context and discuss evidence with colleagues.
- Second, the platform should develop a concise implementation bank containing subject, age-group and learner-profile examples. Each case should document the educational objective, AI function, adaptation, teacher checks, ethical considerations and observed learner response.
- Third, accessibility and ethical review should become an annual maintenance process. Tools named in learning materials should be checked for changes in terms of use, data practices, cost, accessibility and age restrictions. Alternative tools or non-AI options should be provided where appropriate.
- Fourth, evaluation should move beyond satisfaction. Follow-up studies should examine classroom transfer through lesson artefacts, teacher interviews, observations and student participation indicators. A pre–post design or comparison condition would allow stronger conclusions about changes in competence.
- Finally, local professional-learning communities should be encouraged to adapt and translate resources while preserving the project's core principles of human-centred, inclusive and responsible AI use.

LIMITATIONS

This research makes use of project documentation and evaluations data collection. This research focuses on the contributions made by the outputs both in terms of intention and representation without focusing on the accuracy of implementation in all partner countries. The researcher's participation in this project might have been influenced by his bias despite having some reflexive measures. The pilot survey relied only on self-perceptions and had no control group or any pre–post test for competency assessment and proof of practice in the classroom. Without the individual level dataset, analyses of country level differences and association between previous experience and ratings were impossible. Outcome of the students, experiences of disabled learners and use of the platforms in the future were out of the scope of evidence collected. Lastly, the quick pace of change in AI technology might influence the relevance of certain tools.

CONCLUSION

SmartEd demonstrates how outputs for a project can be developed as a coherent learning trajectory for teachers instead of just standalone products. IO1 produces fundamental, pedagogical, and ethical knowledge related to AI, IO2 converts this knowledge into flexible and subject-oriented class designs, and IO3 enables convenient access and learning. Inclusion is operationalized across all three outputs through differentiation, adaptation, multimodality, accessibility, collaboration, and continuous reflection by teachers. The analysis of the data gathered during the virtual pilot showed that there is perceived high relevance of SmartEd for teachers' confidence and preparedness to use inclusive and differentiated methods. This gives the reasons to consider this product as suitable for wider implementation and additional investigation without making any causal conclusions on the impact of the intervention. Thus, the major contribution made by SmartEd is a design proposition for the future – teacher development in terms of knowledge of AI becomes more educational when these components are explicitly linked.

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CONFLICT OF INTEREST

The authors contributed to the SmartEd project and to the development of project materials. No commercial or financial conflict of interest is declared.

DATA AVAILABILITY

The analysis used the published SmartEd intellectual outputs and an aggregate virtual-piloting report. No individual participant dataset was used in this study. Project resources are available through the SmartEd project website and consortium repositories.

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