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# TICE Match Pro: An Intelligent Recommendation System for the Contextualized Integration of Information and Communication Technologies in Education

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**Research Article**

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## Abstract

**Background/purpose.** The TICE Match Pro system has been developed to address the persistent challenge of effectively integrating information and communication technologies in education. Given the abundance of digital resources and the varied constraints teachers face, selecting the most appropriate tools remains complex. This research aims to facilitate this selection process by providing personalized recommendations tailored to teachers' pedagogical and technical contexts.

**Materials/methods.** The system's design is grounded in theoretical frameworks such as TPACK (Technological Pedagogical Content Knowledge) and SAMR (Substitution, Augmentation, Modification, Redefinition). TICE Match Pro analyzes both instructional needs and technical constraints to generate contextualized recommendations. The approach involves matching teachers' profiles with suitable digital tools through an intuitive and accessible interface intended for regular classroom use.

**Results.** Expected outcomes include increased adoption of ICT, enhanced teaching practices, and improved alignment between pedagogical objectives and technological tools. The system also anticipates providing valuable insights for assessing the impact of ICT integration on educational practices.

**Conclusion.** TICE Match Pro offers a promising solution for optimizing ICT integration in education by bridging the gap between available digital resources and teachers' specific needs. Future empirical studies are planned to evaluate the system's effectiveness and acceptability in real- world classroom environments.

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## 1. Introduction

The integration of information and communication technologies for education (ICT) is now a strategic lever for improving the quality and effectiveness of learning. Numerous studies have shown that ICT promotes learner engagement, stimulates pedagogical innovation, and enhances interactivity in the classroom. However, despite these advantages, its adoption by teachers remains uneven. This situation can be explained by the diversity of tools available, the disparity of teaching contexts, and the lack of support in choosing the most appropriate digital solutions.

Faced with the proliferation of digital educational resources, many teachers say they feel overwhelmed, which limits their ability to integrate the tools into their practices in a meaningful way. In addition, existing recommendation systems often remain too generic and do not take into account the specific pedagogical needs or contextual constraints of teachers. These limitations highlight a significant gap in the research and development of intelligent solutions capable of providing contextualized and reliable recommendations. In this context, this study proposes the development of an intelligent recommendation system, TICE Match Pro, which aims to support teachers in making informed choices about digital tools suited to their teaching practices. By drawing on recognized theoretical models such as TPACK and SAMR, the system aims to add value by personalizing recommendations and taking local educational realities into account. This approach differs from previous work in its focus on the contextualized integration of ICT and its aim to respond to the specific challenges encountered in contemporary educational environments.

The study is therefore part of a research and development initiative aimed at filling a scientific and practical gap: to propose an innovative and operational model for techno-pedagogical recommendations that can enhance the effectiveness and equity of ICT integration in education.

## 2. Research Objectives and Hypotheses

The objectives of this research are divided into several strategic axes aimed at optimizing the integration of ICT in pedagogical practices. First, it is a question of designing an innovative recommendation system, TICE Match Pro, which integrates pedagogical, contextual and technical data in a synergistic way, in order to formulate suggestions for more relevant ICT tools adapted to the specific needs of teachers. Secondly, this study aims to assess the impact of personalisation of recommendations on the adoption of ICT tools by analysing how a tailor-made approach can positively influence teacher engagement. Third, it is essential to examine the transparency of the recommender system and its effect on user trust, as a clear understanding of the recommender mechanisms is important to foster teacher buy-in. Finally, this research aims to evaluate the long-term impact of the system on the quality of the integration of ICT in pedagogical practices, based on rigorous qualitative and quantitative analysis methodologies.

In this context, several hypotheses have been formulated to guide the design of the system and anticipate the expected effects of its use:

H1: A recommendation system integrating pedagogical, contextual, and technical data makes it possible to formulate suggestions for ICT tools that are more relevant than generic recommendations.

H2: The personalization of recommendations promotes a better adoption of ICT tools by teachers, by responding specifically to their needs and constraints.

H3: The transparency of the system reinforces teachers' confidence in the system by allowing them to understand the recommendation mechanisms.

H4: The use of the recommendation system has a positive effect on the quality of the integration of ICT into pedagogical practices, thus contributing to an improvement in learning outcomes.

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These objectives and hypotheses, articulated around an empirical approach, aim to contribute significantly to the literature on the integration of ICT and to propose concrete solutions for the challenges faced by contemporary educators.

## 3. Methodology

This research is part of a research and development (R&D) project aimed at designing, implementing, and evaluating the TICE Match Pro system. To ensure scientific rigor and reproducibility of results, the methodological plan adopted is based on three complementary and interdependent phases: needs analysis, system development, and empirical evaluation.

The first phase consisted of identifying teachers' expectations and constraints with regard to the integration of ICT in education.

- Participants: a sample of secondary school teachers (mathematics, life and earth sciences, physics, and chemistry) working in a variety of contexts (urban and rural).

- Instruments: a structured questionnaire collecting sociodemographic data as well as information on digital practices, obstacles encountered, and expectations. The items were formulated on a five-point Likert scale. Semi-structured interviews were conducted with a subsample to gain a deeper understanding of the perceptions and needs expressed.

- Procedure: the questionnaire was administered online and in person, on a voluntary basis. The anonymity of respondents was strictly respected.

- Objective: to obtain qualitative and quantitative data enabling teacher profiles to be drawn up and their specific needs in terms of integrating ICT in education to be identified.

The second phase focused on designing the TICE Match Pro system, using advanced machine learning and natural language processing (NLP) techniques.

- Data sources: A structured database of TICE tools, classified according to educational, disciplinary, and technical criteria; data entered by teachers (subject taught, grade level, educational objectives, technical constraints).

- Architecture: the recommendation engine was designed using a hybrid approach combining content-based filtering, collaborative filtering, and integration of the educational context in order to generate contextualized and tailored recommendations.

The final phase consisted of testing the system in real educational environments.

- Design: case studies were conducted in pilot schools, allowing us to observe how teachers used and adopted the system.

- Data collection procedures: system usage logs (digital traces), satisfaction and acceptability questionnaires, inspired by the Technology Acceptance Model (TAM), as well as post-experiment interviews with teachers.

- Analysis techniques: quantitative analysis, using both descriptive statistics (means, standard deviations, frequencies) and inferential statistics (correlation tests, ANOVA) to measure the impact of recommendations on the adoption of ICT tools; qualitative analysis, based on thematic coding of interviews, aimed at highlighting perceptions, obstacles, and levers associated with the use of the system; data triangulation, in order to reinforce the validity and reliability of the results obtained.

Finally, all stages of the research were conducted in accordance with ethical principles: obtaining informed consent, guaranteeing anonymity and data confidentiality, and transparency in the communication of results.

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## 4. Theoretical Framework

This research is structured around the intersection of three fundamental disciplinary fields, thus providing a solid conceptual basis for the development of the TICE Match Pro system:

### *4.1. ICT Pedagogical Integration Models: Frameworks*

such as TPACK (Technological Pedagogical Content Knowledge) and SAMR (Substitution, Augmentation, Modification, Redefinition) provide relevant analytical grids for assessing how technologies can transform educational practices. These models make it possible to identify synergies between technological, pedagogical, and disciplinary knowledge, while highlighting the importance of a thoughtful and contextual integration of digital tools.

### *4.2. Learning Theories*

Constructivist and socioconstructivist approaches shed light on how learners construct their knowledge through social interactions and personalized learning environments. These theories support the idea that adapting instructional content to the specific needs of each learner, as proposed by adaptive learning, is crucial to foster meaningful and sustainable engagement.

### *4.3. Foundations of Intelligent Recommendation Systems*

Recommendation systems can be based on collaborative or hybrid content, and offer insights into how to design algorithms that can generate relevant and contextualized recommendations.

By integrating these three theoretical dimensions, the proposed framework aims to formalize a coherent technical and pedagogical architecture, thus ensuring that the "TICE Match Pro" system responds to the contemporary challenges of integrating ICT in education.

This approach not only makes it possible to structure the development of the system, but also to anticipate the ethical and pedagogical implications of its use in various educational contexts.

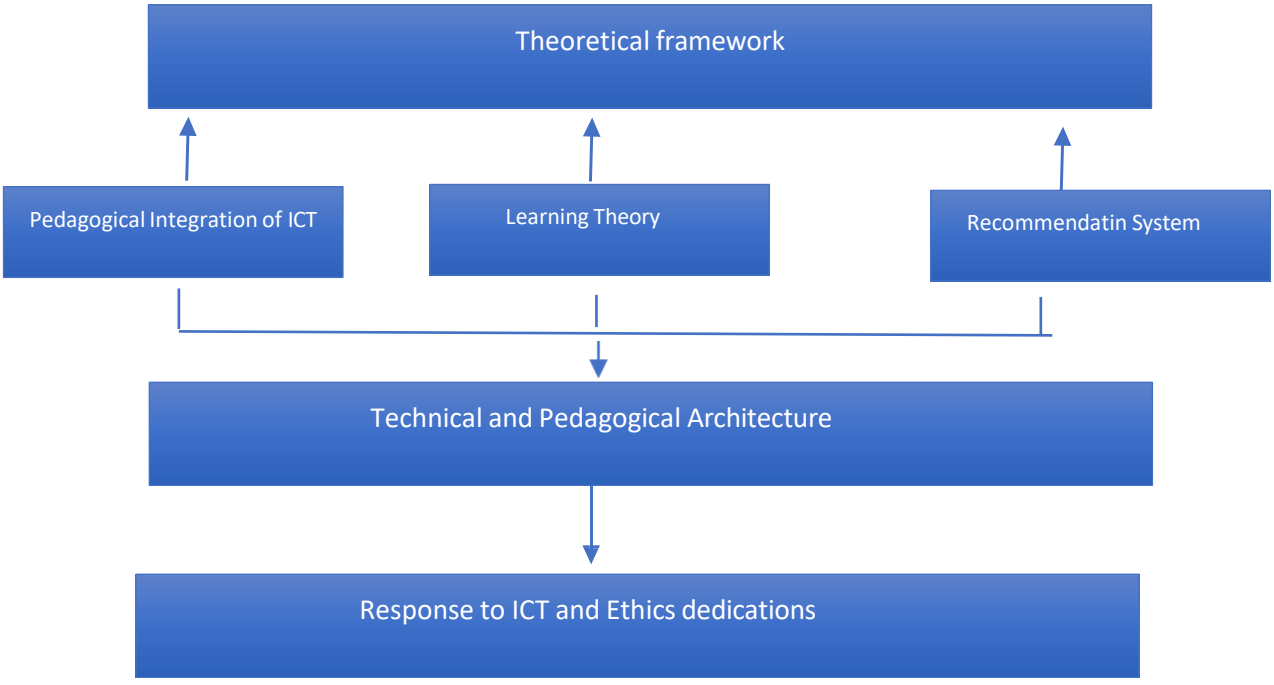


**Figure 1.** Fundamental Principles of Intelligent Recommendation Systems

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The development of a recommendation system for ICT integration is at the intersection of three complementary theoretical fields: ICT pedagogical integration models, learning theories, and the foundations of intelligent recommendation systems.

### *4.3.1. Models for the Integration of ICT in Education*

The TPACK (Technological Pedagogical Content Knowledge) model by Mishra & Koehler (2006) highlights the interaction between technological, pedagogical, and disciplinary knowledge. The SAMR (Substitution, Augmentation, Modification, Redefinition) model, proposed by Puentedura (2013), evaluates the level of integration of technologies according to their ability to transform pedagogical practices. These models offer relevant analytical grids to guide the development of a recommendation system based on explicit pedagogical criteria. 2. Theories of learning and personalization.

Constructivist and socioconstructivist approaches (Vygotsky, 1978) value social interactions and the construction of knowledge by the student. The use of ICT is aligned with these approaches, particularly through personalized learning environments. Work on adaptive learning (Brusilovsky & Millán, 2007) shows that technologies can adjust educational content to the specific needs of each learner.

### *4.3.2. Foundations of Recommender Systems*

Recommender systems can be content-based, collaborative, or hybrid (Adomavicius & Tuzhilin, 2005). In an educational context, the effectiveness of these systems depends on their ability to integrate pedagogical and contextual factors (Ricci et al., 2015; Mastafi, 2021). The use of machine learning and natural language processing (NLP) makes it possible to design systems capable of interpreting pedagogical intentions and making relevant recommendations.

Table 1. Modelling of ICT Integration

| Areas | Main models/theories | Contribution to TICE Match Pro |
|---|---|---|
| ICT Integration | TPACK, SAMR | Structure the pedagogical analysis of needs |
| Learning | Constructivism, Adaptive Learning | Personalize recommendations |
| Recommender systems | Content, collaborative, contextual | Developing an intelligent and scalable engine |

In light of the theoretical framework previously outlined, the design of the "TICE Match Pro" system has been translated into a functional diagram, aimed at modelling the different stages of the recommendation process. This graphical representation makes it possible to visualize the articulation between the collection of contextual information, the analysis of pedagogical needs, the intelligent processing of data, and the generation of adapted recommendations. The diagram thus offers a systemic view of the functioning of the recommendation engine, highlighting the interactions between the different components of the system. It is an essential step in formalizing the technical and pedagogical architecture of the system, while ensuring its consistency with the theoretical principles used. This modelling also constitutes a preliminary methodological basis essential for any subsequent phase of development and implementation of the system.

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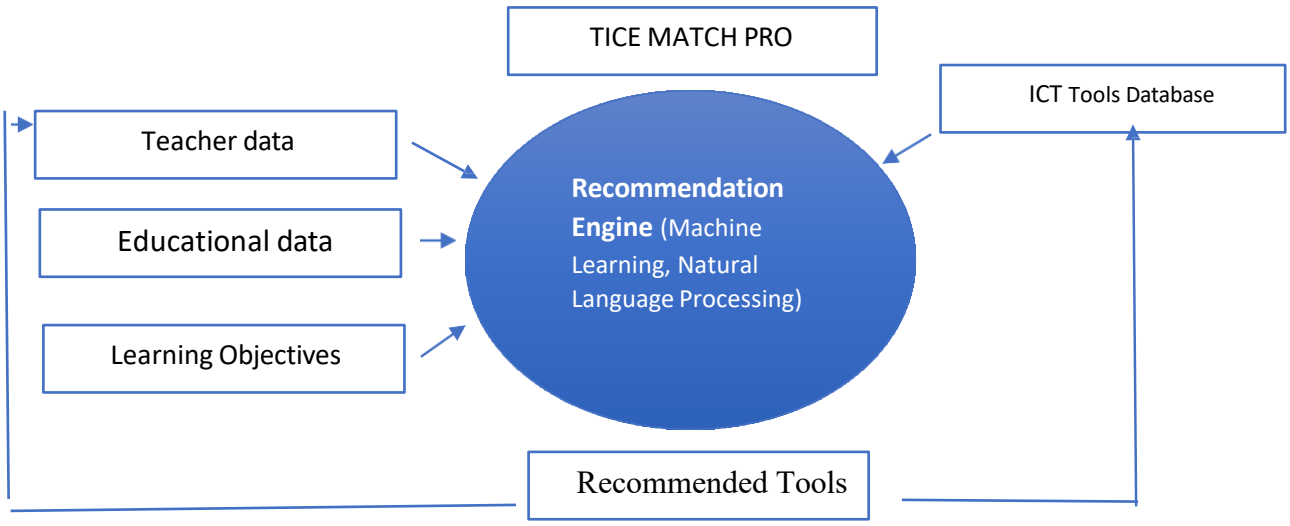


**Figure 2.** Functional Architecture of the "TICE Match Pro" System

The diagram above illustrates the functional architecture of the "TICE Match Pro" system, designed to recommend personalized ICT tools to teachers.

1. Input phase: The user begins by entering his or her educational data: subject taught, level, type of session, technical constraints, etc.

2. Teacher Data & Instructional Objectives: This information is collected to describe the specific needs of the teaching context.

3. Database of ICT tools: At the same time, the system has a structured database of digital tools, classified according to pedagogical, technical, and disciplinary criteria.

4. Recommendation engine: It cross-references user data with database entries, taking into account the educational objectives.

5. Machine learning: The system continuously improves its recommendations through the analysis of user profiles and user feedback.

6. Natural Language Processing (NLP): It is used to interpret textual descriptions of objectives or constraints entered in natural language, converting them into usable criteria.

7. Recommended tools: As an output, the system offers a list of ICT tools that are contextualized, justified, and adapted to the teacher's pedagogical situation.

## 5. Expected Results and Discussion

The expected results of this research are divided into several axes, each of which raises crucial issues for the implementation of the "TICE Match Pro" system:

1. Personalization of recommendations: The quality and availability of the data provided by teachers will be decisive for the personalization of recommendations. An intuitive and accessible interface will be essential to ensure regular and reliable use of the system, thus optimizing the suitability of the ICT tools offered to the specific needs of users. Previous studies, such as those by Chen et al. (2018), have demonstrated that personalizing recommendations significantly improves user engagement in digital learning environments.

2. Adaptability to educational contexts: While the system is designed to adapt to a variety of educational contexts, its effectiveness will depend on local technical constraints, such as connectivity and teachers' digital skills. This underscores the need to integrate training and support during deployment in order to maximize the impact of the system on pedagogical practices. Previous

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research, such as that of Ertmer and Ottenbreit-Leftwich (2010), has highlighted that professional support and continuous training are key factors for the successful integration of ICT in classrooms.

3. Transparency and trust: User buy-in to the system will be strongly influenced by their understanding of the recommending mechanisms and their trust in the system.

A rigorous ethical framework will be necessary to ensure the transparency of recommendations and avoid algorithmic biases, which is fundamental to strengthening the legitimacy and acceptability of the system. Work by Diakopoulos and Koliska (2017) highlights the importance of algorithmic transparency in establishing user trust in recommender systems.

In short, these expected results call for an in-depth reflection on the conditions for the successful implementation of "TICE Match Pro", as well as on the criteria to be used in order to generalize its use in various educational contexts. This discussion highlights the importance of a systemic and collaborative approach to overcome the challenges related to the integration of ICT in contemporary education, while building on previous research that confirms the relevance of the axes identified.

## 6. Conclusion

This research led to the theoretical design of the "TICE Match Pro" system, an intelligent device aimed at supporting teachers in the contextualized and reasoned integration of Information and Communication Technologies for Education. By mobilizing complementary theoretical frameworks from pedagogy, personalized learning, and intelligent recommendation systems, this study proposes a model articulating pedagogical relevance, contextual adaptability, and algorithmic transparency.

The expected results highlight the importance of personalization of recommendations, adaptability to pedagogical contexts, and transparency of recommendation mechanisms, which are crucial elements to foster user buy-in and maximize the impact on pedagogical practices. By comparing these results with previous work, it appears that TICE Match Pro is part of a research and development dynamic that responds to the contemporary challenges of ICT integration, while relying on solid theoretical foundations.

## 7. Suggestion

In the future, it will be essential to conduct empirical experiments to assess the real impact of TICE Match Pro on digital pedagogical practices and to refine the system based on user feedback. This research and development approach, rooted in ethical reflection, will pave the way for techno-pedagogical solutions that are more adapted to contemporary educational environments, thus contributing to the successful integration of ICT in education.

## Declarations

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Conflicts of Interest. The authors declare no conflict of interest.
Funding. This research received no funding.
Ethical Approval. The study complied with ethical guidelines governing research in the field of education, particularly with regard to the protection of personal data.
Data Availability Statement. The data can be provided by the corresponding author upon request.

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