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Artificial Intelligence in teacher education: validation and structure of the A.U.T.O. Scale

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Abstract: The rapid diffusion of Generative Artificial Intelligence (GenAI) in education highlights the need to understand the factors influencing future teachers' readiness to integrate these technologies responsibly. This study proposes the A.U.T.O. Scale, a multidimensional instrument that assesses AI readiness among pre-service teachers by integrating key constructs from the *Technology Acceptance Model*, the *Theory of Planned Behaviour*, and the literature on *AI anxiety*. The scale comprises four dimensions: AI-Related Concerns and Anxiety (A), Perceived Usefulness of AI for Teaching (U), Behavioural Intention and Use Tendency (T), and Perceived Ease of Use and Optimisation (O), assessed through five-point Likert-scale items. The framework also considers relevant background variables, including age, gender, educational pathway, and previous familiarity with GenAI. By jointly addressing cognitive, affective, behavioural, ethical, and pedagogical aspects of AI adoption, the proposed framework provides a comprehensive approach to examining future teachers' attitudes toward AI. The study hypothesises that the scale will show a factor structure consistent with the four proposed dimensions and satisfactory levels of internal consistency. The A.U.T.O. Scale may support the identification of different AI-readiness profiles and the evaluation of training interventions aimed at fostering critical, responsible, and sustainable use of AI in teaching practice.

Keywords: artificial intelligence; initial teacher training; AI readiness

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1. Introduction

The rapid diffusion of Generative Artificial Intelligence (GenAI) systems and adaptive learning algorithms has initiated a radical paradigm shift within the global educational ecosystem. The international scientific literature consistently highlights that the effectiveness of AI integration in educational settings does not depend linearly on the mere availability of technology or on the level of schools' digital infrastructure. Rather, this process is strongly mediated and conditioned by a range of factors, specifically beliefs, epistemic perceptions, emotional responses, and the exercise of Teacher Agency (Priestley et al., 2015; Ertmer, 2005).

Within the field of initial teacher education, particularly with reference to students enrolled in degree programmes in Primary Education and in teacher specialisation and qualification programmes, mapping and understanding attitudes towards AI prior to entering the teaching profession assumes crucial strategic importance. Technological beliefs developed during university education tend to become structured as relatively stable cognitive schemas, functioning as interpretive

filters that will subsequently shape future teaching practices and teachers' propensity towards methodological innovation (Teo, 2011). To operationalise prospective teachers' attitudes towards the complex and multifaceted landscape of AI, empirical education research has progressively integrated established psychometric models of technology acceptance with emerging constructs capable of capturing the distinctive characteristics of generative technologies and algorithmic systems. The conceptual framework underpinning the present study rests on three fundamental theoretical pillars. The first is the *Technology Acceptance Model* (TAM), originally developed by Davis (1989), which posits that the behavioural intention to adopt a given technology is significantly predicted by two broad cognitive variables: *Perceived Usefulness* (PU), namely the extent to which an individual believes that the technology will enhance their job performance, and *Perceived Ease of Use* (PEOU), understood as the expectation concerning the degree of physical or mental effort required to interact with the technological medium. In extensions of the model applied to the educational domain (Teo, 2011), TAM demonstrates that prospective teachers engage in a continuous cost–benefit assessment, evaluating the potential of AI both in terms of increasing the efficiency of routine tasks (e.g., reducing administrative and bureaucratic workload) and in terms of facilitating the personalisation of learning.

The second pillar is the *Theory of Planned Behaviour* (TPB), formulated by Ajzen (1991), which extends the predictive capacity of technology acceptance models by focusing on Behavioural Intention (BI) as the immediate antecedent of action. According to Ajzen, prospective teachers' intentions are co-determined not only by strictly rational or utilitarian evaluations, but also by the influence of subjective norms—namely, the perceived social pressures exerted by the academic community, peers, and ministerial institutions—and by perceived behavioural control, which reflects the individual's sense of internal and external self-efficacy in relation to the technological medium.

The third and final pillar concerns AI anxiety and the ethical and pedagogical implications of AI adoption. Unlike traditional and non-simulative educational technologies, such as Interactive Whiteboards or Electronic Registers, AI systems replicate high-level human cognitive functions, including natural language processing, autonomous text and image generation, and evaluative processes. This distinctive feature gives rise to forms of psychological resistance that are specific to AI technologies. Studies on the construct of AI Anxiety (Wang, 2023) and on the broader concept of AI Literacy (Ng et al., 2021) highlight that teachers' anxiety should not be reduced to an anachronistic form of technophobia. Rather, it is deeply rooted in specific ethical concerns—such as the protection of minors' privacy and personal data, the proliferation of algorithmic biases, and academic plagiarism—as well as in pedagogical and existential concerns. These include fears surrounding the de-professionalisation of the teaching role, the erosion of empathy within educational relationships, and the potential decline of students' critical thinking and cognitive autonomy.

2. Materials and Methods

Within the contemporary psychometric and methodological landscape, the need to quantitatively assess these dimensions has led researchers to adopt or adapt transdisciplinary instruments, including:

- the General Attitudes Towards Artificial Intelligence Scale (GAAIS), validated by Schepman and Rodway (2020), which captures the dichotomy between optimism regarding technological progress and dystopian perspectives associated with human replacement or loss of control. The instrument is frequently adapted within teacher education programmes to assess students' general attitudinal background;
- the Artificial Intelligence Anxiety Scale (AIAS) developed by Wang (2022), which specifically isolates the negative-affective component of attitudes towards AI across three dimensions—social, occupational, and cognitive—thereby capturing concerns regarding the potential loss of professional relevance of teaching staff in the face of knowledge automation;
- extensions of the TPACK framework for AI. Authors such as Celik (2023) have expanded the classical Technological Pedagogical Content Knowledge model (Mishra & Koehler, 2006) by introducing the dimension of AI Readiness and/or ethical and pedagogical competencies related to algorithmic systems, thereby assessing prospective teachers' sense of instructional self-efficacy in relation to artificial intelligence.

It is within this scientific framework that the A.U.T.O. Scale is situated. This measurement instrument provides a holistic synthesis of the core constructs underpinning the TAM (Davis, 1989), the TPB (Ajzen, 1991), and theories concerning algorithmic anxiety (Wang & Wang, 2022). The acronym A.U.T.O. evokes the dialectical relationship between the automation of processes and the "autonomous guidance" that teachers must retain over the technological medium. The ultimate aim is to develop an instrument suitable for empirical research and immediately interpretable in terms of its underlying structural components. Accordingly, the A.U.T.O. Scale addresses the need for a balanced assessment of AI Readiness, one that goes beyond measuring purely technical proficiency and places the ethical, affective, and relational dimensions of the teaching profession on the same conceptual and evaluative level. The instrument was developed through a process of adaptation and integration of items derived from previously validated scales. Items were selected on the basis of their consistency with the underlying theoretical framework and subsequently contextualised to the domain of artificial intelligence in education and to the target population, namely prospective teachers. Items concerning Perceived Usefulness, Perceived Ease of Use, and Behavioural Intention were primarily adapted from the literature on the Technology Acceptance Model and from more recent TAM-based instruments specifically developed for Generative AI in educational settings. Items concerning AI Anxiety & Ethical Concerns, by contrast, were supplemented with indicators addressing the pedagogical, cognitive, and ethical-legal risks highlighted in the literature on AI anxiety and AI in education. The resulting version of the scale will undergo a validation process and an assessment of its psychometric properties in relation to the target sample. Overall, the adopted strategy may be defined as a theory-driven

adaptation and contextualisation of existing instruments, supplemented by new items intended to ensure adequate coverage of content specifically relevant to the educational domain. Item selection was guided by a dual criterion. On the one hand, priority was given to constructs and indicators that have demonstrated psychometric robustness in the existing literature; on the other hand, consideration was given to the need to represent pedagogical, ethical, and professional dimensions that are not sufficiently addressed by currently available instruments.

Accordingly, the following research questions were formulated:

- RQ1. Does the A.U.T.O. Scale exhibit a factor structure consistent with the proposed four-dimensional theoretical model?
- RQ2. Does the A.U.T.O. Scale demonstrate adequate levels of internal consistency across the four dimensions identified?
- RQ3. What relationships exist among Perceived Usefulness, Perceived Ease of Use, Behavioural Intention, and AI Anxiety & Ethical Concerns among prospective teachers?
- RQ4. To what extent are prospective teachers' individual and educational characteristics—including age, gender, year of study, specialisation pathway, and familiarity with GenAI—associated with different levels of AI Readiness?

3. Results

The structured questionnaire comprises four broad dimensions. Each factor is described below in terms of its theoretical meaning, psychometric relevance, and corresponding measurement items. All items are rated on a five-point Likert scale, ranging from 1 = strongly disagree to 5 = strongly agree.

Factor A: AI-Related Concerns and Anxiety. This factor captures the negative emotional-affective dimension and potential resistance to AI adoption among prospective teachers, drawing on the AI Anxiety Scale (Wang & Wang, 2022; Russo et al., 2025) and other studies on the topic (Zhang et al., 2024). Unlike traditional software, AI affects domains that are intimately human, triggering concerns related to the dehumanisation of processes and ethical and professional standards. Accordingly, the items associated with this factor examine the perceived level of threat across three complementary domains: pedagogical-relational (loss of empathy), cognitive (the emergence of "intellectual laziness" among students and the erosion of critical thinking), and ethical-legal (violations of minors' data privacy and manipulation through algorithmic biases), as well as perceptions of technological uncertainty and instability. The items associated with this factor are:

- **A1.** I am concerned that the use of AI in teaching may reduce opportunities for human interaction and empathy between teachers and students.
- **A2.** I am concerned that excessive use of AI may reduce students' reasoning and critical-thinking skills.
- **A3**. I am concerned about the rapid pace at which AI technologies evolve and change.
- **A4**. I am concerned that the use of AI in teaching may raise issues concerning students' privacy or the processing of their data.

- **A5**. I am concerned that the use of AI in teaching may involve the presence of biases (prejudices).
- **A6**. I am concerned about the difficulty of verifying the authenticity and originality of students' work produced with the support of AI.
- **A7**. I am concerned that differences in access to digital technologies may create new inequalities among students.
- **A8**. I am concerned about the prospect of using AI tools in my future teaching practice.
- **A9**. I am concerned that I may not feel sufficiently competent in using AI in my future teaching practice.

Factor U: Perceived Usefulness of AI for Teaching. This factor, derived from the construct of the TAM (Davis, 1989) and the TAM-GenAI (Kong et al., 2024), investigates the cognitive-evaluative component of prospective teachers, understood as the pedagogical, methodological, and administrative value attributed to AI as a tool for professional empowerment. The items assess whether respondents perceive AI as a strategic ally capable of providing tangible added value through the personalisation of learning pathways, support for inclusive teaching practices for students with Special Educational Needs, the generation of creative stimuli, and the optimisation of time devoted to lesson planning, assessment, and administrative tasks. The items associated with this factor are:

- **U1**. I believe that the use of AI can help me personalise teaching activities according to the needs of my future students.
- **U2**. I believe that the use of AI can reduce the time required to prepare teaching activities.
- **U3**. I believe that the use of AI can help me develop more inclusive teaching materials.
- **U4**. I believe that the use of AI can improve the quality of the teaching activities I implement.
- **U5**. I believe that the use of AI can make lesson preparation and instructional planning more efficient.
- **U6**. I believe that the use of AI can make the assessment of my future students' learning processes and outcomes more efficient.
- **U7**. I believe that the use of AI can promote the inclusion of students with Special Educational Needs.
- **U8**. I believe that the use of AI can reduce the time required to carry out certain administrative and organisational tasks associated with teaching.

Factor T: Behavioural Intention and Use Tendency. Grounded in the Theory of Planned Behaviour (TPB) and in constructs examined in other studies (Kong et al., 2024; Ayanwale et al., 2022), this factor represents the conative component of attitude, serving as a transitional bridge between abstract theoretical orientation and actual proactive planning in future professional contexts. It therefore measures two interrelated aspects: future behavioural intention and the stated propensity or tendency to integrate AI into professional practice. Specifically, this factor captures prospective teachers' explicit predisposition to introduce AI-based systems both in the short term (e.g., during teaching practicums and substitute

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teaching assignments) and in the long term (i.e., through their sustained integration into their methodological approach), together with their intention to pursue continuing professional development opportunities and to co-design digital learning activities with colleagues. The items associated with this factor are:

- **T1**. I intend to use AI tools to support the planning of my future teaching activities.
- **T2**. I intend to use AI tools to support the assessment of my future students' learning processes and outcomes.
- **T3**. I intend to use AI tools to design teaching activities in which the use of AI is guided and oriented toward the development of students' critical-thinking skills.
- **T4**. I intend to use AI tools with a certain degree of regularity in my future teaching practice whenever I consider them appropriate.
- **T5**. I intend to continue exploring ways of using AI to improve my teaching practice.
- **T6**. I intend to experiment with the use of AI during my teaching practicum and in my initial teaching experiences.
- **T7**. I intend to participate in AI-related training activities to improve my ability to use AI in teaching.

Factor O: Perceived Ease of Use and Optimisation. This construct, derived from the constructs of the TAM (Davis, 1989) and TAM-GenAI (Kong et al., 2024; Giganti et al., 2026), assesses the perceived ease with which prospective teachers can learn, integrate, and use AI tools in their professional and teaching activities. More specifically, the factor considers the perceived ease of learning how to use AI tools, integrating them into planned teaching activities, and employing them to support selected tasks associated with the teaching profession. The items are not intended to directly measure the effectiveness of these tools or the benefits resulting from their use, which are primarily associated with Perceived Usefulness, but rather the degree of ease and reduced effort perceived in using them. From this perspective, the factor captures the extent to which prospective teachers perceive AI as an accessible and relatively easy-to-learn tool that can be integrated into their professional practice, both in the design of teaching activities and in the performance of selected teaching-related tasks. The items associated with this factor are:

- **O1**. I find it easy to learn how to use the AI tools (e.g., chatbots, text and image generators) that I choose for teaching purposes.
- **O2**. I find it easy to integrate AI tools (e.g., chatbots, text and image generators) into the teaching activities I design.
- **O3**. I find it easy to use AI to make the preparation of teaching activities more efficient.
- **O4**. I find it easy to use AI to facilitate the performance of certain teaching-related tasks.

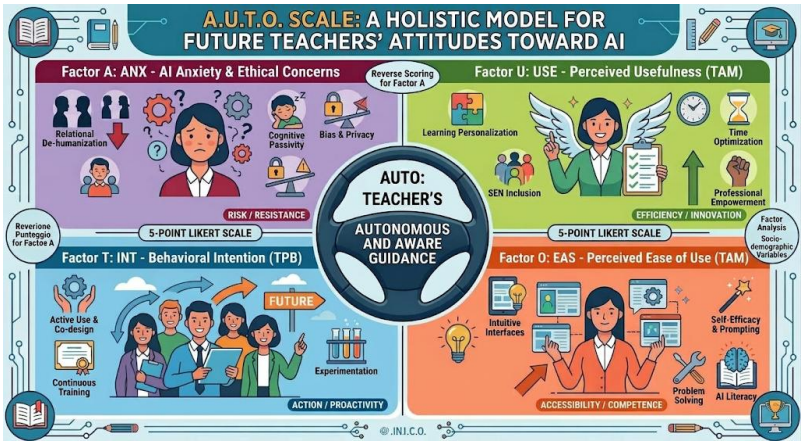
To ensure the appropriate psychometric application of the A.U.T.O. Scale in quantitative or mixed-methods research designs, several methodological aspects concerning scoring, validation of the factor structure, and score interpretation should be taken into consideration. First, the items belonging to Factor A, concerning concerns and anxiety related to the use of AI, are formulated with an

opposite polarity to that of the other factors: higher scores indicate a greater presence of concerns or anxiety. Accordingly, reverse-scoring of the A items is necessary if the aim is to construct an overall composite index positively oriented toward AI acceptance or readiness to use AI. Psychometric evaluation should include, depending on the research design and sample size, an assessment of the factor structure, internal consistency, and convergent and discriminant validity. In particular, during the instrument development phase, an exploratory factor analysis may be conducted, followed, where feasible, by a confirmatory factor analysis on an independent sample. Another relevant aspect concerns the collection of information on individual characteristics and previous experience with AI technologies. To this end, the questionnaire may include an initial section designed to collect variables such as gender, age, year of study, educational or school level of reference, and level of familiarity with generative AI. The frequency of previous use of GenAI tools, such as chatbots and other similar applications, for study, work, or personal purposes may also be assessed. Depending on the specific research hypotheses and sample characteristics, these variables may be considered as potential covariates, predictors, or moderating variables. Their relationships with the four dimensions of the scale should be examined empirically, with particular attention to the dimensions concerning AI-related concerns and anxiety and behavioural intention to use AI. Based on the theoretical model adopted, the A.U.T.O. Scale hypothesizes a multidimensional structure comprising four factors: AI-Related Concerns and Anxiety (A), Perceived Usefulness of AI for Teaching (U), Behavioural Intention and Use Tendency (T), and Perceived Ease of Use and Optimisation (O). This structure represents a measurement hypothesis that must be empirically tested. Consistent with the main technology acceptance models, perceived usefulness and perceived ease of use are hypothesised to be positively associated with behavioural intention to use AI. Conversely, higher levels of concern and anxiety toward AI are hypothesised to be associated with lower behavioural intention to use AI. These relationships must, however, be empirically tested and may be influenced by factors such as familiarity with technology, previous experience, and perceived competence.

The purpose of the A.U.T.O. Scale is therefore to describe a multidimensional profile of AI Readiness among prospective teachers by jointly considering perceptions of usefulness and ease of use, behavioural intentions, and potential concerns associated with the integration of AI into professional practice. The construction of an overall AI Readiness score should not be assumed a priori but should instead be supported by the results of factor analyses and subsequent validity assessments. In particular, it should be empirically determined whether the four factors represent correlated but distinct dimensions or whether they can also be subsumed, potentially through a hierarchical structure, under a broader general construct of AI Readiness. The scale may also be used to evaluate educational interventions aimed at developing knowledge and competencies related to AI. In such contexts, administering the instrument at multiple time points may allow researchers to examine changes in concerns, perceived usefulness and ease of use, and behavioral intentions. However, if longitudinal comparisons of scores are to be conducted, measurement invariance across the different assessment time points should first be examined. In this way, the instrument may contribute to the study of the factors that facilitate or hinder the integration of AI into the teaching profession,

enabling these dynamics to be examined across different institutional, cultural, and educational contexts.

Figure 1. Factors of the A.U.T.O. Scale



4. Discussion

The A.U.T.O. Scale is proposed as a multidimensional instrument for assessing the AI Readiness of prospective teachers, integrating four complementary dimensions: AI-Related Concerns and Anxiety (A), Perceived Usefulness of AI for Teaching (U), Behavioural Intention and Use Tendency (T), and Perceived Ease of Use and Optimisation (O). Consistent with the adopted theoretical framework, the scale is expected to exhibit a factor structure aligned with the identified conceptual dimensions, together with adequate levels of internal consistency. Particular attention may be devoted to the relationships among the different dimensions, examining, on the one hand, the positive associations between perceived usefulness, perceived ease of use, and behavioural intention and, on the other, the potential role of anxiety and ethical concerns in shaping willingness to use AI. These relationships will, naturally, need to be empirically and psychometrically examined through subsequent analyses. The relevance of the A.U.T.O. Scale lies primarily in its potential to conceptualise the acceptance of Artificial Intelligence in initial teacher education as a complex phenomenon that cannot be reduced solely to technical competence or willingness to use technological tools. Integrating the affective and ethical dimensions with those concerning perceived usefulness, perceived ease of use, and behavioural intention enables a more nuanced understanding of AI Readiness, consistent with the pedagogical, relational, and ethical nature of the teaching profession. From this perspective, anxiety towards AI is not interpreted exclusively as a form of technological resistance, but also as an expression of concerns relating to privacy protection, algorithmic bias, the quality of educational relationships, the development of critical thinking, and the professional role of teachers. A further element of interest concerns the possibility of examining the relationship between scale scores and participants' individual and educational characteristics, such as age, year of study, educational pathway, and familiarity with GenAI. This may enable the exploration of potential differences in AI Readiness

profiles and contribute to a deeper understanding of the role of prior experience and educational context in shaping attitudes towards AI. Similarly, the scale could be employed in longitudinal studies or pre–post evaluation designs to assess potential changes in attitudes and usage intentions following specific educational or training interventions.

The A.U.T.O. Scale therefore seeks to contribute to educational research by providing an integrated perspective on AI acceptance within the education and training of prospective teachers. Its multidimensional approach makes it possible to complement the instrumental dimension of technology adoption with the pedagogical, affective, ethical, and professional dimensions that characterise the use of AI in educational settings. Subsequent empirical validation of the instrument will therefore represent an essential step in establishing its psychometric robustness and determining its practical utility for research and for the design of teacher education programmes aimed at fostering a conscious, critical, and pedagogically grounded use of AI.

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