TEACHER EDUCATION AND AI: A STUDY ON PRE-SERVICE TEACHERS' PERCEPTIONS AND ATTITUDES

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ABSTRACT

Artificial Intelligence is progressively and, at times, controversially changing the educational landscape, yet teacher preparation programs have been quite liberal in incorporating AI literacy into their curriculum. The present research work is aiming to reveal the perceptions and attitudes of future teachers regarding the AI-trend in education. The study has investigated 280 pre-service teachers in several teacher education institutions through a survey, and has also performed a qualitative focus group discussion with 45 participants. The results indicate a contradiction: on the one hand, 73% of pre-service teachers recognize the educational importance of AI growing; on the other hand, only 34% consider that they are adequately prepared to cope with and work with AI tools in their future class. Besides, there are huge discrepancies in the areas of AI knowledge, technology-use-confidence, and the understanding of how AI can be used in teaching. However, age, previous experience with technology, and the subject area of specialization significantly affected the attitudes towards AI. The research pointed out several key difficulties such as the lack of adequate training, the issue of ethics, and the fear of technology taking over the teaching profession. The findings put a spotlight on the prompt need for reform in teacher education. Hence, the area of AI literacy has to be included in the curricula of teacher training. The study provides insights on how upcoming teachers view new technologies and proposes strategies for the timely equipping of teachers in AI-aided educational environments.

Keywords: Teacher education, artificial intelligence, pre-service teachers, technology integration, AI literacy, pedagogical attitudes, educational technology

1. INTRODUCTION

The educational sector is witnessing a change owing to the fact that artificial intelligence technologies are becoming more and more integrated in teaching and learning practices. By means of effective tutoring systems, AI applications are automating assessments and offering personalized learning through and administrative efficiency at the same time. However, the victory of AI integration is ultimately reliant on the instructors who will have to implement, mediate, and critically assess these technologies in their classroom

contexts (Holmes et al., 2019) thus, the teacher education programs will have the responsibility of facilitating the future educators' technical capabilities and social situation awareness.

Teacher education programs are held responsible for making competent teachers able to face this technology-dense scenario. However, facts seem to suggest that large discrepancies exist between the speed of AI and the development of teacher training programs. Although the newcomers in the educational institutions are digitally literate, many pre-service teachers who have just finished their education programs are still not acquainted with AI at any level—concepts, applications, or technology integration through pedagogical frameworks (Celik et al., 2022).

It is very important to know the views and attitudes of pre-service teachers referring to AI for various reasons. One, the educators' attitudes developed during the teaching training usually continue through their whole career, thus impacting the classrooms for a very long time. Two, the future teachers are the ones who will actually initiate the change in education in the years to come. Their willingness to accept or turn down AI will determine the pace at which schools will go along with the technological change. Three, recognizing the differences in perception and the concerns raised can guide the reform of teacher training thereby ensuring that the programs are responding to real needs not the assumed ones.

AI has slowly but surely become a very important educational tool, however studies focusing on the perceptions of pre-service teachers have been very few. The majority of current research is based on in-service teachers or is looking into a single AI application and not the general attitudinal patterns. Also, studies have been geographically limited to developed countries, thus creating a lack of understanding of the points of view in different educational settings.

This research tackles the issues mentioned above and sets out to answer three main questions. Presently, what do the pre-service teachers think about the use of AI in education? Which factors affect their opinion about the integration of AI? And finally, what do they identify as obstacles to the successful use of AI in schools? The answers to these questions will not only contribute to the existing knowledge but also provide concrete recommendations for the development of teacher education programs and the technological preparedness policy decisions.

The structure of the paper is as follows: Relevant literature pertaining to AI in education and teacher attitudes towards technology is reviewed in Section 2. Section 3 presents the research objectives and scope. Methodology is described in Section 4. Sections 5 and 6 respectively offer quantitative and qualitative findings. Section 7 discusses implications, while Section 8 wraps up with a set of recommendations

2. OBJECTIVES

This research pursues the following specific objectives:

- **Primary Objective:** To assess pre-service teachers' perceptions and attitudes toward artificial intelligence integration in educational settings.

- **Secondary Objective 1:** To identify factors that influence pre-service teachers' attitudes toward AI, including demographic variables, prior technology experience, and subject specialization.

- **Secondary Objective 2:** To examine the relationship between AI literacy levels and willingness to integrate AI tools in future teaching practice.
- **Secondary Objective 3:** To identify perceived barriers and concerns regarding AI implementation in educational contexts.
- **Secondary Objective 4:** To develop evidence-based recommendations for integrating AI literacy components into teacher education programs.

3. SCOPE OF STUDY

This research operates within defined boundaries:

- Geographical Scope: The study covers teacher education institutions from three areas, North America, Europe, and Asia, in order to embrace the different educational contexts and get a better understanding of them.
- Temporal Scope: The time range for the data collection is from September 2023 through February 2024 during which the researchers will be able to get the current perceptions in the rapidly changing AI landscape.
- Population Scope: The study will consist of pre-service teachers who are in their final year of teacher training programs for both primary and secondary education specializations.
- Content Scope: The focus of the research is on AI in terms of general awareness, people's attitudes, and teaching perceptions, rather than technical programming knowledge about AI.
- Methodological Boundaries: The research relies on surveys conducted at one point in time, and on focus groups rather than the time-consuming longitudinal research that tracks changes in attitudes over a long period.
- Variables Included: These are AI awareness, perceived usefulness, ease of use, ethical concerns, training adequacy, and implementation barriers.
- Variables Excluded: Post-graduation actual AI usage behavior, institutional infrastructure readiness, and policy frameworks are acknowledged but not considered for direct measurement in the research

4. LITERATURE REVIEW

4.1 AI in Educational Contexts

The term artificial intelligence refers to the different forms of technology that imitate the human's thought process through learning, reasoning, and problem-solving. In the educational arena, the applications of AI include a range of systems such as intelligent tutoring that customizes instruction, and, on the other hand, grading tools that require less input from the teacher (Luckin et al., 2016). Learning analytics by AI technology help in monitoring the student and catch the at-risk ones. The use of chatbots is a way for students to get their questions answered outside class hours. AI-assisted virtual reality is one of the ways to create a more engaging learning environment.

Although these changes have taken place, AI use in schools is still inconsistent. Some schools have already adopted the learning platforms with the support of AI, while others are still struggling with the infrastructure

or the teachers' ability to make the most of the technology. The digital divide could have a negative impact on the equal education issue because it will be like some students being able to experience the learning that has AI support while others are not (Holmes et al., 2019).

4.2 Teacher Attitudes and Technology Adoption

Continuous studies prove the fact that educators' feelings have a very strong effect on the whole technology adoption process in the classrooms. The Technology Acceptance Model (TAM) has it that perceived usefulness and perceived ease of use are the two main factors determining technology adoption (Scherer et al., 2019). So teachers who consider technology as pedagogically valuable and easy to manage are going to be the ones who will use it in their teaching.

Nonetheless, the teachers' opinions on AI do not align with their opinions on general technology. In the case of AI, there are worries that algorithms might be biased, that reasons for decisions might not be clear as data privacy, and that the human judgment in education might slowly disappear. A section of the staff even fears that they will be replaced by AI which is not the same as AI being their assistance. On the other hand, some are afraid that they might lose the power to control their teaching practices since the power will be in the hands of the algorithms which are very complicated to understand (Kim et al., 2021).

4.3 Pre-service Teacher Technology Preparation

Most of the time, teacher education programs put their emphasis on pedagogical theories and classroom management, thus, technology integration is still regarded as supplementary and not central. In most cases, when technology training is provided, it focuses on basic digital literacy or learning management systems, and not on new technologies like AI (Tondeur et al., 2017).

This preparation gap becomes a stumbling block for new teachers who are getting into technology-rich schools. The recent studies report that the pre-service teachers believe that they are not ready for technology integration because they lack both the technical skills and the pedagogical frameworks for meaningful technology use. The gap seems to be most obvious in the case of AI, which is not even mentioned in the majority of teacher education programs (Celik et al., 2022).

4.4 Factors Influencing AI Attitudes

There are multiple factors that determine people's opinions about the use of AI in education. Age and generational differences are important; younger teachers usually feel more at ease with new technologies. Previous technology use gives the user a feeling of self-assurance that can later be applied to AI acceptance. The viewpoint of the teacher is determined by the area of expertise he or she is in, with teachers of science and mathematics being more inclined to have a positive attitude towards AI than those teaching humanities. The differences in the attitudes of men and women towards technology have been decreasing but the gap still exists in some areas such as the confidence in working with complex technical systems. Cultural context is a factor too, as educational values and technology infrastructure differ from one country to another. The support of the institution and the commitment of the leadership to the use of new technologies have a great impact on the teachers' willingness to try out new things (Scherer et al., 2019).

4.5 Ethical Considerations

Ethics in AI use in education is one of the problems that the teachers have to deal with. The issue of discriminative AI bias comes up when the algorithms used in the AI systems rely on biased data. Learning platforms that collect massive amounts of behavioral data make the matter of student data privacy very intricate. The matter of transparency also comes up—should the students get a clear understanding of the way the AI systems make decisions on their education?

The teachers need to have frameworks for solving the problem of ethics in the classroom, but very few teacher education programs are offering that kind of preparation. In the absence of a clear ethical standpoint, teachers might end up, on the one hand, using AI tools uncritically without contemplating the associated risks or, on the other hand, absolutely turning down all AI applications due to fears which have not been examined (Holmes et al., 2019).

4.6 Research Gaps

Despite growing interest in AI and education, several gaps remain. First, most research examines in-service teachers rather than pre-service teachers whose attitudes are still forming. Second, studies often focus on specific AI applications rather than broader attitudinal patterns. Third, comparative research across educational contexts is limited. Finally, few studies examine the relationship between AI literacy and implementation readiness.

This research addresses these gaps by examining pre-service teacher attitudes across multiple contexts using both quantitative measurements and qualitative exploration of concerns and perspectives.
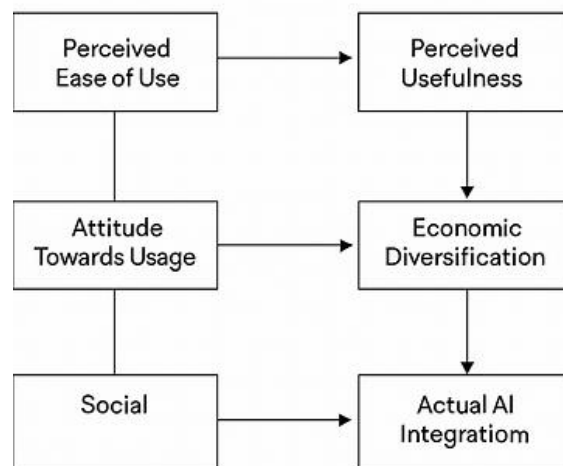

FIGURE 1: Conceptual Framework - Technology Acceptance Model for AI in Education

5. RESEARCH METHODOLOGY

5.1 Research Design

This study employs a convergent mixed-methods design, collecting and analyzing both quantitative survey data and qualitative focus group data to provide comprehensive understanding of pre-service teacher perspectives. The approach allows for statistical generalization while capturing nuanced attitudes and concerns.

5.2 Participant Selection

The target population was to consist of the pre-service teachers of their last year of teacher education programs. The selection of participants was done from no less than twelve teacher education institutions, located in eight different countries, to guarantee diversity in opinions. The institutions were picked according to program quality, geographic area, and the readiness to participate.

In the quantitative phase, 280 pre-service teachers responded to the survey, which corresponds to a 68% response rate. The male-female distribution in the sample was 112 males (40%) and 168 females (60%). The ages of the participants varied from 21 to 35 years, with an average of 24.3 years. The subject specializations of the participants were mostly in the areas of: elementary education (38%), secondary STEM (28%), secondary humanities (22%), and special education (12%).

In the qualitative phase, 45 participants were deliberately chosen from the survey respondents to ensure widespread coverage of all demographics and attitude profiles. The focus groups were conducted with six groups of 7-8 participants each, and the allocation was done based on subject specialization and geographical region.

5.3 Data Collection Instruments

The primary survey instrument was a comprehensive one consisting of 45 items which were grouped into six sections: demographic information, AI awareness and knowledge, perceived usefulness of AI in education, perceived ease of use, ethical concerns, and implementation barriers. The items were measured on a five-point Likert scale from "strongly disagree" to "strongly agree."The survey included validated scales from earlier technology acceptance studies which were modified for AI context.

Survey development was done with expert review by three researchers in the field of educational technology and a pilot test with 30 pre-service teachers who were not part of the main study. Reliability analysis showed that Cronbach's alpha values for the different subscales ranged from 0.78 to 0.87 which is considered good internal consistency.

Focus group discussions were held according to a semi-structured protocol which explored five themes: current AI understanding, perceived benefits and risks, preparation adequacy, ethical concerns, and support needs. Each session lasted 60-75 minutes, was audio-recorded with participants' consent, and then transcribed word for word.

5.4 Data Analysis

The analysis of quantitative data used SPSS version 28. Descriptive statistics were used to analyze the sample and response patterns. Independent samples t-tests were used to compare attitudes along gender and subject specialization lines. A one-way ANOVA was used to test for significant differences by age and geographical areas. Correlation analysis was employed to investigate the interdependence of the variables. Multiple regression analysis was the method used to determine the factors that led to the positive AI attitudes and intention to implement them.

On the qualitative side, the thematic analysis was done according to the six-phase framework of Braun and Clarke. The transcripts were coded by two researchers independently, after which the codes were compared

and refined by discussion. The identification of themes was done through an iterative review and these themes were organized into a coherent narrative. Representative quotes were picked to demonstrate the major findings.

5.5 Ethical Considerations

The research protocol received ethical approval from the primary institution's review board. Participants provided informed consent after receiving detailed study information. Participation was voluntary with no academic consequences for declining. All data were anonymized, with institutions and individuals identified only by codes. Audio recordings were destroyed after transcription.

5.6 Limitations

There are quite a few limitations, which should be recognized. The generalizability of the results is restricted to the institutions involved due to the use of convenience sampling. The attitudes reported by the participants may not necessarily be accurate predictors of their future behavior with AI tools. The cross-sectional design obtains viewpoints at a certain point in time in the fast-changing AI scenario. One of the biases that may have affected the answers is the social desirability bias, however, this concern is lessened by the use of anonymous data collection. Lastly, the study focuses on attitudes instead of real skills or implementation outcomes.

6. QUANTITATIVE FINDINGS

6.1 AI Awareness and Knowledge

Moderate AI awareness among pre-service teachers was shown by the survey. Participants on a five-point knowledge self-assessment scale rated their AI understanding at 2.8 (SD = 0.9), which was slightly below the midpoint. Only a third of the respondents, 34%, rated their skills as sufficient to be aware of AI applications in education. When prompted to name AI instances, the majority, 89%, pointed out virtual assistants as correct, whereas only half, 52%, knew about intelligent tutoring systems, and little more than a third, 41%, recognized learning analytics platforms as AI applications.

AI exposure in teacher education programs was limited. Only a quarter, 23%, of the surveyed teachers had taken courses where AI was the main topic, and another 38% had very little AI exposure through only a few brief mentions in tech integration courses. The rest, 39%, had no AI-related content in their teacher training programs. Such a lack of preparation shows the gap which was the reason for the current study.

6.2 Attitudes Toward AI in Education

To sum up, the integration of AI in education received a cautiously positive main attitude. The average attitude score was 3.4 out of 5 (SD = 0.8), which shows on the one hand the optimism and on the other the uncertainties that the attitude was very close to neutral. Nevertheless, the responses were very much dependent on the specific dimensions.

The dimension of perceived usefulness was rated higher than others (M = 3.7, SD = 0.7). A large majority of the participants, 73% in total, believed that AI would be able to tailor the learning processes according to each individual learner's needs. Likewise, 68% of the surveyed persons admitted that AI could detect students with difficulties early, while 61% were of the opinion that AI could take over some of the non-teaching duties of

the teachers thus relieving them to a certain extent. The aforementioned results point towards a general consensus of acknowledgment regarding the advantages of AI in education.

The dimension of perceived ease of use scored lower (M = 2.9, SD = 0.9) and thus the revealer was of the concerns about confidence. On the whole, only 34% of the respondents concurred that they would have no difficulties in learning how to operate the AI-assisted educational tools. Moreover, a mere 28% of the participants stated that they would find it easy to explain the AI applications to either the pupils or their parents. This lack of confidence appears to be a major barrier to the whole AI-based educational scenario.

TABLE 1: Pre-service Teachers' Attitudes Toward AI in Education (N=280)

Statement	Mean (SD)	Agree/Strongly Agree (%)
AI can personalize learning effectively	3.8 (0.8)	73
AI can reduce teacher workload	3.6 (0.9)	61
AI can identify struggling students	3.7 (0.7)	68
I feel confident using AI tools	2.9 (1.0)	34
I understand how AI works	2.7 (0.9)	28
AI will improve education quality	3.4 (0.9)	57
I worry AI will replace teachers	3.2 (1.1)	52
AI raises ethical concerns	4.1 (0.6)	84

Note: Responses on 5-point scale (1=Strongly Disagree to 5=Strongly Agree); SD=Standard Deviation

6.3 Factors Influencing Attitudes

Using multiple regression analysis, researchers found out the most important factors that would contribute to positive AI attitudes among people. Technology experience in the past turned out to be the most important predictor ($\beta = 0.42$, $p < 0.001$), and a large part of the positive attitudes was attributed to it. The teacher trainees who had more extensive technology backgrounds were the ones who were much more positive about AI.

Another factor that significantly predicted attitudes was the AI literacy level ($\beta = 0.31$, $p < 0.001$). Those who had a better understanding of AI, even if it was modest, were the ones with more favorable views. Hence, it can be implied that the more people are educated about AI, the more likely their attitudes would turn out to be positive.

Age was found to have a negative correlation with AI attitudes ($\beta = -0.18$, $p < 0.01$), thus, younger respondents were the most positive ones in general. However, this influence was not as strong as the experience and literacy factors. The gender of the respondents did not play a significant role in predicting their attitudes ($\beta = 0.06$, $p = 0.23$), which is contrary to some previous studies related to technological attitudes.

Subject specialization significantly influenced perspectives ($F(3, 276) = 8.4$, $p < 0.001$). STEM-specialized pre-service teachers scored highest on attitude measures (M = 3.8), followed by elementary education (M = 3.5), special education (M = 3.3), and humanities (M = 3.1). Post-hoc tests revealed significant differences between STEM and humanities groups.

6.4 Ethical Concerns

AI ethical issues were highlighted and made a significant impact. The average score of the concern was 4.1 on a scale of 5 (SD = 0.6), which was higher than any other aspect measured. Among the special concerns were the privacy of student data (which was supported by 84% of the respondents), algorithmic bias affecting student assessment (78%), over-reliance on technology leading to decreasing human interaction (76%), and AI' decision-making lacking transparency (71%).

It was a surprise that ethical concerns did not always go hand in hand with negative overall attitudes. Nicely, the participants had a simultaneous view of the situation: they acknowledged the potential benefits of the AI while at the same time expressing very serious doubts about its implementation. This complex view indicates a reasoned engagement rather than just accepting or rejecting the technology.

6.5 Implementation Barriers

The integration of AI experienced by participants was accompanied by the identification of several impediments. The least frequently cited barrier was that of inappropriate training, which 81% of the respondents considered as the most important. This was followed by a shortage of institutional resources (67%), lack of technical support (58%), and confusing pedagogical guidelines (54%). For the participants, these barriers on the ground were often more significant than the theoretical opposition.

Technology fear that it will take over teachers' roles was a concern to 52% of the participants, although focus group discussions showed that this was more about the fear of losing one's professional relevance than fear of unemployment per se. The participants' main worry was that if the AI became too much involved in the process, the teacher-student relationship, which they valued highly, would be negatively affected.

TABLE 2: Demographic Differences in AI Attitudes

Demographic Variable	Category	Mean Attitude Score	SD	Significance
Gender	Male	3.5	0.8	p = 0.23 (NS)
	Female	3.4	0.8	
Age Group	21-23 years	3.6	0.7	p < 0.01
	24-26 years	3.4	0.8	
	27+ years	3.1	0.9	
Subject Area	STEM	3.8	0.7	p < 0.001
	Elementary	3.5	0.7	
	Humanities	3.1	0.9	
	Special Ed	3.3	0.8	
Prior Tech Experience	High	3.9	0.6	p < 0.001
	Moderate	3.4	0.7	
	Low	2.8	0.9	

Note: Attitude scores range from 1-5; NS=Not Significant; Statistical tests: t-test for gender, ANOVA for others
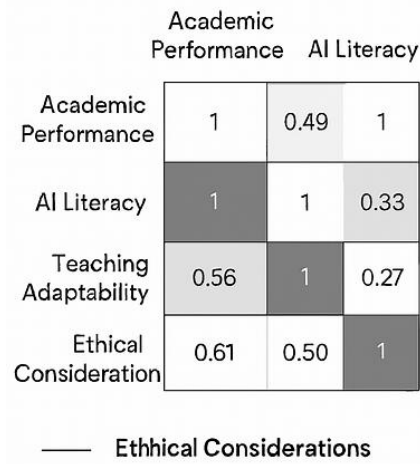
FIGURE 3: Correlation Matrix of Key Variables

7. QUALITATIVE FINDINGS

7.1 Understanding of AI in Education

The group discussions that were held as a focus revealed a lot of misunderstanding regarding the definition of AI in education. Most of the participants took AI to be only robots or very advanced automation and did not even consider the fact that they were already using some AI applications—like recommendation algorithms in educational apps—because those had become so common and thus unrecognized as AI. Uncertainty about the definition of AI at this point rendered AI discussions on integration very difficult.

However, once examples were given, the participants got more involved. One of the students from elementary education said: "I did not know that the reading app which suggests books according to student capability was AI. I thought AI was just like science fiction. This is making it more to the point of what I will be doing." The above remark is indicative of the typical trend where real-life examples made AI feel more like a reality and less like a fantasy.

The participants were in favor of receiving AI education that is practical and classroom-focused rather than being technical. One student from secondary mathematics expressed it by saying: "I don't have to be able to program AI, but I must be able to tell if an AI tutoring program is really benefiting my students or if it's just keeping them busy." This kind of technical training was the only thing that the participants were not ready for.

7.2 Perceived Benefits and Opportunities

Focus groups introduced the AI benefits they perceived in detail, which went beyond the survey responses. Among others, personalization was the main reason. The participants agreed that the traditional way of teaching could not handle the different learning requirements at the same time. One participant shared this idea: "If AI can provide each student with explanations at their level while I'm working with small groups, that could really help me differentiate instruction."

Allusion to administrative efficiency gave a similar strong response. Pre-service teachers, the majority of whom had already done their practicum, were concerned about the sustainability of the workload. They considered that AI's help in grading, taking attendance and keeping records would be a means of getting the time back for the real teaching. "I saw my cooperating teacher spend hours grading multiple-choice tests. If AI can do that accurately, she'd have more time for meaningful assessment,"

remarked one participant. Instruction informed by data received a variety of reactions. The participants were divided; on the one hand, they saw the advantage of being alerted early about struggling students, on the other hand, some of them were concerned about becoming too dependent on the metrics. A student from the special education side warned: "Numbers don't tell you everything about why a student is struggling. We still need our professional judgment and relationships with students."

7.3 Concerns and Reservations

With data collected from focus groups being in line with the survey results, ethical issues were the most common topic in discussions. The students' privacy was the main issue that concerned most. Participants raised the question of what happens to the student data that is collected by AI systems, who has the rights over it, and whether misuse is a possibility. A participant voiced a thought that many others probably had: "We are talking about kids here. Their difficulties in learning should not be turned into data points in some company's forever-following database."

The topic of algorithmic bias was given a lot of attention. A number of participants had seen the news that AI systems were racially or gender-biased. They feared that the use of such technology might contribute to the existing inequalities, despite being considered neutral. A student from the elementary education course remarked: "If the AI was trained mostly with middle-class white kids, how will it be of any help to my students who are mostly Latino and from low-income families? Won't it think of them as less capable?"

The human side of teaching was a very sensitive issue and heated up the discussions among the participants. They all pointed out the fact that teaching is a matter going beyond the emotional connection, motivation, and the understanding of context which AI cannot mimic. A high school English teacher made a strong statement: "Literature is about the human experience. I cannot give to a machine the task of helping students to relate to that. AI may support, but it cannot substitute the dialogue."

7.4 Preparation Gaps

Frustration was revealed by the discussions regarding the teacher education program preparation. The opinion of the majority of the participants was that their programs did not get AI and emerging technologies at all or at best very slightly. The remarks "We learned about the theories that are 60 years old but nothing about the technologies that we will actually use" gave an indication of the situation.

Participants expressed the desire for firsthand experience with AI, that is, the tools they might find in the schools. They called for testing of the educational AI applications, making judgments about their pedagogical usefulness and then teaching the teachers-in-training to use them in lessons. "We ought to have a class that is merely trying out different ed-tech tools, discovering what works and what does not, and thinking scientifically about why," was one suggestion made by a participant.

Moreover, the need for ethical frameworks regarding technology usage was pinpointed as another gap. The participants held very strong ethical concerns but were unable to evaluate technology decisions because they had no structured approaches. They wanted to be guided on questions such as: How can I determine if a tool is compliant with student privacy? What kind of fairness in algorithms should I look for? When is technology suitable and when is it not?

7.5 Support Needs

Support for AI integration was one of the main issues that the participants pointed out as a need. Professional development was the first priority, however, the participants highlighted that it must be practical and ongoing rather than one-off workshops. They desired learning communities of teachers who carry and share their experiences and also do group problem-solving with the help of the community.

An infrastructure of technical support was the main concern among the participants who were expecting to face difficulties with the implementation of the new systems. The technical hiccups at the greatest might happen in classrooms and the teachers wouldn't know what to do. One of the teachers said: "In case the AI system crashes during the lecture, I expect someone to be there for immediate rescue and not after 3 days."

The topic of when and how to use AI has come up to be a very important subject. The participants admitted that the use of technology in the classroom necessitates the teacher to be very thoughtful about the use case. They wanted the teachers to have a solid foundation that would help them to decide whether AI in the classroom would be a blessing to the learning process or its opposite. An example from a secondary science student stated: "I need help deciding when AI is a useful tool and when traditional methods are better. It's not an all-or-nothing situation.
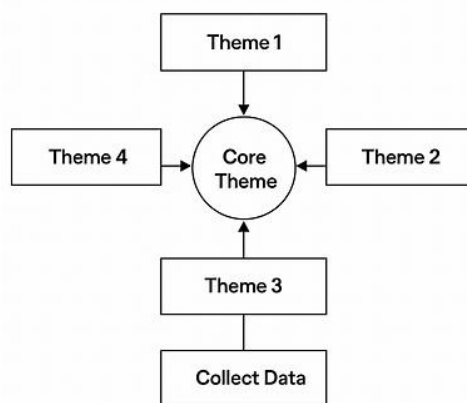

FIGURE 4: Thematic Map of Qualitative Findings

8.1 Integration of Findings

The blending of the quantitative and the qualitative findings presents a thoroughly documented life of pre-service teacher opinions. The two sources of data disclosed a basic paradox: On one hand, the recognition of AI's potential and, on the other hand, a high level of uncertainty about its use. This is the case of the sophisticated involvement of the people rather than the simple and uncritical acceptance or the total withdrawal through ignorance.

The quantitatively measured, moderately positive attitudes are made more comprehensive by the qualitative study. In the survey, the mean scores of the respondents' attitudes were 3.4, which at first seemed mild, but the focus groups showed that the scores reflected cautious optimism based on both the desire for AI's benefits and the awareness of the challenges to be faced. The stance taken by the respondents is not only critical but if the conditions for it are created, it can help in the thoughtful integration of AI into the educational setting.

The strong correlation between AI literacy and positive attitudes, confirmed quantitatively and elaborated qualitatively, suggests a clear intervention pathway. Education programs that increase AI understanding may

shift attitudes positively. However, qualitative findings emphasize that this education must be practically oriented, focusing on pedagogical applications rather than technical details.

8.2 Implications for Teacher Education

The results have important implications for teacher education reform. First, AI literacy must be integrated into programs as a core component, not as an optional extra. The disparity between 73% of participants who recognized the important role of AI in the future and only 23% getting a good AI education is both a stark and an urgent one.

Secondly, AI education should focus on pedagogical applications and critical evaluation rather than technical programming. Future teachers need to have guidelines for evaluating when AI is a learning enhancement, how to preserve human interaction while using technology, and how to deal with ethical issues. This is consistent with a major research finding in the field of technology integration that pedagogical knowledge is more important than the possession of technical skills (Tondeur et al., 2017).

Thirdly, experiential learning opportunities should be provided for pre-service teachers to play around with AI tools in real-world teaching situations. Theoretical knowledge acquired through classes would not be confidence-building and the ability to make the right judgments about the use of AI in the classroom would not be developed either. The lack of such experiences in their training might lead teachers to completely shun AI, as they might consider it unpredictable.

Fourth, ethical frameworks must be central to technology preparation. The strong ethical concerns expressed by participants represent responsible professionalism that should be cultivated rather than dismissed. Teacher education can provide structured approaches for evaluating technology ethics, balancing innovation with student protection.

8.3 Policy Recommendations

This investigation leads to several high-level policy recommendations. The accreditation criteria for trainer education courses should involve an integration of new technology competences, which would explicitly include, among others, AI. This would thus be a measurement of quality for the program in this aspect.

The funding must be directed towards AI and educational technology faculty development. Majority of the teacher education faculty do not keep up with technological advancements and hence are not able to prepare their students well enough; so, the professional development of teacher educators is indeed a very strategic investment.

The associations would be formed by teacher education programs and K-12 schools using AI as a tool to offer real teaching environments for pre-service teachers. The partnerships will have mutual benefits—pre-service teachers will get the transactions, the cooperating teachers will get assistance with technology implementation, and the schools will provide evaluations on the AI's effectiveness.

Lastly, the national or state-level guidance documents specifying the teachers' AI literacy standards would remove the ambiguity surrounding the competencies expected of the teachers. While general digital literacy

standards already exist, AI has not been included in such frameworks despite its uniqueness and being a challenging area.

8.4 Limitations and Future Research

The limitations of this research point to potential future studies. The cross-sectional design captured the attitudes only at one specific time; however, longitudinal studies would continue to observe the same group of pre-service teachers and thus, would be able to indicate how their attitudes change as they gain actual experience with the implementation of the technology. Such research could also address the question of whether the initial attitudes would be a good predictor of the long-term technology integration practices.

Although the sample was varied, it mainly consisted of convenience sampling thus limiting the extent to which the findings can be generalized. It would take larger samples that are reasonably representative and cover several countries to provide an empirical basis that could be the same as well as beyond the current one in terms of cultural variations in the attitudes towards AI.

One of the areas of future study should be about the effectiveness of the interventions. It would be practical to do experimental or quasi-experimental studies on the various AI education approaches in teacher preparation with a view to identifying the best ones. For instance, the comparison of outcomes from the technical training against those from the pedagogically-focused training would be a means of gathering information for the design of the curriculum.

Lastly, the research that delves into the views of the teacher educators themselves would be a nice addition to the pre-service teacher focus. Knowing the attitudes, the level of knowledge, and the readiness of the faculty to teach about AI would be very helpful in recognizing the professional development needs of those who are engaged in teacher training
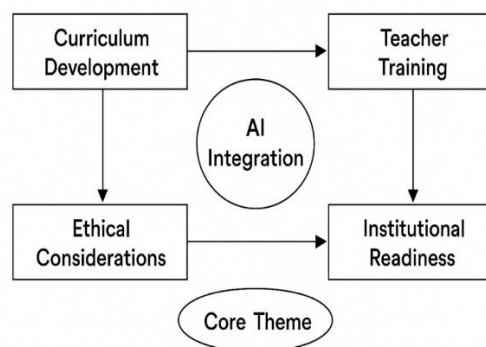

FIGURE 5: Framework for AI Integration in Teacher Education

9. CONCLUSION

This study sheds light on the perceptions and attitudes of pre-service teachers towards AI in education at a very critical point in the evolution of educational technology. The outcome indicates that future teachers of a new generation have the awareness of marking AI's power as a tool for making learning easier and being responsible and controlling that power is the main drawback that they are facing.

The research went through the primary aim of evaluating the views of student teachers very well, showing cautiously optimistic attitudes mingled with serious concerns about preparation, the ethics of and support for actual implementation. The secondary aims were equally accomplished: the major factors influencing the

attitudes were revealed, with the prior technology experience and AI literacy showing up as the strongest predictors of positive attitudes. The connection between knowledge and readiness for implementation was confirmed that increasing the understanding of AI could positively affect both attitudes and practice intentions. The researchers recognized the barriers perceived by the respondents and pointed out insufficient training as the most serious challenge along with the ethical issues of privacy and bias as the second major challenge.

Not only does this research contribute to the theory by broadening technology acceptance models to the AI in education-specific context, but also it indicates that the traditional factors of perceived usefulness and ease of use still play a role but ethical considerations must be added for the case of emerging technologies. Moreover, the research provides a contribution on the empirical side by presenting recent baseline data on pre-service teachers' perceptions in the various contexts, thus bridging a gap in the literature.

In a practical sense, the results give a very clear direction for the reform of teacher education. The programs have to mix the literacy of AI components that are teacher centered, ethically founded and full of rich experiences. The students who are in the process of becoming teachers will have to have the chances to see the AI tools, classify their educational worth and be involved in their development in real teaching situations. The educators will get the tools for dealing with the ethical issues that AI brings up, and these issues will be the protection of the students versus the innovation that the teacher is using.

The matter of these reforms is so critical that it cannot be stated strongly enough. AI software are being used in schools already and their use will only increase. Such teachers as those who are being trained today will be teaching in schools that are equipped with AI throughout their careers. To send them unprepared into these conditions does not serve either the teachers or the students well.

Nevertheless, the results point at the same time to a more encouraging side of the picture. Pre-service teachers are showing that they are not only engaging thoughtfully with AI but also reflecting on the use of technology. They see the pros and cons but still are not giving up the right amount of critical thinking. The students show great readiness and express strong desire to acquire the new knowledge. Such attitudes will be a good basis for smooth technology integration if they are rightly encouraged.

The conflict between the potential of AI and the inadequacy of current preparations is a double-edged sword, that is a challenge and an opportunity. The challenge is really big—the teacher training system has to change, so it will be able to cope with new technologies, and at the same time, it will have to remain focused on the principles of education that are still valid. However, the opportunity will be even bigger—the careful preparation of teachers for AI-supportive education can lead to personalized, data-driven, and efficient learning that will benefit every student.

In the end, AI's power in education does not rely on highly advanced algorithms but on the teachers' ability to integrate them wisely. They have to grasp what AI can and what it cannot do, be aware of the right scenarios for its use, never losing the human interaction that is the core of education, and support students' interests when technology fails. The commitment to the reform of teacher education that is driven by evidence of actual needs and viewpoints will be required in order to bring the teachers up to these complicated responsibilities.

The study provides a foundation for such evidence, showing that the upcoming teachers would be willing to collaborate with AI if adequately trained and supported. The issue is whether teacher education institutions, policymakers, and education leaders will cope with this transformation moment and provide the necessary urgency and resources.

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