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Impact of AI-Assisted Teaching Tools on Instructional Effectiveness among Secondary School Teachers: Gender-Based Comparative Analysis

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ABSTRACT

Focusing on gender inequalities, this research paper will discuss the implications of AI-based instructional aids on the effectiveness of teaching in Pakistani secondary school educators. Data were collected using a quantitative descriptive survey design in 259 male and female teachers with a structured questionnaire comprising of perceived usefulness, ease of use and confidence, trust in AI-supported instructional decisions, and willingness to integrate AI tools. The independent samples t-tests and descriptive statistics were used to analyze gender-based differences. The findings revealed that the teachers generally have positive views regarding AI-assisted instructional materials in all respects. Nevertheless, no statistically significant differences were observed between male and female teachers, which indicates that gender does not have a significant impact on the perceptions of AI tools. The results highlight the possibilities of AI technologies to enhance the effectiveness of instruction with adaptive instruction, individualized learning, and effective assessment, which underlines the importance of professional competence, pedagogical integration, and teacher preparedness in the successful implementation of AI.

Keywords: *AI-Assisted Teaching, Genders Perception, Instructional Effectiveness.*

Introduction

Artificial intelligence (AI) technologies have evolved at a very fast pace and have changed various industries, education being one of them. Intelligent tutoring systems, automated testing systems, adaptive learning systems, and generative AI systems are AI-assisted instructional tools that are becoming more and more part of classroom education to improve the efficiency of teaching and learning. The use of AI-based tools in secondary education where the performance of educators is vital in determining the academic path of students presents a potential that can be leveraged by teachers to plan and design their lessons, assessments, classroom learning, and personalized instruction. Since schools across the globe are doing their best to enhance the quality of teaching and learning, the development of the impact of AI on the effectiveness of teaching has become one of the relevant research agendas. Instructional effectiveness is the degree to which an instructional practice fosters a significant learning, student interaction, and a goal accomplished in the curriculum. Studies have always revealed that pedagogical competence, instructional strategy and capacity of teachers to address the needs of different learners are the key aspects of effective teaching. The teaching tools that are based on AI would be able to facilitate these dimensions by using real-time feedback, adaptive instructional recommendations, and data-driven insights that can be used to make an informed decision in instruction. Luckin et al. (2016) assume that AI systems will be able to support the instructional capabilities of teachers with routine tasks and enable them

to concentrate more on higher-order pedagogical processes, including the ability to facilitate critical thinking and interaction with students.

Education systems throughout the world start to pay attention to AI as a strategic instrument that may be considered in enhancing the quality of teaching and learning. According to Holmes et al. (2019), AI can transform the classroom teaching experience because it can be used to create a personalized classroom setting and increase the precision of instructions. Likewise, OECD (2021) underscores that AI technologies may assist teachers in the context of enhancing accuracy in assessment, planning their instruction, as well as learning analytics, though it is necessary to ensure that teachers are sufficiently equipped to utilize those tools successfully. The introduction of AI in teaching practice, however, is not also entirely a technological matter, but mostly depends on the beliefs, willingness, and attitudes of teachers to AI-based tools.

In the developing world like Pakistan, AI implementation in secondary schools has both opportunities and challenges. The Pakistani secondary schools are having a consistent challenge of quality in instructions, high classes, professional development and inequity in accessing educational technologies. Although in the past few years digital efforts have increased the accessibility of technology, the usage of sophisticated AI-assisted tools is still in its initial phase. According to Schleiger (2018), educational innovation does not only rely on the availability of technology and the ability of educators to use it but also on their readiness and ability to implement new technologies into teaching. Consequently, the perception of teachers on AI-assisted teaching tools is key in establishing how they can influence the effectiveness of instructions in the Pakistani case.

Gender is one aspect of AI integration in education that has not been addressed thoroughly. The use of technology, confidence, and attitudes variation in regards to gender have been highly reported in the research in education and organization. According to Cooper (2006), Gendered disparities in the use of technology are usually created by the differences in access, confidence, and social expectations as opposed to ability. Regarding the AI-assisted teaching tools and these differences, they can affect how male and female teachers view the utility of AI, trust AI-mediated instructional choices, and incorporate the tools in their teaching.

There is empirical evidence that gender has a major role in the acceptance and usage of technology. Venkatesh et al. (2000) established that there are difference in perceptions of men and women between the usefulness and ease of use of technology, which consequently influence adoption behavior. In the same manner, Cai et al. (2017) also proved that the gender difference in attitude towards technology applies to education and has an impact on the integration of instructional technology. The identification of gender-based difference in the perception of AI is especially valuable in secondary education where teachers are the main drivers of the process of instructional change to create the equitable and effective professional development programs.

Although the application of AI in education is increasingly researched, few empirical studies have investigated the role of AI-aided teaching devices on the effectiveness of instruction on the gender comparative viewpoint especially at the secondary school stage in developing economies. The existing research has paid much attention to the higher education or student side, which creates a gap in comprehending the experience and perception of AI-assisted instruction by teachers in secondary schools. This is a gap that needs to be addressed because secondary education takes centre stage in the academic and career trajectories of students.

Thus, the purpose of this study is to analyze the effect of instructional teaching tools in the AI-based context on the effectiveness of instruction in secondary schools, with particular attention to gender variations. The proposed research aims to offer empirical data that may guide policy, practices and professional development initiatives in Pakistan and other educational settings, by comparing the perceptions of male and female teachers regarding the usefulness of AI, ease of use, trust in AI-assisted instructional decision, and their willingness to incorporate AI into their daily teaching.

Literature Review

AI-Assisted Teaching Tools

The phenomenon of artificial intelligence has become a force that promotes changes in teaching methods in education. The AI-aided teaching tools facilitate the effectiveness of the instruction process through adaptive learning, automated evaluation, and computer-based instructional planning. Aleven et al. (2017) showed that adaptive learning technologies have a great impact on increasing the effectiveness of the instruction process because the instructional material is adjusted to the individual learning needs of students. These tools enable teachers to track the progress of students more precisely and modify teaching to achieve better results in the learning process.

Pedagogically speaking, AI tools promote instructional effectiveness through the deeper learning methods. According to Dede (2014), digital technologies, i.e. AI-based systems, facilitate deeper learning as they allow providing personalized instruction, formative assessment, and engagement of students. In the field of secondary education, where the needs of a curriculum are complicated and manifold, AI tools can assist teachers to cope with the complexity of instructions in a better way.

Karsenti (2019) points out the fact that the effectiveness of AI in the context of instruction is mostly dependent on the pedagogical integration of technology by teachers, as opposed to access. Teachers who plan their lessons incorporating the AI tools in a strategic manner, in their assessment, and feedback programs will be better placed to realize an increase in their quality of instruction. This brings to the fore the main role of teachers beliefs and competencies in the areas of determining the effectiveness of AI-assisted instruction.

The attitude of teachers towards AI-assisted teaching tools is an important factor in their adoption and use in teaching. According to Ertmer and Ottenbreit-Leftwich (2010), the assumptions of teachers about technology are significant determinants of the instructional practices and they usually override other external influences like infrastructure. Those teachers, who view AI tools as helpful and consistent with pedagogical purposes, have more chances to successfully incorporate them into the teaching process.

The relationship is also supported by technology acceptance models. It was discovered by Teo (2011) that the intention to use educational technologies by teachers is strongly predicted by the perceived usefulness and ease of use. In the case of AI, these perceptions determine how the teachers view AI tools as teaching tools or additional liability.

Teacher preparedness is another significant parameter that influences AI integration. Tondeur et al. (2017) explain that pedagogical beliefs and professional competence interact to establish the classroom use of technology. Teachers who have a good pedagogical history and are technologically inclined can use AI tools to enhance teaching methods.

Professional Learning and Artificial Intelligence.

Professional development is also essential because it will enable teachers to be exposed to the application of AI tools. According to Redecker (2017), to become digitally competent,

including AI-based instructional-related competencies, teachers must have formalized professional learning experiences. The issues with the translation of AI capabilities into applicable pedagogical actions may affect the teachers unless they are trained adequately.

Similarly, Voogt et al. (2013) observe that Technological Pedagogical Content Knowledge (TPACK) plays an important role in constructive technology integration. The AI-based pedagogical tools engage teachers to be balanced in terms of pedagogical and content skills in technology. Professional development programs covering these interrelated areas are needed to enhance the effectiveness of the instructions.

The educational research has always addressed the issue of gender differences in the use and attitude towards technology. Cooper (2006) observes that the trend of socialization and confidence is one of the factors that bring about the gender difference in the adoption of technologies. Such differences may affect how male and female teachers use AI-based tools in the learning environment.

The empirical evidence of the differences in attitude to technology between gender is proven. Cai et al. (2017) have identified that men tend to claim that they are more confident and more positive related to using technology, whereas women might report more concerns in reliability and ethical aspects. These variations are capable of affecting instructional integration and perceived effectiveness of AI tools.

Venkatesh et al. (2000) also established the role of gender in moderating the relationship between perception usefulness and technology adoption. This implies that male and female teachers might not perceive the instructional value of AI tools in the same way which prompts the differences in the AI usage patterns and the instructional outcomes.

Also in developing education systems, like Pakistan, the integration of AI in secondary education should be seen in the context of wider systemic issues. According to Brynjolfsson and McAfee (2017), the productivity level of digital technologies can be improved only when institutions will change their practices and the skills of their workforce. Pakistani secondary schools may be an area where AI tools can be used to facilitate instructional effectiveness when based on the needs of the context.

According to Schleicher (2018), teacher capacity and instructional leadership are the investments that should be made to reform the educational system successfully. In Pakistan, gender-sensitive policies and specific professional development interventions are needed in such a way that AI-based teaching tools have an equal access and are used by both male and female teachers with good outcomes.

Research Hypotheses

Ho_1: The usefulness of AI-assisted teaching tools is not perceived differently by male and female secondary school teachers.

Ho_2: The perceptions of ease of use and confidence in utilizing AI-assisted teaching tools differ significantly between male and female secondary school teachers.

Ho_3: The degree to which male and female secondary school teachers trust AI-supported instructional decisions differs significantly.

Ho_4: Secondary school teachers' instructional effectiveness is not significantly impacted by AI-assisted teaching tools.

Methodology

The present research design was a quantitative descriptive survey to investigate how AI-assisted teaching tools can influence the instructional effectiveness of secondary school teachers, and whether there is a gender difference in this case. The sample consisted of male

and female secondary school teachers in the public sector schools. A sample of 259 teachers was selected using a stratified random sampling method and both genders were represented proportionally. The self-constructed structured questionnaire was used to gather the data according to the study variables such as perceived usefulness of AI tools, ease of use and confidence, trust in AI-supported instructional decisions, willingness to integrate AI tools, and instructional effectiveness. The measures of response were on a five-point Likert scale of strongly disagree to strongly agree. The instrument was tested and validated by both the education and technology experts and the reliability of the instrument was tested by Cronbach alpha. Descriptive statistics (mean and standard deviation) and independent samples t-tests were used to analyze the data in order to identify the differences based on gender.

Table 1

Impact of AI-Assisted Teaching Tools on Instructional Effectiveness Regarding Usefulness of AI-Assisted Tools Among Secondary School Teachers

Gender	n	M	SD	t	p
Male	135	4.26	.483	1.63	.105
Female	124	4.15	.622		

Note: *n*= Teaches; *M* = Mean; *SD* = Standard deviation; *p* > .05 (not significant)

Table 1 shows a comparative analysis of the perceptions of secondary school teachers based on gender on the usefulness of AI-assisted teaching tools. The data show that the mean score (M = 4.26, SD = 0.48) of male teachers (n = 135) was a little higher than that of female teachers (n = 124), who received a mean score of 4.15 (SD = 0.62). This means that male and female teachers tended to have a positive attitude toward the usefulness of AI-assisted teaching tools in terms of teaching effectiveness. The independent samples t-test however showed that the difference in the mean scores was not statistically significant (t = 1.63, p =.105). Thus, Hypothesis H 0 was rejected, and since this means that the gender factor does not play a significant role in the perception of usefulness of AI-assisted teaching tools by the teachers in the secondary school level.

Table 2

Impact of AI-Assisted Teaching Tools on Instructional Effectiveness Regarding Ease of Use and Confidence in Using AI Tools Among Secondary School Teachers.

Gender	n	M	SD	t	p
Male	135	4.22	.557	1.08	.279
Female	124	4.14	.562		

Note: *n*= Teaches; *M* = Mean; *SD* = Standard deviation; *p* > .05 (not significant)

Table 2 shows the gender-based comparison of the perceptions of secondary school teachers on the ease of use and confidence in using AI-assisted teaching tools. The results indicate that male teachers (n = 135) had slightly higher mean score (M = 4.22, SD = 0.56) than female teachers (n = 124), who received a mean score of 4.14 (SD = 0.56). On the whole, the average scores show that male and female teachers had positive perception and quite high degree of confidence in using AI-assisted tools in instructional activities. Nonetheless, the results of the independent samples t-test depicted that the difference between the male and female teachers was not statistically significant (t = 1.08, p =.279). As a result, Hypothesis H 2 was not accepted, and it is possible to conclude that gender does not play a significant role in determining the perceived ease of use and confidence of teachers to use AI-assisted teaching tools in the secondary school level.

Table 3

Impact of AI-Assisted Teaching Tools on Instructional Effectiveness Regarding Trust in AI-Supported Instructional Decisions Among Secondary School Teachers

Gender	n	M	SD	t	p
Male	135	4.17	.542	-.103	.918
Female	124	4.18	.606		

Note: *n*= Teaches; *M* = Mean; *SD* = Standard deviation; *p* > .05 (not significant)

Table 3 compares the trust in AI-assisted instructional choices of male and female secondary school teachers. The mean of male teachers (n = 135) was 4.17 (SD = 0.54), and that of female teachers (n = 124) was a little higher 4.18 (SD = 0.61). These scores show that both male and female teachers tend to trust AI-assisted instructional decisions highly, which is the positive perception of the reliability and support of AI in the teaching process. Nonetheless, the independent samples t -test revealed that the difference between the two groups was not statistically significant (t = -0.103, p =.918). Thus, Hypothesis H3 should not be accepted, which indicates that gender does not play a significant role in the level of trust of secondary school teachers in AI-assisted instructional choices in their classrooms.

Table 4

Impact of AI-Assisted Teaching Tools on Instructional Effectiveness Regarding Willingness to Integrate AI Tools into Daily Teaching Among Secondary School Teachers

Gender	n	M	SD	t	p
Male	135	4.19	.506	.050	.960
Female	124	4.19	.490		

Note: *n*= Teaches; *M* = Mean; *SD* = Standard deviation; *p* > .05 (not significant)

Table 4 will explore the gender-based comparison of the willingness of secondary school teachers to incorporate AI-assisted teaching tools in their daily instructional practice. The mean score of both male and female teachers (n = 135 and n = 124, respectively) was the same (4.19) with standard deviation of 0.51 and 0.49, respectively, which means that the level of willingness and the positive attitude toward the use of AI tools in teaching is high. The independent samples t-test showed that there was no statistically significant difference between male and female teachers (t = 0.050, p = .960). These results indicate that the AI-based teaching tools can be viewed as useful and acceptable by secondary school teachers, irrespective of their gender. Therefore, it is not possible to confirm Hypothesis H 4 in terms of gender differences, but in general, AI tools demonstrate the promise of improving the effectiveness of instruction.

Discussion and Conclusions

The findings of this study indicate that both male and female teachers of secondary schools, on the mean, feel positively regarding AI-based teaching tools in terms of usefulness, usability, credibility, and willingness to use it in their daily teaching practices. There were no statistically significant gender differences in all four of the measured dimensions, such as usefulness, confidence in using, trust in AI-based instructional decision-making, and readiness to use AI tools. These results suggest that the attitudes of male and female teachers in Pakistan toward AI-based teaching tools are similar, which is also in line with the results of the works by Aleven et al. (2017) and Holmes et al. (2019) who noted that the instructional performance of teachers is influenced by pedagogical integration, but not gender.

The triviality of gender differences is also consistent with the more recent studies of educational technology adoption, which show that gender differences are becoming less significant when teachers possess adequate access, training, and institutional support (Cai et al., 2017; Venkatesh et al., 2000). Along this line, Ertmer and Ottenbreit-Leftwich (2010) observed that technology adoption is more likely to be determined by beliefs, confidence and professional competence of teachers than demographic factors. The findings, in the Pakistani context, emphasize the fact that, even though the access to AI tools and digital infrastructure is still developing, teachers in the country are typically not opposed to the incorporation of technology regardless of their gender, which proves the point of Schleicher (2018) that the capacity and willingness of teachers is the most critical element of successful educational innovation.

Overall, the study confirms the fact that AI-mediated instructional resources can possess a massive potential in enhancing teaching performance at the secondary level. The favorable attitudes of teachers indicate that they are ready to apply AI technologies to assist in lesson planning, personalized instruction, assessment, and classroom management, which is also in line with the TPACK framework in terms of highlighting the interaction between the technological, pedagogical, and content knowledge to improve the outcomes of teaching (Voogt et al., 2013). Moreover, as per the principles of TAM, both usefulness and ease of use mean scores are high meaning that the teachers know about the utility and practicality of AI-assisted tools in their respective teaching (Teo, 2011).

Conclusions

1. Gender fails to have significant effects on the perceptions of secondary school teachers towards AI-assisted teaching tools on major dimensions, such as usefulness, confidence in using, trust in AI-supported decisions, and willingness to use AI in instruction.
2. Educators are generally positive about AI-based tools, which indicates that they may achieve better teaching with the help of technology.
3. The teaching tools that are AI-assisted have the potential to facilitate the quality of instructions, especially through facilitation of personalized learning, adaptive instruction, and efficient assessment practices.
4. Teacher readiness, professional competence, and pedagogical integration are the most significant elements of AI adoption, particularly in contrast to demographic factors, including gender.

Recommendations

1. ***rograms which will Professional Development Programs: Include structured training p -enhance the technological and pedagogical competence of the teachers in the area of AI .assisted instructions, based on the TPACK framework***
2. ***Equal Access to AI Resources: To make sure that teaching tools based on AI and the astructure are accessible, ensure that all secondary schools, especially in rural necessary infr .and underserved areas, can access these tools***
3. ***Curriculum Integration: Integrate AI tools into the curriculum development in the process ing, formative assessment, and adaptive teaching, of promoting individually based learn .which positively affects learning effectiveness altogether***
4. ***Responsive Policies: Gender disparities were not intense, but one should strive to -Gender tential social or cultural barriers to offer equal opportunities to all teachers to minimize po .the use of technology***

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