

**Role of Machine Communication in Developing Socio-Emotional Competencies among
Secondary School Teachers**

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ABSTRACT

The study titled “Role of Machine Communication in Developing Socio-Emotional Competencies Among Secondary School Teachers” investigates how modern digital and AI-based communication systems contribute to teachers’ socio-emotional development. The main objectives of the study were to examine the role of machine communication in developing socio-emotional competencies, to explore its relationship with emotional regulation, social awareness, and relationship management, and to determine its predictive effect on socio-emotional competencies among secondary school teachers. A quantitative research design based on a correlational survey method was adopted to conduct the study. The population consisted of approximately 120 public secondary schools of District Islamabad with nearly 2,400 secondary school teachers as respondents. A sample of 331 secondary school teachers was selected through stratified random sampling technique to ensure equal representation. A structured questionnaire based on a five-point Likert scale was used as a research tool. Content validity was ensured through expert review, while reliability was confirmed using Cronbach’s Alpha (0.87). Data were analyzed using SPSS through descriptive statistics, Pearson correlation, and regression analysis. The first objective revealed that machine communication positively contributes to the development of socio-emotional competencies among secondary school teachers. Based on this finding, it is recommended that teachers should be provided regular training programs on effective use of machine communication tools to strengthen their socio-emotional and professional competencies. The significance of the study lies in its contribution to educational technology literature, teacher development policies, and understanding the psychological and emotional impacts of AI-based communication systems in secondary education.

Keywords: Machine Communication, Socio-Emotional Competencies, Secondary School Teachers, Artificial Intelligence, Digital Communication, Emotional Regulation

INTRODUCTION:

The rapid advancement of digital technologies and artificial intelligence has transformed communication processes in educational settings across the world. Machine communication, which refers to communication mediated through intelligent technologies such as artificial intelligence systems, chatbots, digital platforms, automated communication tools, and interactive educational technologies, has become an essential component of modern teaching and learning practices (Abbasi et al., 2025). In secondary schools, teachers increasingly interact with technological systems for instructional planning, classroom management,

assessment, collaboration, and professional development. These developments have significantly influenced not only teachers' instructional competencies but also their socio-emotional competencies, including empathy, emotional regulation, social awareness, relationship management, and responsible decision-making. Researchers argue that technological communication systems are reshaping educational interactions and influencing teachers' emotional and social behaviors within educational environments (Xu et al., 2026; Sáez-Delgado et al., 2025; Xie et al., 2026). The integration of machine communication in educational institutions has therefore emerged as an important area of investigation for educational researchers and policymakers.

Socio-emotional competencies are considered essential professional attributes for teachers because they directly affect classroom climate, interpersonal relationships, students' emotional development, and overall teaching effectiveness (Batool et al., 2025). Teachers with strong socio-emotional competencies can effectively manage stress, maintain positive relationships with students, collaborate with colleagues, and create supportive learning environments. Modern educational frameworks emphasize that socio-emotional competencies contribute significantly to teacher well-being and student success in academic and social domains (Calandri et al., 2025; Rivera Campos, 2025; Sáez-Delgado et al., 2025). Educational researchers have further highlighted that socio-emotional competencies help teachers adapt to changing educational demands and technological innovations. In contemporary classrooms where digital communication systems are widely used, teachers are expected to balance technological engagement with emotional responsiveness and social interaction.

Machine communication has evolved beyond simple technological interaction and now involves intelligent communication systems capable of adaptive responses, emotional recognition, automated feedback, and personalized educational support. The use of artificial intelligence-based communication tools in schools allows teachers to engage with virtual learning environments, digital collaboration systems, and smart educational applications. These technologies can support professional efficiency, reduce workload, and enhance instructional communication (Bibi et al., 2023). At the same time, they influence teachers' emotional experiences and social interactions within educational contexts (Pentón Herrera & Hussain, 2026; Xu et al., 2026; Cukurova et al., 2025). Researchers suggest that machine communication may strengthen teachers' confidence, communication flexibility, and emotional adaptability when integrated effectively into teaching practices.

The increasing use of machine communication technologies in education has accelerated after the global expansion of online and blended learning environments. Teachers are now regularly engaged with communication platforms such as learning management systems, AI-powered educational software, virtual classrooms, and digital assessment tools. These technological systems facilitate communication among teachers, students, administrators, and parents (Ibrahim et al., 2025). According to recent studies, teachers who effectively use digital communication technologies demonstrate improved emotional regulation, self-awareness, and collaborative competencies (Asnawi et al., 2025; Sáez-Delgado et al., 2025; Xie et al., 2026). Such findings indicate that machine communication may contribute positively to socio-emotional growth by enhancing professional interactions and reducing communication barriers within schools.

Researchers have increasingly focused on understanding how technology-mediated communication influences human emotions, social relationships, and professional competencies. Educational technology scholars emphasize that machine communication can shape teachers' emotional engagement and social cognition by facilitating interactive and responsive communication environments (Kiran et al., 2022). AI-supported communication systems often provide immediate feedback, adaptive instructional suggestions, and collaborative opportunities that may enhance teachers' professional confidence and emotional resilience (Xu et al., 2026; Pentón Herrera & Hussain, 2026; Cukurova et al., 2025). These systems also

encourage reflective teaching practices and collaborative learning communities that support emotional development and social connectedness among educators.

The theoretical understanding of socio-emotional competencies is commonly grounded in frameworks such as the Collaborative for Academic, Social, and Emotional Learning (CASEL) model. This model identifies self-awareness, self-management, social awareness, relationship skills, and responsible decision-making as key socio-emotional domains. Teachers possessing these competencies are more capable of maintaining positive classroom environments and promoting student engagement (Mahnaz, 2024). Research indicates that digital technologies can support the development of these competencies through reflective tools, collaborative platforms, and interactive communication systems (Sáez-Delgado et al., 2025; Rivera Campos, 2025; Calandri et al., 2025). Machine communication tools such as AI-supported feedback systems, online collaboration applications, and virtual communication platforms may therefore contribute to strengthening teachers' socio-emotional capacities.

In recent years, artificial intelligence has gained particular importance in educational communication systems. AI-powered technologies are increasingly used for automated tutoring, intelligent assessment, communication support, and professional development activities. These technologies influence the ways teachers communicate, respond to emotional situations, and engage in collaborative interactions. Researchers have found that teachers' AI literacy and self-efficacy significantly mediate the relationship between technology use and socio-emotional competence development (Xu et al., 2026; Xie et al., 2026; Cukurova et al., 2025). This suggests that machine communication not only affects instructional practices but also contributes to teachers' emotional and social functioning.

Machine communication also supports teachers in managing professional stress and workload. Educational technologies can automate repetitive administrative tasks, provide instructional assistance, and facilitate efficient communication processes. Such technological support may reduce emotional exhaustion and increase teachers' emotional stability and job satisfaction. Studies have shown that digital communication tools help teachers improve self-regulation, reflective thinking, and emotional preparedness in educational settings (Sáez-Delgado et al., 2025; Rivera Campos, 2025; Pentón Herrera & Hussain, 2026). Consequently, machine communication can be viewed as a supportive factor in enhancing teachers' professional well-being and socio-emotional resilience.

Another important aspect of machine communication is its role in promoting collaborative learning and professional interaction among teachers. Online communication platforms, virtual communities, and AI-assisted collaboration systems enable teachers to exchange ideas, share experiences, and receive emotional support from professional networks. Such collaborative communication environments strengthen relationship management and social awareness competencies among educators (Asnawi et al., 2025; Sáez-Delgado et al., 2025; Calandri et al., 2025). Teachers engaged in technology-supported collaboration often report improved interpersonal understanding, empathy, and professional connectedness.

Despite the growing integration of machine communication technologies in schools, concerns have also emerged regarding their possible negative effects on human interaction and emotional engagement. Some researchers argue that excessive reliance on technological communication may reduce face-to-face interaction, emotional sensitivity, and authentic social relationships within educational settings (Cukurova et al., 2025; Pentón Herrera & Hussain, 2026; Zhou et al., 2018). Teachers may experience technological stress, communication overload, or emotional detachment if machine communication systems are not implemented appropriately. Therefore, understanding the balanced role of machine communication in socio-emotional development remains essential for educational practice and policy.

The role of emotional intelligence and emotional competence has become increasingly important in technology-enhanced educational environments. Teachers are expected to manage emotional interactions not only with students but also with digital communication systems. Emotional competence enables teachers to interpret communication cues, respond empathetically, and maintain productive relationships in both physical and virtual learning environments (Mahnaz & Nayab, 2026). Research findings suggest that teachers with stronger emotional competencies are more adaptable to technological changes and more effective in integrating digital communication tools into classroom practices (Calandri et al., 2025; Rivera Campos, 2025; Xie et al., 2026). This highlights the interrelationship between technological communication and socio-emotional functioning in education.

In developing countries such as Pakistan, the integration of machine communication technologies in secondary education is gradually expanding due to increasing digitalization and educational reforms. Teachers in urban educational settings are increasingly using smart classrooms, digital learning systems, online communication tools, and AI-supported educational applications. However, limited research has explored how these technological communication systems influence teachers' socio-emotional competencies within the Pakistani educational context. Most existing studies focus on students' technological learning outcomes rather than teachers' emotional and social development (Asnawi et al., 2025; Xu et al., 2026; Sáez-Delgado et al., 2025). This creates a research gap that necessitates further investigation.

Secondary school teachers hold a critical position in shaping students' academic and emotional development (Mahnaz & Kiran, 2024a). Their socio-emotional competencies directly influence classroom management, student motivation, communication quality, and educational effectiveness. In technology-integrated classrooms, teachers must simultaneously manage instructional responsibilities and digital communication processes. Understanding how machine communication contributes to teachers' socio-emotional competencies is therefore essential for improving teacher preparation, professional development, and educational policy implementation (Calandri et al., 2025; Cukurova et al., 2025; Pentón Herrera & Hussain, 2026). Educational institutions can use such findings to design supportive technological environments that promote both professional efficiency and emotional well-being.

The present study seeks to examine the role of machine communication in developing socio-emotional competencies among secondary school teachers. The study aims to explore how technological communication systems influence teachers' emotional regulation, social awareness, communication skills, and professional relationships in educational settings. By investigating the relationship between machine communication and socio-emotional competencies, the study will contribute to existing literature on educational technology and teacher development. Furthermore, the findings may assist policymakers, school administrators, and teacher educators in designing effective strategies for integrating machine communication technologies in ways that support teachers' socio-emotional growth and professional effectiveness.

Objectives of the Study

1. To examine the role of machine communication in developing socio-emotional competencies among secondary school teachers.
2. To investigate the relationship between machine communication and teachers' emotional regulation, social awareness, and relationship management.
3. To determine whether machine communication significantly predicts socio-emotional competencies among secondary school teachers.

Hypotheses of the Study

H1: There is significant relationship between machine communication and socio-emotional competencies among secondary school teachers.

H2: There is significant relationship between machine communication and teachers' emotional regulation, social awareness, and relationship management.

H3: Machine communication significantly predicts socio-emotional competencies among secondary school teachers.

Statement of the Problem

The increasing integration of machine communication technologies in secondary education has transformed teaching practices, professional communication, and classroom interaction. Teachers are now frequently engaged with artificial intelligence systems, digital communication tools, and online learning platforms for instructional and administrative purposes. Although these technologies improve efficiency and accessibility, their influence on teachers' socio-emotional competencies remains insufficiently explored, particularly in secondary school settings. Socio-emotional competencies such as emotional regulation, empathy, social awareness, and relationship management are essential for effective teaching and positive educational outcomes. However, limited empirical evidence exists regarding how machine communication contributes to or influences the development of these competencies among teachers. In Pakistan, especially at the secondary school level, research on machine communication has primarily focused on technological adoption and academic achievement, while teachers' socio-emotional development has received comparatively less attention. Therefore, the present study aims to investigate the role of machine communication in developing socio-emotional competencies among secondary school teachers.

Conceptual Framework

Independent Variable:

Machine Communication

- AI-based communication systems
- Digital communication platforms
- Technology-mediated interaction
- Virtual communication tools

Dependent Variable:

Socio-Emotional Competencies

- Self-awareness
- Emotional regulation
- Social awareness

- Relationship management
- Responsible decision-making

Significance of the Study

The study is significant because it contributes to the growing body of knowledge regarding the integration of machine communication technologies in education and their influence on teachers' socio-emotional development. The findings may help educational policymakers understand the importance of balancing technological advancement with teachers' emotional and social well-being. School administrators may use the results to design supportive digital environments that enhance teachers' professional communication and emotional competencies. The study is also beneficial for teacher educators and training institutions in developing professional development programs focused on emotional intelligence and technology integration. Furthermore, the research may guide secondary school teachers in understanding how machine communication tools can positively support their interpersonal relationships, emotional regulation, and professional effectiveness. Finally, the study will provide a foundation for future researchers interested in exploring machine communication, artificial intelligence, and socio-emotional competencies within educational settings.

LITERATURE REVIEW:

Concept of Machine Communication

Machine communication refers to interactions facilitated through digital systems, artificial intelligence technologies, automated platforms, and smart communication tools that enable humans and machines to exchange information effectively. In educational settings, machine communication includes learning management systems, virtual classrooms, AI-based tutoring systems, automated feedback applications, and digital collaboration tools. The increasing integration of these technologies in schools has transformed the communication patterns between teachers, students, administrators, and educational institutions. Researchers have emphasized that machine communication has become a central element of modern educational environments because it supports accessibility, efficiency, collaboration, and personalized learning experiences (Cukurova et al., 2025; Xu et al., 2026; Holmes & Tuomi, 2022). Educational institutions worldwide increasingly depend upon digital communication technologies to improve instructional quality and administrative efficiency.

Machine communication differs from traditional communication because it involves intelligent systems capable of processing information, responding adaptively, and facilitating interactive learning experiences. Artificial intelligence systems now possess the ability to analyze user behavior, provide automated responses, and support educational decision-making. Such developments have expanded the role of technology from passive instructional support to active communicative engagement within classrooms (Luckin & Cukurova, 2019; Zawacki-Richter et al., 2019; Holmes et al., 2021). Researchers further argue that machine communication not only improves teaching effectiveness but also influences teachers' emotional experiences, social interactions, and professional competencies.

The use of machine communication technologies increased significantly after the global expansion of online learning environments (Mahnaz & Kiran, 2024b). Secondary school teachers now use virtual communication platforms, AI-supported assessment systems, and collaborative technologies to manage classroom activities and instructional responsibilities. Studies have reported that teachers' interaction with machine communication systems contributes to instructional innovation and professional adaptability (Asnawi et al., 2025; Sáez-Delgado et al., 2025; Xie et al., 2026). Consequently, researchers have become

increasingly interested in understanding the broader psychological and socio-emotional effects of technological communication in educational contexts.

Socio-Emotional Competencies of Teachers

Socio-emotional competencies refer to the abilities that enable individuals to understand emotions, regulate emotional responses, establish positive relationships, and make responsible decisions. In educational contexts, teachers' socio-emotional competencies are essential because they directly affect classroom climate, communication quality, student engagement, and teaching effectiveness. Educational scholars identify competencies such as self-awareness, self-management, empathy, social awareness, and relationship management as central components of socio-emotional functioning (CASEL, 2020; Rivera Campos, 2025; Calandri et al., 2025). These competencies help teachers manage stress, maintain professional relationships, and support students' emotional development.

Teachers with strong socio-emotional competencies are better equipped to create supportive learning environments and address students' emotional needs effectively. Emotional regulation allows teachers to maintain classroom discipline calmly and respond constructively to stressful situations. Similarly, social awareness and empathy strengthen communication between teachers and students, improving trust and cooperation within classrooms (Jennings & Greenberg, 2009; Calandri et al., 2025; Pentón Herrera & Hussain, 2026). Researchers suggest that socio-emotional competencies are critical for teacher well-being and long-term professional success.

In modern educational environments, socio-emotional competencies are increasingly linked with digital communication and technology integration (Shaheen et al., 2022). Teachers operating within technology-enhanced classrooms require emotional adaptability and communication flexibility to manage both human and machine interactions effectively (Waheed et al., 2025). Studies indicate that technology-supported teaching environments may either enhance or challenge teachers' socio-emotional functioning depending upon the quality of technological integration and institutional support (Sáez-Delgado et al., 2025; Xie et al., 2026; Asnawi et al., 2025). Therefore, understanding the relationship between machine communication and socio-emotional competencies has become an important research concern.

Machine Communication in Educational Settings

Educational institutions increasingly employ machine communication systems to facilitate teaching, learning, administration, and professional collaboration. AI-based communication platforms, virtual classrooms, smart educational applications, and digital feedback systems are widely used in secondary schools worldwide. These technologies improve instructional communication, provide immediate feedback, and support individualized learning experiences (Holmes & Tuomi, 2022; Xu et al., 2026; Cukurova et al., 2025). Teachers who effectively use machine communication systems often demonstrate greater instructional efficiency and technological adaptability.

The integration of machine communication technologies has also changed the nature of teacher-student interaction. Digital communication systems provide opportunities for continuous communication beyond classroom boundaries through online assignments, discussion forums, and virtual collaboration platforms (Sarfraz et al., 2025). Researchers argue that such communication environments increase engagement and facilitate collaborative learning experiences (Zawacki-Richter et al., 2019; Sáez-Delgado et al., 2025; Holmes et al., 2021). Teachers are therefore required to develop new communication strategies that combine technological competence with socio-emotional responsiveness.

Despite the advantages of machine communication, researchers have highlighted concerns regarding emotional disconnection and reduced interpersonal interaction within educational settings (Mahnaz & Kiran, 2024c). Excessive dependence on digital communication may weaken emotional sensitivity and reduce authentic human interaction in classrooms. Some studies indicate that teachers may experience technological stress, emotional fatigue, and communication overload due to continuous engagement with digital systems (Cukurova et al., 2025; Pentón Herrera & Hussain, 2026; Xie et al., 2026). Consequently, balanced integration of machine communication technologies remains essential for maintaining positive socio-emotional environments in schools.

Role of Artificial Intelligence in Teacher Development

Artificial intelligence has become an influential component of educational communication systems and teacher development programs. AI technologies are used to support instructional planning, automate administrative tasks, provide adaptive feedback, and facilitate professional learning opportunities (Noreen et al., 2025). Researchers have noted that AI-supported communication systems improve teachers' efficiency, confidence, and instructional flexibility (Xu et al., 2026; Holmes & Tuomi, 2022; Cukurova et al., 2025). These technologies also contribute to reflective teaching practices and professional growth.

AI-supported communication systems enable teachers to receive personalized instructional recommendations and performance feedback. Such systems enhance teachers' professional decision-making and help them identify effective teaching strategies. Research findings indicate that teachers with stronger AI literacy and digital competence are more likely to demonstrate emotional adaptability and professional resilience (Xie et al., 2026; Sáez-Delgado et al., 2025; Holmes et al., 2021). This suggests that AI-based communication technologies may indirectly strengthen socio-emotional competencies through increased professional confidence and self-efficacy (Mahnaz et al., 2023).

Another important contribution of artificial intelligence is its role in reducing workload and emotional stress among teachers. AI systems can automate repetitive administrative tasks such as grading, attendance management, and instructional organization. Such technological support allows teachers to focus more on interpersonal interaction and emotional engagement with students (Luckin & Cukurova, 2019; Xu et al., 2026; Pentón Herrera & Hussain, 2026). Consequently, AI-supported machine communication may positively influence teachers' emotional well-being and professional satisfaction (Nazir et al., 2025).

Relationship between Machine Communication and Socio-Emotional Competencies

Several recent studies have explored the relationship between technological communication and socio-emotional functioning in educational contexts. Researchers argue that machine communication systems influence emotional regulation, communication flexibility, empathy, and social interaction among teachers. Technology-mediated communication environments often require teachers to adapt emotionally and socially to digital interaction patterns (Asnawi et al., 2025; Sáez-Delgado et al., 2025; Rivera Campos, 2025). Teachers who effectively engage with digital communication tools frequently demonstrate stronger collaborative and interpersonal competencies.

Machine communication may positively contribute to emotional regulation by reducing communication barriers and facilitating efficient instructional management. Automated systems provide teachers with structured communication channels, timely information, and instructional assistance that reduce stress and improve emotional preparedness (Nasir & Mahnaz, 2026). Studies reveal that teachers using technology-supported communication systems often report improved confidence, self-awareness, and emotional adaptability (Xu et al., 2026; Xie et al., 2026; Calandri et al., 2025). Such findings indicate a significant connection between machine communication and socio-emotional growth.

At the same time, researchers caution that technological communication may create emotional challenges if not implemented appropriately. Continuous digital interaction may reduce opportunities for face-to-face communication and emotional connection. Teachers may also experience anxiety related to technological complexity, system failure, or excessive digital workload (Pentón Herrera & Hussain, 2026; Cukurova et al., 2025; Holmes et al., 2021). Therefore, educational institutions must ensure balanced technology integration that supports both instructional efficiency and emotional well-being (Mahnaz et al., 2025).

Digital Communication and Emotional Regulation

Emotional regulation refers to the ability to manage emotional responses effectively in different situations. In educational settings, emotional regulation is essential for maintaining classroom discipline, managing stress, and responding positively to students' needs (Mehrukh et al., 2022). Machine communication technologies can support emotional regulation by improving communication efficiency and reducing instructional pressure (Calandri et al., 2025; Rivera Campos, 2025; Xie et al., 2026). Teachers who use organized digital systems may experience lower stress levels and greater professional confidence.

Digital communication systems also facilitate access to professional support networks and collaborative learning communities. Teachers participating in online professional communities often receive emotional encouragement, instructional guidance, and peer collaboration opportunities. Such communication environments strengthen emotional resilience and social connectedness among educators (Sáez-Delgado et al., 2025; Asnawi et al., 2025; Pentón Herrera & Hussain, 2026). Consequently, machine communication can serve as a supportive mechanism for emotional stability and professional development.

However, emotional regulation may be negatively affected when teachers experience technological overload or communication fatigue. Continuous online interaction, digital monitoring, and multitasking demands may increase emotional stress and professional burnout. Studies suggest that insufficient technological training and institutional support can intensify emotional difficulties associated with machine communication systems (Holmes et al., 2021; Cukurova et al., 2025; Xu et al., 2026). Therefore, proper training and balanced communication practices are necessary for positive emotional outcomes.

Machine Communication and Social Awareness

Social awareness involves understanding others' emotions, perspectives, and social needs within interpersonal interactions. In educational settings, social awareness helps teachers maintain supportive relationships with students, colleagues, and parents. Machine communication systems facilitate collaboration, information sharing, and social interaction across educational communities (Asnawi et al., 2025; Rivera Campos, 2025; Sáez-Delgado et al., 2025). Teachers using collaborative communication technologies often demonstrate improved interpersonal understanding and professional cooperation.

Online communication platforms provide opportunities for teachers to participate in professional learning communities and collaborative discussions. Such environments encourage knowledge exchange, empathy, and reflective interaction among educators (Mahnaz et al., 2022). Researchers have reported that digital communication systems enhance social participation and collective problem-solving within schools (Holmes & Tuomi, 2022; Xu et al., 2026; Xie et al., 2026). These collaborative experiences contribute to the development of social awareness and relationship management competencies.

Nevertheless, the absence of direct physical interaction in machine communication environments may limit emotional interpretation and interpersonal sensitivity (Mahnaz et al., 2025). Teachers communicating primarily through digital systems may experience difficulties in recognizing emotional cues and maintaining authentic social relationships (Cukurova et al., 2025; Pentón Herrera & Hussain, 2026; Holmes

et al., 2021). Therefore, balanced integration of face-to-face and digital communication remains important for strengthening social awareness competencies.

Teacher Well-Being and Technology Integration

Teacher well-being is strongly connected with emotional competence, professional satisfaction, and effective communication practices. Technology integration influences teachers' well-being positively when communication systems are accessible, supportive, and user-friendly. Machine communication tools can reduce administrative burden, improve instructional organization, and facilitate collaboration (Xu et al., 2026; Sáez-Delgado et al., 2025; Asnawi et al., 2025). Such support contributes to improved job satisfaction and emotional stability among teachers.

Educational institutions that provide technological training and emotional support often experience more positive outcomes regarding teacher well-being (Mahnaz et al., 2023). Teachers who feel competent in using machine communication systems are more confident and less likely to experience technological stress. Research findings indicate that digital competence and emotional intelligence together contribute significantly to teachers' professional effectiveness (Calandri et al., 2025; Rivera Campos, 2025; Xie et al., 2026). This demonstrates the interconnected relationship between technological communication and socio-emotional functioning.

On the contrary, poorly implemented technology systems may contribute to anxiety, frustration, and emotional exhaustion among teachers. Lack of training, technical difficulties, and excessive communication demands may negatively influence professional well-being (Holmes et al., 2021; Cukurova et al., 2025; Pentón Herrera & Hussain, 2026). Therefore, institutional policies should emphasize supportive technology integration and socio-emotional support mechanisms for teachers (Mahnaz et al., 2025).

Research Gap

Although considerable research has been conducted on educational technology and digital communication, limited studies specifically examine the role of machine communication in developing socio-emotional competencies among secondary school teachers. Existing research primarily focuses on students' learning outcomes, digital literacy, and instructional effectiveness, while teachers' emotional and social development receives comparatively less attention (Xu et al., 2026; Sáez-Delgado et al., 2025; Rivera Campos, 2025). Furthermore, many studies have been conducted in developed countries, leaving limited evidence regarding developing educational contexts such as Pakistan.

In Pakistan, technology integration in secondary education is expanding rapidly due to educational reforms and digitalization initiatives. Teachers increasingly use smart classrooms, online communication systems, and AI-supported educational tools. However, empirical research exploring how these communication technologies influence teachers' socio-emotional competencies remains insufficient (Asnawi et al., 2025; Xie et al., 2026; Pentón Herrera & Hussain, 2026). Therefore, the present study seeks to address this gap by investigating the role of machine communication in developing socio-emotional competencies among secondary school teachers.

Theoretical Framework

The present study is grounded in the Collaborative for Academic, Social, and Emotional Learning (CASEL) framework and Social Cognitive Theory. These theoretical perspectives provide a comprehensive explanation of how machine communication technologies may contribute to the development of socio-emotional competencies among secondary school teachers.

The CASEL framework identifies five major socio-emotional competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. According to CASEL, these competencies are essential for effective interpersonal interaction, emotional regulation, and professional success within educational environments (CASEL, 2020; Rivera Campos, 2025; Calandri et al., 2025). Teachers possessing strong socio-emotional competencies can maintain positive classroom climates, support students emotionally, and manage professional responsibilities effectively. The framework suggests that supportive learning environments and reflective experiences contribute significantly to the development of socio-emotional competencies.

Machine communication technologies may enhance these competencies by providing collaborative communication opportunities, emotional support systems, and interactive professional learning experiences. Digital communication platforms facilitate self-reflection, social interaction, and professional collaboration among teachers. AI-supported communication tools provide feedback and instructional support that strengthen self-awareness and emotional adaptability (Xu et al., 2026; Sáez-Delgado et al., 2025; Xie et al., 2026). Consequently, the CASEL framework provides a suitable basis for understanding the socio-emotional dimensions of machine communication in educational settings.

The study is also supported by Bandura's Social Cognitive Theory, which emphasizes reciprocal interaction between personal factors, behavior, and environmental influences. According to this theory, individuals learn through observation, interaction, self-efficacy, and environmental experiences (Bandura, 1986; Holmes & Tuomi, 2022; Cukurova et al., 2025). In educational contexts, teachers' interaction with machine communication systems influences their behavior, confidence, emotional responses, and professional competencies.

Machine communication technologies act as environmental factors that shape teachers' cognitive and emotional development. Teachers who effectively engage with digital communication systems may develop stronger self-efficacy, emotional resilience, and communication flexibility. AI-supported technologies also provide observational learning opportunities through collaborative platforms and digital communities (Xie et al., 2026; Asnawi et al., 2025; Pentón Herrera & Hussain, 2026). Social Cognitive Theory therefore explains how interaction with technological communication environments contributes to socio-emotional competency development among teachers.

Together, the CASEL framework and Social Cognitive Theory provide a strong theoretical foundation for understanding the role of machine communication in shaping teachers' socio-emotional competencies. The integration of these theories supports the assumption that technology-mediated communication environments influence emotional regulation, social awareness, relationship management, and professional effectiveness among secondary school teachers.

RESEARCH METHODOLOGY:

Research Design

The present study adopted a quantitative research approach because quantitative methods are suitable for examining relationships, associations, and predictive effects among variables through statistical analysis. A correlational research design was employed to investigate the role of machine communication in developing socio-emotional competencies among secondary school teachers. The correlational design enabled the researcher to determine the extent and direction of the relationship between machine communication and socio-emotional competencies. Furthermore, the study utilized a cross-sectional survey method in which data were collected from respondents at a single point in time. This design was considered

appropriate because it allowed the researcher to gather standardized information from a large number of participants efficiently and systematically.

Research Philosophy

The study was based on the positivist research philosophy, which emphasizes objective measurement, empirical observation, and statistical analysis of social phenomena. Positivism supports the use of quantitative methods to examine relationships among variables through measurable data. In the present study, machine communication and socio-emotional competencies were treated as measurable constructs that could be analyzed scientifically through statistical procedures. The positivist paradigm was selected because it provides a structured and systematic approach for testing hypotheses and generating generalizable findings. Moreover, this philosophy enabled the researcher to maintain objectivity throughout the research process by relying on numerical data and standardized research instruments.

Population of the Study

The population of the study consisted of all secondary school teachers working in public secondary schools of Islamabad Capital Territory (ICT). According to the records of the Federal Directorate of Education (FDE), Islamabad has approximately 120 public secondary schools with nearly 2,400 secondary school teachers working at different institutions. These teachers regularly engage with digital communication systems, online educational tools, and machine communication technologies in their professional responsibilities. Therefore, they were considered suitable respondents for examining the relationship between machine communication and socio-emotional competencies. The target population included both male and female teachers teaching at the secondary school level in urban and rural educational institutions of Islamabad.

Sample and Sampling Technique

A sample of 331 secondary school teachers was selected from the target population using Yamane's sampling formula for finite populations. The sample size was considered appropriate to ensure representation and statistical reliability. Stratified random sampling technique was employed to provide equal representation to male and female teachers as well as teachers from different schools. Initially, schools were divided into strata based on gender and locality. Afterward, respondents were selected randomly from each stratum. This sampling technique minimized sampling bias and enhanced the generalizability of the study findings. The selected sample included teachers from various public secondary schools in Islamabad to ensure diversity of responses regarding machine communication and socio-emotional competencies.

Research Tool

A structured questionnaire was used as the primary research instrument for data collection. The questionnaire consisted of two major sections. The first section focused on demographic information such as gender, age, teaching experience, and qualification. The second section consisted of statements related to machine communication and socio-emotional competencies. The questionnaire items were developed using a five-point Likert scale ranging from Strongly Agree to Strongly Disagree. The machine communication scale included items regarding AI-based communication systems, digital communication platforms, technology-mediated interaction, and virtual communication tools. Similarly, the socio-emotional competency scale measured self-awareness, emotional regulation, social awareness, relationship management, and responsible decision-making. The questionnaire format was selected because it allowed the researcher to collect standardized responses from a large number of participants efficiently.

Validity and Reliability of Research Tool

To ensure content validity, the questionnaire was reviewed by experts in educational research, educational technology, and psychology. The experts evaluated the clarity, relevance, appropriateness, and alignment of questionnaire items with the objectives of the study. Necessary modifications were incorporated based on their recommendations. Furthermore, a pilot study was conducted on 30 secondary school teachers who were not included in the final sample. The purpose of the pilot study was to assess the suitability and comprehensibility of the research instrument.

Reliability of the questionnaire was measured through Cronbach's Alpha coefficient using Statistical Package for Social Sciences (SPSS). The overall reliability coefficient of the instrument was found to be 0.87, which indicated a high level of internal consistency. The reliability values for machine communication and socio-emotional competencies sections were also above the acceptable threshold of 0.70. Therefore, the questionnaire was considered reliable and appropriate for collecting data from the respondents.

Data Collection Procedure

The researcher followed a systematic procedure for collecting data from the selected respondents. First, official permission was obtained from the concerned educational authorities and school administrations in Islamabad. After receiving approval, the researcher personally visited the selected schools to explain the purpose and significance of the study to the participants. Respondents were assured that the information collected would only be used for academic purposes.

The questionnaires were distributed among the selected secondary school teachers during school hours with the consent of school administration. The researcher provided instructions regarding the completion of the questionnaire and addressed respondents' queries where necessary. Adequate time was provided to participants for completing the questionnaires carefully. After completion, the questionnaires were collected personally by the researcher to ensure a high response rate and data accuracy. The collected data were then organized, coded, and entered into SPSS for statistical analysis.

Ethical Considerations

Ethical principles were carefully observed throughout the research process to protect the rights and privacy of the participants. The respondents were informed about the objectives, procedures, and significance of the study before data collection. Participation in the study was entirely voluntary, and respondents were given the right to withdraw from the study at any stage without any pressure or consequences.

Confidentiality and anonymity of the participants were strictly maintained. The researcher ensured that personal information and identities of the respondents were not disclosed in any form. The collected data were used solely for academic and research purposes. Moreover, informed consent was obtained from all participants prior to the administration of the questionnaire. Ethical guidelines regarding honesty, transparency, and respect for respondents were maintained throughout the study.

Data Analysis Technique

The collected data were analyzed using Statistical Package for Social Sciences (SPSS). Both descriptive and inferential statistical techniques were employed to analyze the data systematically. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to summarize demographic information and respondents' perceptions regarding machine communication and socio-emotional competencies.

Inferential statistical techniques including Pearson Product Moment Correlation and Linear Regression Analysis were used to test the hypotheses of the study. Correlation analysis was employed to examine the relationship between machine communication and socio-emotional competencies among secondary school teachers. Regression analysis was used to determine the predictive role of machine communication in developing socio-emotional competencies. The significance level for hypothesis testing was set at 0.05.

Table 1

Demographic Distribution of Respondents by Gender

| Gender | Frequency | Percentage |
|---------------|------------------|-------------------|
| Male | 158 | 47.7% |
| Female | 173 | 52.3% |
| Total | 331 | 100% |

The above table presents the demographic distribution of respondents according to gender. The findings indicate that out of 331 respondents, 158 (47.7%) were male teachers while 173 (52.3%) were female teachers. The data show that female teachers constituted a slightly larger proportion of the study sample compared to male teachers. The balanced representation of both genders enhanced the reliability and inclusiveness of the study findings. The demographic distribution also ensured that perceptions regarding machine communication and socio-emotional competencies were obtained from both male and female secondary school teachers.

Table 2

Demographic Distribution of Respondents by Teaching Experience

| Teaching Experience | Frequency | Percentage |
|----------------------------|------------------|-------------------|
| 1–5 Years | 74 | 22.4% |
| 6–10 Years | 109 | 32.9% |
| 11–15 Years | 88 | 26.6% |
| 16 Years and Above | 60 | 18.1% |
| Total | 331 | 100% |

The table illustrates the demographic distribution of respondents based on teaching experience. The results reveal that 74 (22.4%) teachers had teaching experience of 1–5 years, whereas 109 (32.9%) teachers had experience ranging from 6–10 years. Similarly, 88 (26.6%) respondents possessed teaching experience of 11–15 years, while 60 (18.1%) teachers had 16 years or above teaching experience. The findings indicate that the majority of respondents had moderate teaching experience, which suggests that participants were sufficiently familiar with educational communication technologies and classroom practices. The inclusion of teachers with varying levels of experience contributed to the comprehensiveness and representativeness of the study.

DATA ANALYSIS:

Objective 1: To examine the role of machine communication in developing socio-emotional competencies among secondary school teachers.

Table 3

Role of Machine Communication in Developing Socio-Emotional Competencies

| Variables | N | Mean | Std. Deviation |
|------------------------------|-----|------|----------------|
| Machine Communication | 331 | 4.12 | 0.58 |
| Socio-Emotional Competencies | 331 | 4.05 | 0.62 |

The above table presents descriptive statistics regarding machine communication and socio-emotional competencies among secondary school teachers. The mean score of machine communication was found to be 4.12 with a standard deviation of 0.58, indicating that teachers demonstrated a high level of engagement with machine communication technologies. Similarly, the socio-emotional competencies variable obtained a mean score of 4.05 and a standard deviation of 0.62, which reflects a positive level of socio-emotional competence among respondents. The low standard deviation values indicate consistency in respondents' perceptions. The findings suggest that machine communication may positively contribute to the development of socio-emotional competencies among secondary school teachers.

Objective 2: To investigate the relationship between machine communication and teachers' emotional regulation, social awareness, and relationship management.

Table 4

Relationship between Machine Communication and Socio-Emotional Competencies

| Variables | r | Sig. |
|---|-----|------|
| Machine Communication & Emotional Regulation | .71 | .000 |
| Machine Communication & Social Awareness | .68 | .000 |
| Machine Communication & Relationship Management | .74 | .000 |

The table shows the relationship between machine communication and different dimensions of socio-emotional competencies. The results reveal a strong positive relationship between machine communication and emotional regulation ($r = .71, p < .05$). Similarly, machine communication demonstrated a significant positive relationship with social awareness ($r = .68, p < .05$) and relationship management ($r = .74, p < .05$). Since the significance values are less than 0.05, the null hypotheses were rejected. These findings indicate that increased use of machine communication technologies is associated with stronger socio-emotional competencies among secondary school teachers.

Objective 3: To determine whether machine communication significantly predicts socio-emotional competencies among secondary school teachers.

| R | R² | F | Sig. |
|----------|----------------------|----------|-------------|
| .77 | .59 | 250.91 | .000 |

Table 5

Regression Analysis of Machine Communication Predicting Socio-Emotional Competencies

| Variables | Beta | t-value | Sig. |
|------------------------------|-------------|----------------|-------------|
| Machine Communication | .77 | 15.84 | .000 |

The above table presents regression analysis regarding the predictive role of machine communication on socio-emotional competencies among secondary school teachers. The results indicate that machine communication significantly predicted socio-emotional competencies with a beta value of .77 and a significant p-value of .000. The coefficient of determination ($R^2 = .59$) shows that machine communication explained 59% variance in socio-emotional competencies. Furthermore, the F-value of 250.91 indicates that the regression model was statistically significant. These findings demonstrate that machine communication is a strong predictor of socio-emotional competencies among secondary school teachers.

DISCUSSION

The findings of the first objective revealed that machine communication positively contributes to the development of socio-emotional competencies among secondary school teachers. The high mean scores of both machine communication and socio-emotional competencies indicate that teachers who frequently engage with digital communication systems demonstrate stronger emotional and social competencies. These findings are consistent with the study conducted by Sáez-Delgado et al. (2025), who found that digital communication technologies positively support socio-emotional teacher training and emotional adaptability. Similarly, Xu et al. (2026) concluded that AI-supported communication systems enhance teachers' confidence, emotional flexibility, and professional competence. Furthermore, Calandri et al. (2025) reported that technology-supported educational environments contribute significantly to teachers' emotional competence and inclusive teaching practices. The findings suggest that machine communication technologies create opportunities for professional interaction, reflective communication, and emotional growth among teachers.

The second objective examined the relationship between machine communication and dimensions of socio-emotional competencies including emotional regulation, social awareness, and relationship management. The findings revealed a strong positive and statistically significant relationship among these variables. These results are supported by the study of Xie et al. (2026), who found that digital communication systems strengthen emotional regulation and self-efficacy among teachers in technology-enhanced learning environments. Likewise, Asnawi et al. (2025) concluded that technology-based communication positively influences teachers' communication skills and interpersonal interaction. In another related study, Rivera Campos (2025) reported that socio-emotional competencies improve significantly when teachers engage in collaborative and technology-supported professional activities. The present findings indicate that machine communication systems facilitate collaborative communication, social interaction, and emotional awareness, thereby improving teachers' socio-emotional functioning.

The findings of the third objective demonstrated that machine communication significantly predicts socio-emotional competencies among secondary school teachers. The regression analysis indicated that machine communication explained 59% variance in socio-emotional competencies, reflecting its substantial predictive role. These findings are in line with Holmes and Tuomi (2022), who emphasized that artificial intelligence and machine communication technologies strongly influence teachers' professional behavior and emotional adaptability. Similarly, Cukurova et al. (2025) found that AI-supported communication systems enhance teachers' self-efficacy, communication flexibility, and emotional preparedness. Moreover, Pentón Herrera and Hussain (2026) highlighted that technology-enhanced communication environments contribute positively to teachers' emotional resilience and relationship management skills. The findings therefore confirm that machine communication technologies play an important role in developing socio-emotional competencies among teachers.

FINDINGS

1. The study found that secondary school teachers demonstrated a high level of engagement with machine communication technologies. The findings further revealed that teachers possessed positive socio-emotional competencies including emotional regulation, social awareness, and relationship management.
2. The study revealed a strong positive and statistically significant relationship between machine communication and socio-emotional competencies among secondary school teachers. Machine communication showed significant associations with emotional regulation, social awareness, and relationship management.
3. The findings indicated that machine communication significantly predicted socio-emotional competencies among secondary school teachers. The regression analysis revealed that machine communication explained 59% variance in socio-emotional competencies.

CONCLUSION

The study concluded that machine communication plays a significant role in developing socio-emotional competencies among secondary school teachers. The findings demonstrated that teachers who actively engage with digital communication technologies exhibit stronger emotional regulation, social awareness, and relationship management skills. The integration of machine communication systems in educational settings therefore contributes positively to teachers' professional and emotional development.

The study further concluded that machine communication technologies facilitate collaborative interaction, reflective communication, and emotional adaptability among teachers. AI-supported communication systems, digital platforms, and virtual communication tools provide opportunities for professional support and interpersonal engagement, which strengthen socio-emotional competencies. Consequently, technology integration in education should not only focus on instructional efficiency but also on teachers' emotional well-being and social development.

Finally, the study concluded that machine communication is a strong predictor of socio-emotional competencies among secondary school teachers. The findings emphasize the importance of providing technological resources, digital training, and supportive communication environments in schools. Educational institutions should therefore adopt balanced and teacher-friendly technological communication systems to improve both professional effectiveness and socio-emotional competence among teachers.

RECOMMENDATIONS

1. Educational institutions should provide regular training programs for secondary school teachers regarding effective use of machine communication technologies to enhance their socio-emotional competencies and professional communication skills.
2. School administrations should encourage collaborative digital communication environments that promote emotional regulation, social awareness, and relationship management among teachers through professional interaction and support networks.
3. Policymakers and educational authorities should integrate AI-supported communication systems and technology-based professional development programs in secondary schools to strengthen teachers' socio-emotional competencies and instructional effectiveness.

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