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AI-Enhanced Cross-Cultural Competence in STEM Education

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Abstract

Cross-cultural competence (CCC) is leaders' most critical skill set in science, technology, engineering, and math (STEM) education because it can help them effectively manage cultural diversity. The research provides insights into the potential of AI to foster more inclusive and culturally aware educational environments for STEM students using a theory that combines Constructivism and Cultural-Historical Activity Theory (CHAT). The study discusses two research questions: (1) How can AI-driven tools be used in STEM education to enhance cross-cultural sensitivity and communication? (2) What is the impact of AI-facilitated reflective practices on students' self-awareness of cultural biases? This research shows how AI-based language translators and cultural simulations enable learners to adapt to different cultures. According to Constructivism, learning occurs when learners actively construct their knowledge from experiences towards cultural sensitivity, understanding, and respecting other cultures while reducing stereotypes. CHAT, on its part, views AI as aligning with AI as one of the artifacts or tools that are at the disposal of human beings in order to facilitate social interaction; thus, it has the potential to enhance intercultural communication where verbal cues are not only linguistic but also non-verbal. A total of 228 respondents were reached through surveys, resulting in preliminary results showing improved CCC due to accommodative devices such as culturally-specific software simulations or language translators employing AI models. This study adds value to the existing literature by presenting empirical evidence of how AI can foster CCC in STEM education. It highlights the imperative of AI's theoretical and practical applications in educational curricula.

Keywords: adaptation, democratizing access, global leadership, inclusive innovation, sensitivity

1. Introduction

In the current state of STEM (Science, Technology, Engineering, and Mathematics) education, there is an increasing recognition of the necessity of Cross-Cultural Competence (CCC) to prepare students for success in a globally connected world. These efforts highlight the need for educators and students to understand better and appreciate cultural diversity (Liu, 2023a; Merriweather et al., 2022). Various studies have also shown how non-traditional pedagogies like experiential learning can effectively teach CCC in the context of the Smart Machine Age (Wernick & Branch, 2022). These approaches show that engaging students in problem-solving experiences is essential so they can develop a comprehensive understanding of CCC. Additionally, research shows that mentorship should be more holistic culturally while advocating anti-racism training among international STEM faculty members to support US STEM doctoral candidates who are racial minorities (Merriweather et al., 2022), providing another vital path towards enhancing CCC in higher education.

Incorporating cross-cultural competence (CCC) into educational systems has become increasingly crucial as STEM learns how to adapt and grapple with cultural hurdles in a rapidly globalizing world. The cumulative efforts from researchers focused on innovative pedagogical methodologies, improved mentorship mechanisms, and systemic curriculum reformation point out the need for educational institutions to adjust and look forward. These adjustments aim to equip students with the necessary technical and cultural knowledge and to nurture a cohort of empathetic, respectful, and culturally cognizant STEM leaders (Bunce, 2021; Gu, 2022). As CCC becomes more and more prevalent in STEM higher education, which seeks to manage cultural diversity while producing influential global leaders, there are ample opportunities for exploration.

Another issue is assessing how ready STEM students are for diversity. We need to identify gaps in current educational practices to better equip students with the interpersonal skills they need once they enter the global labor market (Lu et al., 2021). By systematically integrating CCC training into STEM curricula, we hope to teach students critical values like cultural intelligence and more. Based on prior research, the present study will look at how Artificial Intelligence (AI) can help boost CCC among these students. This study contributes to the current literature by providing empirical evidence of AI's effectiveness in developing CCC within STEM education. It suggests an imperative for AI's theoretical and practical application in educational curricula.

2. Theoretical Framework

2.1 Keys to Cultural Diversity in STEM Education

The importance of CCC has spurred different research studies and innovative teaching methods that integrate it into STEM education. Resources, training for educators, and participating in diversity-focused activities with diverse values are key strategies proposed for creating an inclusive educational environment that will shape well-rounded students with cultural intelligence and interpersonal skills needed to succeed in today's global labor market (Yang et al., 2023). Efforts to increase cultural diversity in STEM education emphasize respect, openness, active engagement, and deep understanding rather than surface-level knowledge (Liu, 2023b). Immersive learning experiences can be transformative within the curricula by increasing the self-efficacy, awareness, and capacity of the educators to engage with students from different cultures (Ogodo, 2023). These strategies align with Cultural-Historical Activity Theory (CHAT) and offer insights to prepare educators effectively navigate and teach diverse classrooms for understanding and enhancing these complex educational practices.

2.2 Cultural-Historical Activity Theory (CHAT) for Human Educational Practices

Cultural-Historical Activity Theory (CHAT) is an analytical framework that helps us understand human practices comprehensively. This theory tells us that people do things because they are socially situated and mediated by specific symbolic and material tools. To analyze professional work practices, CHAT considers the psychological motives behind them, the tools used, power dynamics, culture, and history (Stetsenko, 2023). This makes it super reflective and gives lots of information in fields like social work (Foot, 2014). Since CHAT focuses on where human thought comes from and how our thoughts are affected by tools, this approach has significant implications for designing ed-tech products and curricula (Roth & Lee, 2007; Niven, 2023).

The idea of object-oriented action is central to CHAT. It states that when we take actions, they are always directed toward objects that represent something meaningful to society. It can be seen in a math class why CHAT should be studied more for its potential in educational research (Batiibwe, 2019). Human emotions are essential to CHAT as they are influenced by the cultural and historical evolution within societies. Burkitt says it is easier to foster a more inclusive and empathetic educational environment considering these dimensions of learning (Burkitt, 2021). CHAT provides a robust framework for understanding the complexity of human activities within their sociocultural contexts. By emphasizing the mediating role of cultural artifacts and the collective nature of human practices, CHAT offers valuable insights into the processes of learning and development. For example, CHAT views teaching-learning activities as a dialectical unity, where subjects appropriate human objectification to develop superior mental operations (Teo & Alves, 2023). Therefore, exploring human activities within a sociocultural framework is naturally transformed into the field of constructivism in learning, which specifically stresses the active role of learners in establishing knowledge through their interactions with the world and its cultural artifacts.

2.3 Constructivism in Learning

In Constructivism, learning is an active process in the eyes of educators. They believe learners construct new knowledge based on their experiences, fostering cultural sensitivity. The understanding and respect of different cultures while reducing stereotypes is a view that constructivist thinkers have. Allen (2004) explains that The Culture Portfolio Project demonstrates this thinking through its open-ended investigations about France to students. By challenging stereotypes about French-speaking countries, students learn to promote cultural sensitivity through self-discovery and critical thinking, which goes along with the typical beliefs of a constructivist (Allen, 2004).

Interactive behavior has also been linked to adapting to different cultural norms and sociological influences through technology as a medium. For example, Greener's (2017) study showed how technology can create more inclusive learning environments with a constructivist approach. Technology allows people from all walks of life to feel comfortable and respected when communicating online, which makes for a better overall experience for everyone involved (Greener, 2017).

While this next bit was not pulled from the input text, it still holds weight for the argument being made today due to its well-thought-out content on two types of experiences converging into one school system. A Kay College for Education in Israel program was explicitly designed for Jewish students and Bedouin Muslim female teaching students to create shared life and intercultural understanding between them. This initiative reflects a constructivist approach by facilitating learning through interaction, so no doubt some challenging conversations took place during this time but were necessary (Gat, 2023). Adapting online constructivist teaching

methods from traditional approaches to be culturally sensitive is essential for creating inclusive environments that respect and integrate cultural diversity, requiring educators to recognize biases, learn about diverse cultures, and tailor teaching to accommodate multicultural classrooms (Mitchell & Mousa, 2019).

2.4 AI and Cross-Cultural Competence

According to Constructivism, learning occurs where learners actively build their knowledge through experiences for cultural sensitivity—the understanding and respecting of different cultures while reducing stereotypes. AI aligns with CHAT, which stresses cultural tools and social interactions as important mediators; therefore, it ensures AI in education promotes fairness and respects human values by empowering users to shape AI tools according to their needs and perceptions of equity (Lundin et al., 2023) . One's self-awareness regarding cultural biases—central to CCC—is improved through reflective practices driven by AI, empowering them to adapt their behaviors within intercultural scenarios. Moreover, as CHAT underscores, flexibility is essential when dealing with various methods different cultures use. The research uses AI under this theoretical model to develop innovative ways of cultivating cultural awareness in STEM scholars' lives. We should explore new ways to enhance CCC in STEM students through AI and other immersive technologies. Early signs show that AI-driven tools like culturally specific software simulations and translators have effectively improved CCC (Abdelali & Bennoudi, 2023). In this way, future research should investigate their effectiveness further because they might be a game changer for STEM education (Yang et al., 2023).

3. Methods and Data

3.1 Key Factors highlighted in the Theoretical Framework

Liamputtong's interpretation (2010) suggests that respect for other cultures allows us to learn from each other, which is what cultural sensitivity means to highlight. Przytula et al. (2023) argue that international mobility programs are capable of helping students gain various types of competencies, such as competencies, knowledge, and attitudes, which they then can apply within their own culture by recognizing and respecting cultural differences or by using this lens to navigate diverse settings. Manthienvichienchai et al. (2002) show a direct relationship between communicational competence with others and self-reflective capacity along with open dialogue facilitation when it comes to successful implementation into practice with people from different backgrounds. Those who aim to thrive in multi-racial environments must be equipped with communicative abilities and self-understanding. Dobrowolski et al. (2019) believe that young professionals should be able to communicate effectively across various cultures while also being sufficiently aware of themselves to avoid being influenced by their own cultural origins. Self-awareness is an essential trait when it comes to navigating through cross-cultural interactions. This awareness must be accompanied by adept cross-cultural communication to navigate these situations smoothly.

Another essential thing found in Liao et al.'s study in 2021 is the instrumental role emotional intelligence plays when coupled with cultural adaptability, which facilitates better intercultural adjustment and performance within multicultural contexts. On top of these competencies, proficiency in cultural adaptability and conflict resolution are essential components of cross-cultural competency for navigating complex multicultural settings. The researchers from Liao et al.'s study (2021) further emphasized how emotional intelligence, when paired with alterability and conflict resolution, plays an instrumental role in facilitating superior

intercultural adjustment and performance within multicultural contexts. Przytuła et al.'s research (2023) successfully confirms the value of short-term foreign mobility programs in enhancing students' cross-cultural competencies, such as mediation and negotiation techniques, adaptability, and problem-solving skills that promote better student interaction.

According to Liao and Thomas (2020), CCC quality leaders must navigate cultural differences effectively. Building cultural intelligence helps to understand various cultures through intercultural experiences if they are sensitive and open-minded enough, as Liamputtong (2010) and Dobrovolska et al. (2019) would agree. People need solid cross-cultural communication skills and conflict resolution abilities to have successful global interactions and stay competitive within organizations (Przytuła et al., 2023; Liao et al., 2021; Cox & Blake, 1991). Building up knowledge about diverse backgrounds, attitudes, and behaviors like empathy will give future leaders what they need to survive in an increasingly interconnected world (Cox & Blake, 1991).

Cross-cultural competence is becoming widely recognized as an essential part of the higher education learning environment, especially in STEM fields. The study conducted by Alexis et al. on a Singapore Study Abroad Program with STEM undergraduate students shows that studying abroad can be hugely beneficial in developing cross-cultural and global interdependency (Alexis et al., 2017). They found that programs like these can significantly enhance foreign language skills, different cultural knowledge, cross-cultural skill development, and transformation of worldviews for more successful cross-cultural awareness and communication competence. Wernick and Branch explore international service learning as a technique to teach students cross-cultural competence within the "Smart Machine Age"(Wernick & Branch, 2022). Developing cross-cultural competence does not stop at just being a pedagogical adjustment but is also a strategic necessity. Aggarwal and Wu (2021) argue that developing this skill is critical to enhancing business outcomes across various organizational functions. Extending this perspective into STEM education would significantly improve our graduates' readiness for local and international markets by enhancing their creativity, innovation, and problem-solving abilities. The survey outlined below is aimed at the intersection of Artificial Intelligence (AI) and Cross-Cultural Competence (CCC) in STEM education.

3.2 Survey Design and Data Collection

This study used a random sampling method to obtain different views on Cross-Cultural Competence (CCC) concerning AI use in STEM education. The survey was conducted online over two weeks using the Wenjuanxing platform in China, total garnered 237 responses who consent to participate in the survey for research purposes by March 2, 2024. However, 228 respondents who completed all questions are selected for data analysis, which attain a 95% confidence level and a ±5% margin of error for guaranteeing statistical significance and generalizability.

The researchers designed the survey with an inclusive consent statement to inform participants about its purpose, confidentiality, and how their responses would be used to promote trust and to consider ethical compliance. Moreover, the survey questions were developed according aspects involving CCC in STEM education and AI's role based on literature review on key factors highlighted in the theoretical framework after collecting demographic information such as age, educational background, and language barrier experiences and current challenges faced when learning CCC.

For example, the survey collected information on AI's contribution to fostering cross-cultural competence by asking queries regarding people's familiarity with AI technology, i.e.,

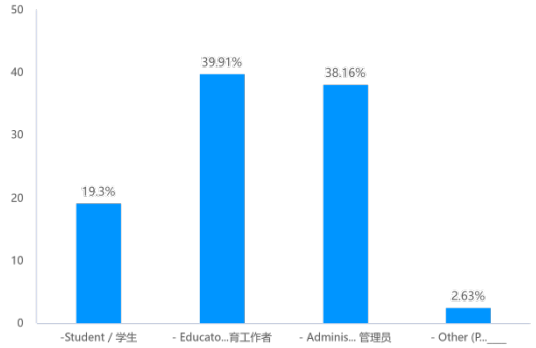
whether they know about any AI application or not, its effectiveness, i.e., whether it helps improve someone's CCC or not. Additionally, what impact can AI make on cultural differences? How can one involve others in resolving conflicts? At last, some open-ended questions were asked so that respondents could give suggestions or narrate their experiences.

4. Result Analysis

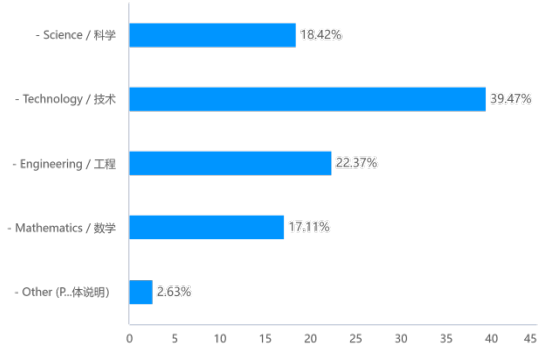
4.1 Descriptive Analysis

Table 1

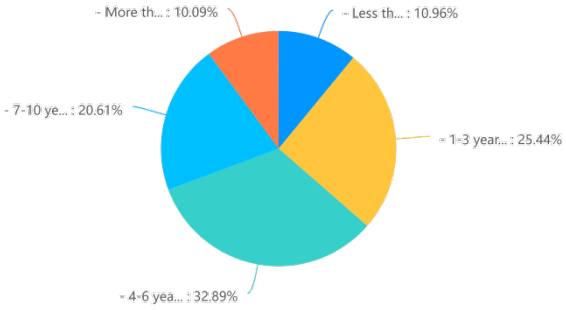
1. What is your role in STEM education?



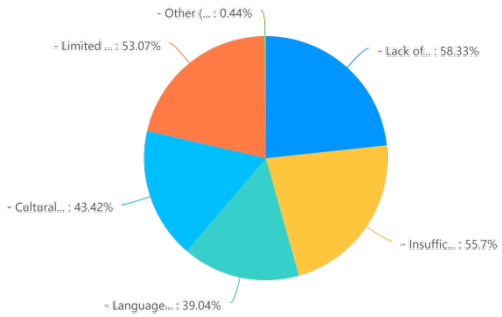
2. What is your field of study or expertise within STEM?



2. How many years of experience do you have in STEM education?



4. What challenges have you faced in developing CCC within STEM education?



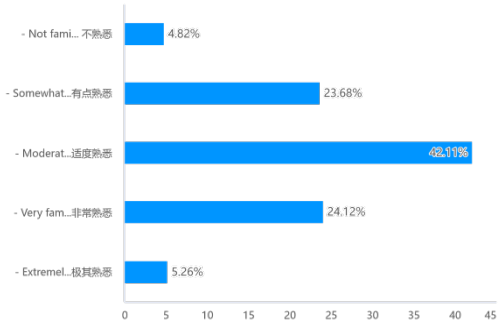
The findings suggest that Artificial Intelligence may be a powerful tool for fostering CCC during STEM teaching. Therefore, integrating Artificial Intelligence guided by the Constructivism-CHAT framework is considered strategic as it prepares globally competent professionals in the science and technology sectors. Finally, this paper calls for partnerships between educational institutions, policymakers, and tech companies to make AI devices more affordable, thus making them available even for those disadvantaged areas and emphasizing multicultural competence in leading the field of STEM. Ensuring that there are systemic changes with targeted interventions geared towards improving responses to societal diversity within the sphere of STEM education at a global level requires collaborative efforts between these institutions.

The data of 228 responses in STEM education shows educators (39.91%) and administrators (38.16%) as the main respondents, with students at 19.30% (see Table 1). Technology is the most popular field (39.47%), followed by engineering (22.37%), science (18.42%), and mathematics (17.11%). Experience levels are spread, with 32.89% having 4-6 years in STEM. The top challenges in developing Cross-Cultural Competence (CCC) are insufficient resources (58.33%), curriculum content emphasis (55.7%), and limited AI tool access (53.07%). Cultural biases (43.42%) and language barriers (39.04%) are also noted, with other challenges at 0.44%.

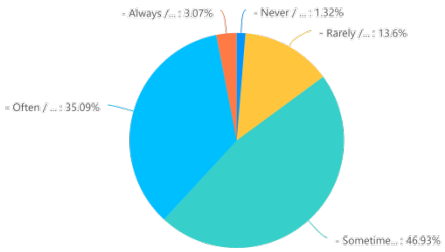
4.2 AI experiences

Table 2-1

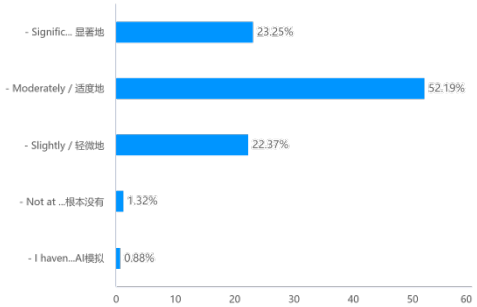
5. How familiar are you with the use of AI in educational settings?



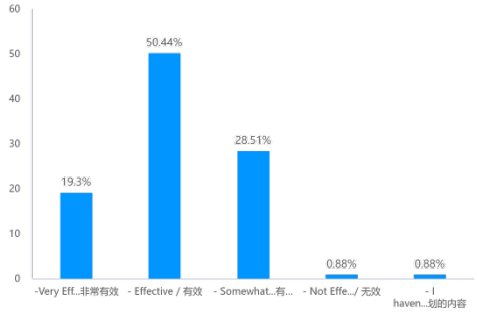
6. In your experience, how often are AI technologies used to provide personalized learning experiences in STEM education?



7. Have AI-driven cultural simulations helped you better understand and empathize with different cultures?



8. How effectively do you find AI-curated content enhancing your knowledge of global cultures?



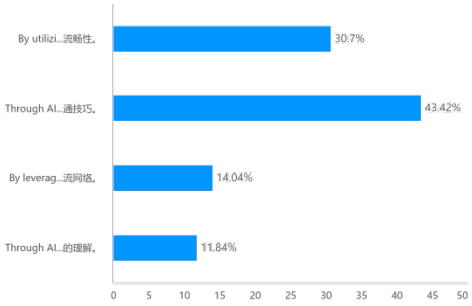
The survey indicates that the majority of respondents are aware of AI technology, with only 4.82% unfamiliar (see Table 2-1). Familiarity ranges from 23.68% having some knowledge to 5.26% being highly familiar. Usage is common, with 35.09% using AI frequently in STEM education and 46.93% using it occasionally. A small 1.32% never use AI for education, and 13.60% rarely do. When it comes to AI simulations, 52.19% use them moderately, 23.25% significantly, and 22.37% lightly. Perception of AI's educational effectiveness is high, with 76.25% considering it effective to some degree, and only 0.88% finding it ineffective.

According to Table 2-2, the survey shows STEM students prioritize AI for improving cross-cultural communication for processing information to adapt to global environments (43.42%), as AI language translation tools to overcome linguistic barriers (30.7%), for

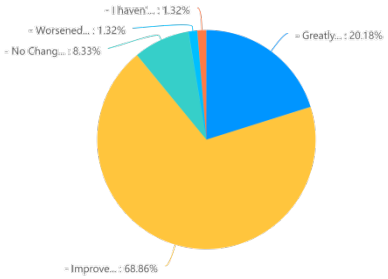
personalized recommendations in global networks (14.04%) and for insights into cultural norms and etiquette (11.84%). The survey data also highlights strong support for AI in enhancing cultural understanding and self-awareness. A majority, 70.61%, view AI-provided educational content on diversity and inclusivity as essential for recognizing cultural biases. Additionally, 62.28% are keen on AI analyzing communication to identify biases, while 53.51% appreciate AI's role in understanding emotional responses across cultures. Fewer, 39.91%, are interested in AI for self-reflection, suggesting room for improvement in these tools. Furthermore, 69.74% feel that AI increases their awareness of cultural biases, with 17.11% experiencing a significant impact, and a small 3.07% yet to explore AI's reflective capabilities.

Table 2-2

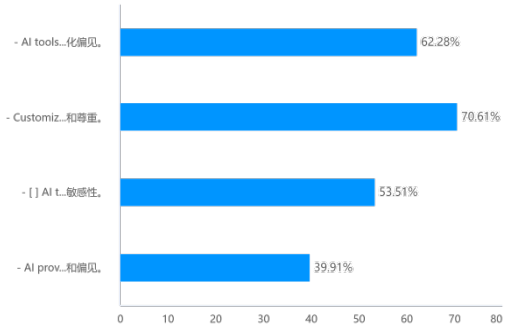
9. How do you hope AI can enhance STEM cross-cultural communication skills?



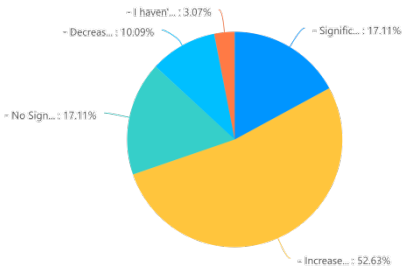
10. Have AI tools for language translation and understanding
Did non-verbal cues improve your cross-cultural communication?



11. How has AI helped you become more aware of your own cultural biases?



12. How has using AI for reflective practices like journaling influenced your awareness of cultural biases?



4.3 Validity and Reliability analysis

This paper analyzes the validity of the survey through factor load coefficient analysis and reliability of the survey through Cronbach reliability analysis for 16 questionnaire questions as follows.

4.3.1 Validity analysis

Table 3 Validity Analysis

Questionnaire	Factor load coefficient□					Common degree value
	Factor1	Factor2	Factor3	Factor4	Factor5	
2、What is your role in STEM education?	0.017	-0.005	0.869	0.140	-0.055	0.778
3、 What is your field of study or expertise within STEM?	-0.109	-0.096	0.056	-0.102	0.895	0.836
4、 How many years of experience do you have in STEM education?	0.041	0.309	0.780	-0.020	0.095	0.715
5、On a scale of 1 to 5， how would you rate the emphasis on CCC within your current STEM education environment?	0.187	0.764	0.162	0.088	0.008	0.653
6、Have you encountered any language barriers or cultural biases in your STEM education experience?	-0.090	-0.051	0.126	0.894	-0.076	0.832
9、 How familiar are you with the use of AI in educational settings?	0.246	0.786	0.136	-0.148	-0.038	0.721
10、In your experience， how often are AI technologies used to provide personalized learning experiences in STEM education?	0.307	0.750	0.105	-0.137	-0.177	0.717
12、 - Have AI-driven cultural simulations helped you better understand and empathize with different cultures? - AI	0.741	0.104	0.041	-0.115	0.158	0.599
14、 - How effectively do you find AI-curated content enhancing your knowledge of global cultures?	0.705	0.173	0.006	-0.199	-0.063	0.570
16、 - Have AI tools for language translation and understanding non-verbal cues improved your cross-cultural communication?	0.670	0.165	0.034	-0.223	-0.033	0.529
19、 - How has using AI for reflective practices like journaling influenced your awareness of cultural biases?	0.705	0.063	0.001	0.144	0.065	0.526
20、-To what extent do real-world problem-solving activities develop critical thinking as self-awareness of CCC in STEM students?	0.312	0.514	-0.191	0.193	0.396	0.592
22、 - How well do adaptive AI learning experiences prepare you for cultural differences?	0.667	0.311	-0.018	0.205	-0.090	0.591
24、 - Have AI simulations of intercultural conflicts helped you develop effective conflict resolution strategies?	0.749	0.141	0.010	-0.003	-0.088	0.589
26、 - How effectively are AI or AI platforms facilitating collaborative projects among diverse teams?	0.705	0.412	0.024	0.084	0.048	0.676
28、 - How has exposure to various AI-driven learning methodologies impacted your ability to adapt in multicultural environments?	0.592	0.243	0.028	-0.054	-0.164	0.441
Characteristic root value (before rotation)	5.423	1.721	1.179	1.063	0.978	-
Variance interpretation rate% (before rotation)□	33.893%	10.756%	7.368%	6.641%	6.110%	-
Cumulative variance interpretation rate% (before rotation)	33.893%	44.649%	52.017%	58.658%	64.768%	-
Feature root value (after rotation)	4.154	2.552	1.478	1.091	1.088	-
Variance interpretation rate% (after rotation)	25.960%	15.952%	9.240%	6.816%	6.800%	-
Cumulative variance interpretation rate% (after rotation)	25.960%	41.912%	51.152%	57.968%	64.768%	-
KMO value□			0.874			-
Barth spherical value			1204.587			-
df□			120			-
p-value□			0.000			-

Through factor load coefficient analysis (in blue) for each question (see Table 3), the above table shows common degree values of all research items are higher than 0.4, which shows that the information can be effectively extracted. In addition, the KMO value is 0.874,

which is greater than 0.6; the variance interpretation rates of the five factors are 25.960%, 15.952%, 9.240%, 6.816%, and 6.800%, respectively, and the cumulative variance interpretation rate after rotation is 64.768%>50%. It means that the information content of the research item can be effectively extracted.

4.3.2 Reliability analysis

Table 4 Cronbach Reliability Analysis

Questionnaire	CITC□	α coefficient with deleted items	Cronbach α coefficient
2、What is your role in STEM education?	0.140	0.820	
3、 What is your field of study or expertise within STEM?	-0.127	0.846	
4、 How many years of experience do you have in STEM education?	0.299	0.816	
5、On a scale of 1 to 5， how would you rate the emphasis on CCC within your current STEM education environment?	0.533	0.795	
6、Have you encountered any language barriers or cultural biases in your STEM education experience?	-0.082	0.822	
9、 How familiar are you with the use of AI in educational settings?	0.586	0.791	
10、In your experience， how often are AI technologies used to provide personalized learning experiences in STEM education?	0.599	0.792	
12、 - Have AI-driven cultural simulations helped you better understand and empathize with different cultures?	0.561	0.795	
14、 - How effectively do you find AI-curated content enhancing your knowledge of global cultures?	0.538	0.797	0.814
16、 - Have AI tools for language translation and understanding non-verbal cues improved your cross-cultural communication?	0.527	0.798	
19、 - How has using AI for reflective practices like journaling influenced your awareness of cultural biases?	0.486	0.799	
20、-To what extent do real-world problem-solving activities develop critical thinking as self-awareness of CCC in STEM students?	0.426	0.804	
22、 - How well do adaptive AI learning experiences prepare you for cultural differences?	0.590	0.793	
24、 - Have AI simulations of intercultural conflicts helped you develop effective conflict resolution strategies?	0.557	0.794	
26、 - How effectively are AI or AI platforms facilitating collaborative projects among diverse teams?	0.713	0.784	
28、 - How has exposure to various AI-driven learning methodologies impacted your ability to adapt to multicultural environments?	0.507	0.799	
Total effective samples		228	

Standardized Cronbach α：0.819□

The reliability coefficient value is 0.814 (see Table 4), which is greater than 0.8, thus indicating that the reliability quality of the research data is high. For the "α coefficient of deleted items", the reliability coefficient will not increase obviously after any item is deleted, so it shows that the item should not be deleted.As for "CITC value," since the CITC values corresponding to Question 2, Question 3, and Question 6 are less than 0.2, we can correct this item before collecting official data (since Question 2 and Question 3 are only descriptive statistics, they can be ignored).

To sum up, the validity and reliability analyses indicate that the reliability quality of the research data is high and the information content of the research item can be effectively

extracted. Therefore, data collected based on these 16 survey questions can be used for further analysis.

4.3.3 Correlation analysis

Survey questions are classified into artificial intelligence(AI) and cross-cultural competence(CCC), among which cross-cultural competence includes cross-cultural communication(c-communication), cross-cultural bias(c-bias), cross-cultural conflict(c-conflict) and cross-cultural diversity(c-diversity). Correlation analysis is conducted to discover how AI can help STEM students improve their intercultural competence (see Table 5). The coefficients between AI and CCC, C-diversity, C-conflict, C-bias, C-communication, and Background are positive. The P value shows a significance of 0.01, indicating that there is a positive correlation between AI and CCC, C-teamwork, C-conflict, C-prejudice, C-communication, and background.

Table 5 Pearson-Correlation

	AI
CCC	0.487**
C-diversity	0.532**
C-conflict	0.462**
C-bias	0.379**
C-communication	0.435**
Background	0.160*

* $p<0.05$ ** $p<0.01$

4.3.4 Linear Regression

This research further takes AI as the core explanatory variable, C-diversity, C-conflict, C-bias, C-communication and Background as the control variables, and CCC as the dependent variable for linear regression analysis. The regression results show the R^2 value of the model is 0.672, which means that AI, C-diversity, C-conflict, C-bias, C-communication and Background can explain the 57.2% change of CCC (see Table 6). The model passed the F test (F=13.744, p=0.000<0.05). In addition, the multiple co-linearity of the model was tested, and it was found that all the VIF values in the model were less than 5, which meant that there was no co-linearity problem. And the D-W value is near the number 2, which shows that the model has no auto-correlation and there is no correlation between sample data, so the model has good applicability. The final concrete analysis shows that:

The regression coefficient of AI is 0.267(t=5.415, p=0.000<0.01), which means that AI will have a significant positive impact on CCC, indicating that the use of AI can improve the CCC ability of STEM students.The regression coefficient of C-diversity and C-communication is 0.129(t=1.691，p=0.022<0.05) and 0.111(t=2.267, p=0.024<0.05), which means that C-diversity and C-communication will have a significant positive impact on CCC, Cross-cultural diversity and Cross-cultural communication can improve the Cross-Cultural Competence of STEM students.

The p values of C-conflict, C-bias and Background are not significant, which may be due to the relationship between data quality, measurement error and sample selection deviation, which leads to the insignificant influence on CCC.

Table 6 Linear Regression Results

	coefficient	95% CI	Co-linear diagnosis	
			VIF	Tolerance
constant	0.910** (3.521)	0.404 ~ 1.417	-	-
AI	0.267** (5.415)	0.170 ~ 0.363	1.496	0.668
C-diversity	0.129* (1.691)	-0.021 ~ 0.279	2.444	0.409
C-conflict	0.000 (0.003)	-0.137 ~ 0.137	2.306	0.434
C-bias	-0.016 (0.275)	-0.100 ~ 0.132	1.614	0.620
C-communication	0.005 (0.071)*	-0.147 ~ 0.137	1.913	0.523
Background	0.111 (2.267)	0.015 ~ 0.207	1.039	0.962
Samples	228			
R^2	0.572			
Adjusted R^2	0.552			
F Value	F (6,221)=13.744,p=0.000			

Dependent variable：CCC

D-W value：2.283

* p<0.05 ** p<0.01, T value is in brackets.

5. Discussion and Conclusion

Students' Cross-Cultural Competence (CCC) is influenced significantly by adopting AI in STEM education through the Constructivist-CHAT framework. This method prioritizes personalized, culturally sensitive information AI provides to create an environment that encourages learners to think critically about different viewpoints. The benefits of this approach are twofold: It not only imparts technical knowledge but also equips students with global competencies in science and technology sectors. Culture and STEM are inherently linked for a reason—developing CCC will prepare students to thrive and contribute as they engage with our world.

AI's potential to level the playing field and foster cultural competence should drive educational institutions, policymakers, and tech companies towards collaboration for the quality and accessibility of education, especially in fields like STEM which underpin technological advancements and workforce development. These collaborations play a crucial role as facilitators between academic theory and practical problem-solving needed by the tech industry. For example, Mariam et al.'s work (2021) on partnership strategies between Bandung Techno Park and PNJ demonstrates how collaborative knowledge creation significantly enhances organizational competitiveness along with innovation models. Furthermore, Boronachin et al.'s study (2017) on involving tech firms in teaching further highlights the importance of strategic partnerships for developing competitive educational centers adapted to skill needs in an ever-changing world. Through these partnerships we can bridge the digital divide so every student has access to the resources they need to become STEM professionals with global competence. This transformation is necessary if we want our curricula in these fields to be inclusive, effective and systemic.

In order to implement AI-enhanced Cross-Cultural Competence (CCC) in STEM education successfully, it is highly recommended that educational institutions must incorporate AI tools into the curriculum design that specifically involve culturally–based simulations as well as language translation technologies for facilitating students' comprehension and empathy. Furthermore, professional development programs should train educators on using AI to foster

CCC, emphasizing reflective practices to increase self-awareness of cultural biases. This will require creating interactive learning spaces through AI facilitated teamwork, peer mentoring schemes, and group projects. Collaboratively learning from different cultures can be enhanced through peer mentorship initiatives and group projects facilitated by artificial intelligence. Importantly, these strategies need to be reviewed with the help of AI analytics to improve their outcomes.

Although the study highlights how effective AI technologies can be if implemented with STEM curricula in disadvantaged areas, we could see a more significant gap between educational institutions caused by their access to these technologies and teaching tools. This study has limitations such as potential biases in self-reported data and survey samples collected online from the specific context (e.g., the use of the Wenjuanxing platform in China). Suggestions for future research could also be expanded to include more diverse educational settings and longitudinal studies to assess the long-term impact of AI on CCC because our global education system is so different across regions.

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