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# AI-Supported Online Language Learning: Learners' Self-Esteem, Cognitive-Emotion Regulation, Academic Enjoyment, and Language Success

Ting Xiao, Sisi Yi and Shamim Akhter

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# AI-Supported Online Language Learning: Learners' Self-Esteem, Cognitive-Emotion Regulation, Academic Enjoyment, and Language Success

**Ting Xiao[1,2], Sisi Yi[3,*], and Shamim Akhter[4]**
*[1]Department of Genetic Engineering, Faculty of Biology-Oriented Science and Technology, KINDAI University, Wakayama, Japan; [2]Graduate School of Bioscience Major in Bioscience, Nagahama Institute of Bio-Science and Technology, Shiga, Japan; [3]Yangzhou Technician College, Yangzhou, China; [4]Universiti Utara Malaysia, Sintok, Malaysia; *Corresponding author*

## Abstract

The consideration of students' emotional and psychological health is crucial to facilitate effective teaching and grading practices. This study set out to shed light on the interplay between self-esteem (S-E), cognitive-emotion regulation (CER), academic enjoyment (AE), and language success (LS) in artificial intelligence (AI)-supported online language learning. To this end, the foreign language learning self-esteem scale, the Cognitive Emotion Control Questionnaire, the foreign language enjoyment scale, and a researcher-made test were distributed to 389 English as a foreign language learners in China. Screening the data with confirmatory factor analysis and structural equation modeling, the effects of S-E, CER, AE, and LS were identified and quantified. These results highlighted the important function that online courses assisted by AI perform in enhancing students' CER and AE. This implied that students who have cultivated a robust sense of self-efficacy are adept at effectively regulating their cognitive and affective processes in AI-supported language learning. Possible improvements in language education are discussed, as are the study's broader implications.

*Keywords:* self-esteem, cognitive-emotion regulation, academic enjoyment, language success, AI-supported online language learning

# Background AI-Supported Online Language Learning: Learners' Self-Esteem, Cognitive-Emotion Regulation, Academic Enjoyment, and Language Success

The emergence of large language models and chatbots, such as ChatGPT, has had a profound impact on scientific discussions, elevating artificial intelligence (AI) to a prominent position. Nevertheless, it is important to acknowledge that research in the field of AI has been ongoing for several decades. As a consequence, there has been a growing fascination with the potential of AI to assist in the field of education, particularly in terms of its ability to personalize learning. However, there are also apprehensions regarding the implications for academic integrity, security, and privacy on a broader scale. The implementations of AI in education have led to considerable improvements in areas including administration, curriculum creation, and assessment (Luan et al., 2020; Qiao & Zhao, 2023).

Regrettably, the issue of AI in language instruction has received little academic attention, and the existing studies have only recently started to pinpoint crucial areas that need further investigation. Therefore, it is important to further explore the possibilities of AI applications to find out how they may be used to teach language skills useful in the actual world. It is also crucial to think about how the AI programs' real-time feedback may help students achieve their language learning objectives, as well as how to improve students' self-study on their computers and mobile devices via the use of different types of feedback. This research analyzed the benefits presented by utilizing AI to build language abilities in language learning settings. Specifically, it delved into the depths to which AI might encourage students to improve their self-esteem (S-E), cognitive-emotion regulation (CER), academic enjoyment (AE), and language success (LS).

## Literature Review

The concept of S-E refers to an individual's evaluation of their own worth or value. More specifically, it denotes the extent of individuals' belief in their capabilities and qualities (Bracken, 2009). S-E has had a significant influence on several aspects of student life, including decision-making, relationships, emotional well-being, and general state of health. Furthermore, it impacts motivation, since those with a robust and optimistic self-perception comprehend their capabilities and may be inclined to embrace new endeavors (Rubio-Alcalá, 2017). According to Murk (2006), learners with stronger S-E exhibited higher self-assurance and established more ambitious goals for themselves, even when confronted with challenges and obstacles. Persisting in their endeavors has proven important in enhancing learners' overall effectiveness. Moreover, Hosseinmardi et al. (2021) as well as Prasad et al. (2023) suggested that S-E had the potential to enhance individuals' self-regulatory abilities and emotional well-being. The connection between S-E and reading comprehension has been closely linked to students' autonomy, as highlighted by Zhang (2022). Qiao and Zhao (2023) indicated that the use of AI-based instruction was critical in enhancing oral skills and promoting self-assisted processes in language learners.

This highlights the capacity of AI to augment educational experiences, motivating students to assume agency over their learning and employ meta-cognitive strategies in the oral component of language acquisition. Furthermore, Yang et al. (2022) established a novel task-oriented voice chatbot called Ellie that

served as an English conversation companion. The results of their investigation indicated that students exhibited a notable degree of enthusiasm in their engagement with Ellie. Additionally, the chatbot's task design and operational goals were shown to be suitable, as seen by the high rates of task success and S-E improvement. Their study highlighted the advantageous possibilities of chatbots in English as a foreign language (EFL) settings. Martínez-Ramón et al. (2022) supported the efficacy of artificial neural networks in forecasting psychological characteristics such as S-E; enjoyment with education was also supported.

CER in learners refers to deliberate cognitive strategies used to control the processing of emotionally intense information (Aldao & Nolen-Hoeksema, 2010; Garnefski et al., 2004). CER encompasses several internal and external mechanisms that are responsible for monitoring, assessing, and altering emotional responses, particularly in terms of their intensity and duration (Rezaei & Zebardast, 2021). Scholars have recently begun to investigate the cognitive components of emotion regulation, as opposed to other types of methods, such as behavioral strategies (e.g., Griffiths et al., 2021; Rezaei & Zebardast, 2021; Weidi & JeeChing, 2023). Extensive research over time has proven the essential link between mental procedures and emotion control in individuals. This cognitive regulation is critical for individuals to successfully regulate and retain control over their emotions, especially in the face of dangerous or difficult conditions (Weidi & JeeChing, 2023).

The concept of enjoyment serves as a substitute for the emotional response elicited by the successful completion of a task, as discussed in the field of positive psychology (Pekrun, 2006). As Jiang and Dewaele (2019) highlighted, the idea of enjoyment is intricate and diverse, as it is influenced by five separate mechanisms: (a) emotional, (b) mental, (c) inspirational, (d) interpersonal, and (e) physical. Previous research conducted by Elahi Shirvan et al. (2020) confirmed the beneficial impact of pleasure on several aspects of students' educational experiences, including learning attitudes, motivation levels, interactions with peers and teachers, as well as general well-being.

The level of enjoyment experienced in language lessons undergoes a transformation over time, influenced by factors such as the learner's characteristics and the instructional environment (Dewaele et al., 2018). Furthermore, Macintyre et al. (2019) emphasized that the degrees of pleasure and terror experienced by students in a language classroom have a substantial influence on their levels of involvement and performance. The alignment between context-oriented attributes and the cognitive needs of students serves as a driving force for their engagement and enjoyment in the classroom (Chen et al., 2021). Furthermore, the interactions between teachers and students have a pivotal role in fostering a positive and engaging learning environment inside the classroom (Elahi Shirvan et al., 2020).

Additionally, the connections among enjoyment, motivation, positive attitudes, and language success were confirmed by Liu (2022). Higher levels of self-evaluation and thinking skills were associated with greater enjoyment and more effective immunization among EFL college students (Aldosari et al., 2023). In their review of the relevant literature, Heeg and Avraamidou (2023) determined that the use of AI may increase students' enjoyment of in-class participation. Customizing and individualizing lessons and assignments following a learner's skills, aptitudes, and capacities is an essential use of AI that has made education more effective (Neji et al., 2023). AI provides students with a more pleasurable and engaging or immersive learning experience, which in turn improves the student's ability to absorb and remember knowledge, which is the cornerstone of education (Kizilcec, 2023).

## The Purpose of this Research

Research has identified a number of factors that determine academic achievement. According to Wei (2020), when students actively participated in S-E, CER, and AE, they had improved learning outcomes in the cognitive, meta-cognitive, and emotional zones. While it is clear that S-E, CER, and AE enhance students' well-being, there is a dearth of research that has investigated the connections between and among these elements in the context of AI-supported online education. This lacuna in the literature prompted the undertaking of this study which aimed to examine the relationships among S-E, CER, AE, and LA in the context of AI-supported online language development. The outcomes were expected to offer evidence to formulate significant conclusions about language training and its assessments in AI-supported online language learning. This inquiry was framed by a single research question. Do higher levels of self-esteem foster the cognitive-emotion regulation, academic enjoyment, and language success in AI-supported online language learning?

## Methodology

The current investigation was undertaken with a cohort of 389 students who attended classes in private language institutions at the intermediate level in China. The participants were selected using either opportunity sampling or convenience sampling methods. Duolingo as well as ChatGPT were employed to support their online instruction. There were 201 female participants and 188 men. Their ages ranged from 20 to 27 years old. The participants had sufficient skills to complete the questionnaires in English.

This investigation commenced in February 2023, and persisted until June of the same year. The procedure was executed via a Web-based system linked to the Internet. The questionnaire included the foreign language learning self-esteem scale (FLLSE), the Cognitive Emotion Control Questionnaire (CERQ), the foreign language enjoyment scale (FLES), and a researcher-made test. The receipt of 389 fully completed forms resulted in a return percentage of 76.4%.

FLLSE was used to explore the depth of students' S-E. This tool was designed by Rubio (2007), and uses a five-point Likert scale ranging from one (*strongly disagree*) to five (*strongly agree*). The FLLSE is comprised of a total of 25 questions broken down into four categories. In our investigation, the dependability of this instrument was found to be satisfactory ($\alpha = 0.881$).

Using CERQ, developed by Garnefski et al. (2002), we analyzed the cognitive emotion control techniques participants applied while facing threatening or upsetting life experiences. The CERQ is a 36-item survey that divides a person's reactions to threatening or stressful life events into nine conceptually distinct subscales, each of which consists of four items. Strategies for controlling one's emotions via the use of cognition were evaluated using a five-point Likert scale ranging from five (*almost never*) to one (*almost always*). The internal consistencies of the various subscales were all within the desirable range, from 0.783 to 0.914.

FLES, created and validated by Dewaele and MacIntyre (2016), was used to assess the level of pleasure experienced by students learning foreign languages. The FLES questionnaire comprises 21 questions rated

on a five-point Likert scale, from *strongly disagree* to *strongly agree*. The analysis of Cronbach's alpha coefficient came in at 0.789, a satisfactory level of dependability.

To evaluate the participants' LA, the researchers devised a test that was based on the students' classroom materials as well as the participants' existing levels of competence in the target language. Three EFL instructors were asked to evaluate the validity and reliability of this exam; their suggestions were implemented to improve the test. This exam was divided into four parts to assess listening, speaking, reading, and writing skills. The overall score was 20 points.

The Kolmogorov-Smirnov (K-S) test was conducted to ascertain if the data adhered to a normal distribution. The results of further examination revealed that the data followed a normal pattern. Consequently, the statistical techniques of confirmatory factor analysis (CFA) and structural equation modeling (SEM) were applied to screen the data. CFA was used to validate the observed variables' component structure, and to determine whether there was a connection among the variables and their latent constructs. Linear structural relations (LISREL) 8.80 software, a proprietary statistical software package used in SEM for manifest and latent variables (Jöreskog, 1990), was used throughout these analyses.

## Results

In this section we provide information on the reports that were generated from the data analysis, along with in-depth explanations for each component. First, we examine descriptive data relevant to the various parts of each instrument (Table 1).

**Table 1**

*Descriptive Statistics*

| Variable | *N* | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|
| Language capability | 389 | 6 | 30 | 19.165 | 6.445 |
| Real in-class language use | 389 | 6 | 30 | 20.044 | 5.585 |
| In-class correlations | 389 | 6 | 30 | 20.195 | 5.404 |
| Attitude toward behavior in the class | 389 | 7 | 35 | 23.638 | 6.064 |
| Self-esteem | 389 | 29 | 125 | 83.041 | 20.934 |
| Self-blame | 389 | 4 | 20 | 13.614 | 3.805 |
| Other-blame | 389 | 4 | 20 | 13.272 | 4.023 |
| Rumination | 389 | 4 | 20 | 13.630 | 3.948 |
| Catastrophizing | 389 | 4 | 20 | 13.563 | 3.500 |
| Putting into perspective | 389 | 7 | 20 | 15.185 | 2.430 |
| Positive refocusing | 389 | 4 | 20 | 14.648 | 3.411 |
| Positive reappraisal | 389 | 8 | 20 | 14.409 | 2.506 |
| Acceptance | 389 | 7 | 20 | 15.604 | 3.417 |

| | | | | | |
|---|---|---|---|---|---|
| Planning | 389 | 5 | 20 | 13.887 | 3.956 |
| Cognitive-emotion regulation | 389 | 80 | 167 | 127.812 | 17.527 |
| Academic enjoyment | 389 | 26 | 105 | 71.689 | 15.606 |
| Academic success | 389 | 9 | 20 | 17.129 | 2.836 |

The most frequent answer, after accounting for SE, was attitude toward behavior in the class ($M$ = 23.638, $SD$ = 6.064). When the main variables of the CER scale were dissected into their constituent pieces, acceptance had the highest mean value ($M$ = 15.604, $SD$ = 3.417) of the variables in the scale. On the third instrument, the results for AE were $M$ = 71.689 and $SD$ = 15.606. The mean score for AS, was 17.129, while the associated standard deviation was 2.836.

Next, the data was subjected to the K-S test to search for unusual patterns. The results are shown in Table 2.

**Table 2**

*Results of the K-S Test*

| Variable | K-S Z Score | Sig. (2-tailed) |
|---|---|---|
| Language capability | 1.196 | 0.114 |
| Real in-class language use | 1.024 | 0.245 |
| In-class correlations | 1.162 | 0.134 |
| Attitude toward behavior in the class | 0.896 | 0.398 |
| Self-esteem | 0.777 | 0.582 |
| Self-blame | 1.104 | 0.175 |
| Other-blame | 1.316 | 0.063 |
| Rumination | 1.168 | 0.131 |
| Catastrophizing | 1.045 | 0.225 |
| Putting into perspective | 1.236 | 0.082 |
| Positive refocusing | 1.099 | 0.201 |
| Positive reappraisal | 1.304 | 0.072 |
| Acceptance | 1.238 | 0.092 |
| Planning | 1.031 | 0.238 |
| Cognitive-emotion regulation | 0.712 | 0.691 |
| Academic enjoyment | 0.566 | 0.905 |
| Academic success | 0.822 | 0.508 |

All instruments and their components exhibited statistically non-significant values, as shown in Table 2. This observation may suggest that parametric approaches were well-suited for the analysis of the data. Pearson product-moment correlation was then used to examine the connections among S-E, CER, AE, and AS.

**Table 3**

*Correlation Coefficients: S-E, CER, AE, and AS*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. Language capability | — | | | | | | |
| 2. Real in-class language use | 0.543** | — | | | | | |
| 3. In-class correlations | 0.613** | 0.625** | — | | | | |
| 4. Attitude toward behavior in the class | 0.578** | 0.607** | 0.615** | — | | | |
| 5. Cognitive-emotion regulation | 0.856** | 0.825** | 0.813** | 0.894** | — | | |
| 6. Academic enjoyment | 0.753** | 0.788** | 0.675** | 0.704** | 0.601** | — | |
| 7. Academic success | 0.635** | 0.665** | 0.573** | 0.604** | 0.635** | 0.557** | — |

**Correlation is significant at the 0.01 level (2-tailed)

The findings summarized in Table 3 revealed notable associations among the different components of the subscales of S-E, CER, AE, and AS.

Subsequently, a causal analytic framework and SEM were used to investigate the interplay among S-E, CER, AE, and AS. The statistical analysis was conducted using LISREL 8.80. Assessment of the concordance between the model and the data included the use of many measures, such as the size of the chi-squared statistic, the root mean squared error of approximation (RMSEA), the goodness of fit index (GFI), the normed fit index (NFI), and the comparative fit index (CFI).

**Table 4**

*Model-Fitness Measures (Model 1)*

| Fitting index | χ2 | df | χ2/df | RMSEA | GFI | NFI | CFI |
|---|---|---|---|---|---|---|---|
| Cut value | | | < 3 | < 0.1 | > 0.9 | > 0.9 | > 0.9 |
| Model 1 | 4020.72 | 1374 | 2.926 | 0.070 | 0.953 | 0.962 | 0.948 |
| Model 2 | 7496 | 2609 | 2.873 | 0.069 | 0.942 | 0.961 | 0.973 |

Table 4 displays the outcomes, showing that all fitness levels for Model 1 were suitable. These values consisted of the chi-square/*df* ratio (2.926), RMSEA (0.070), GFI (0.953), NFI (0.962), and CFI (0.948). Furthermore, as shown in Table 4, the Model 2 parameters have been fulfilled, suggesting a satisfactory

correspondence. The chi-square/*df* ratio (2.873), RMSEA (0.069), GFI (0.942), NFI (0.961), and CFI (0.973) were the parameters evaluated.

**Figure 1**

*Schematic Visualization of Path Coefficient Values (Model 1)*

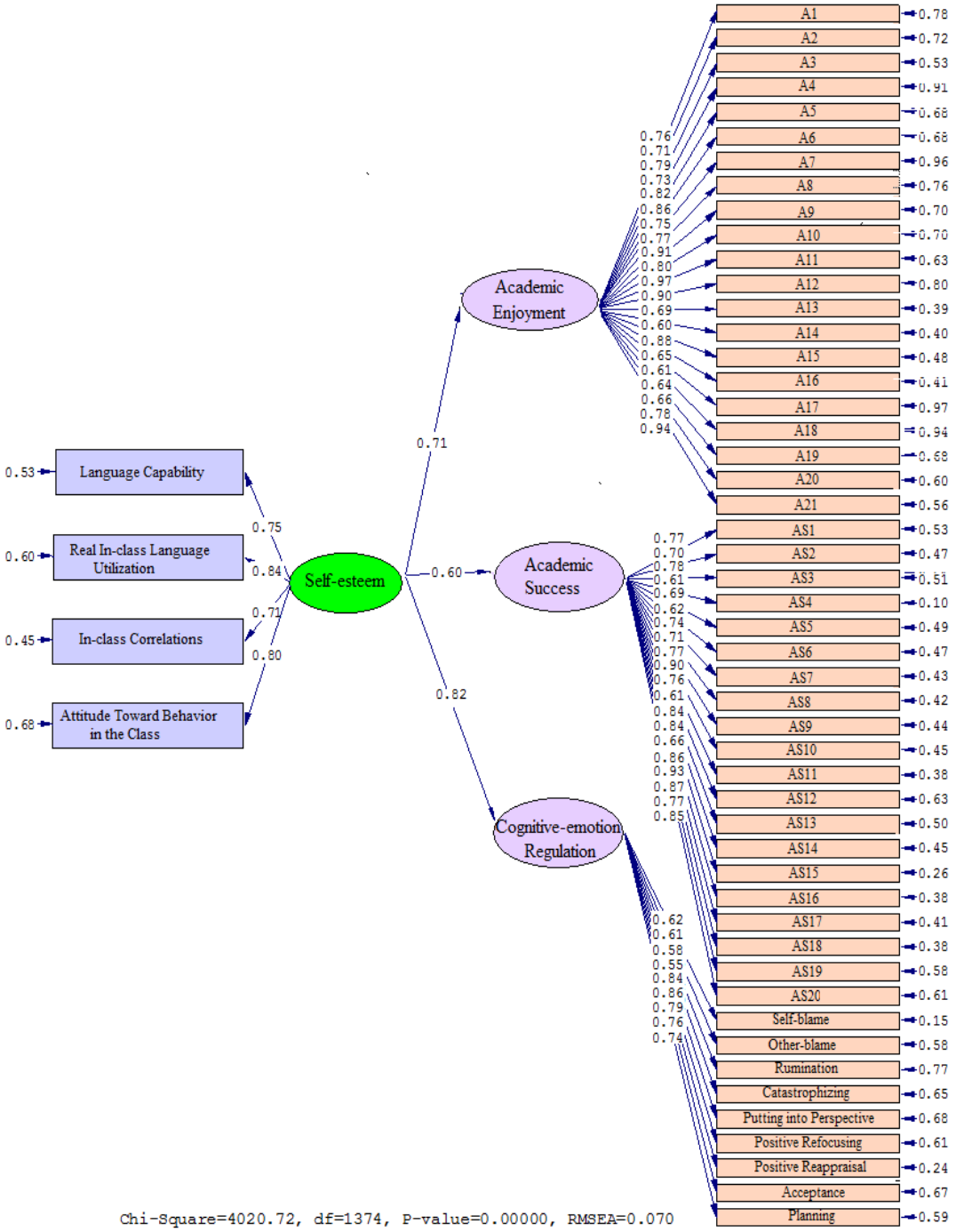

**Figure 2**

*Path Coefficient Importance t-Values (Model 1)*

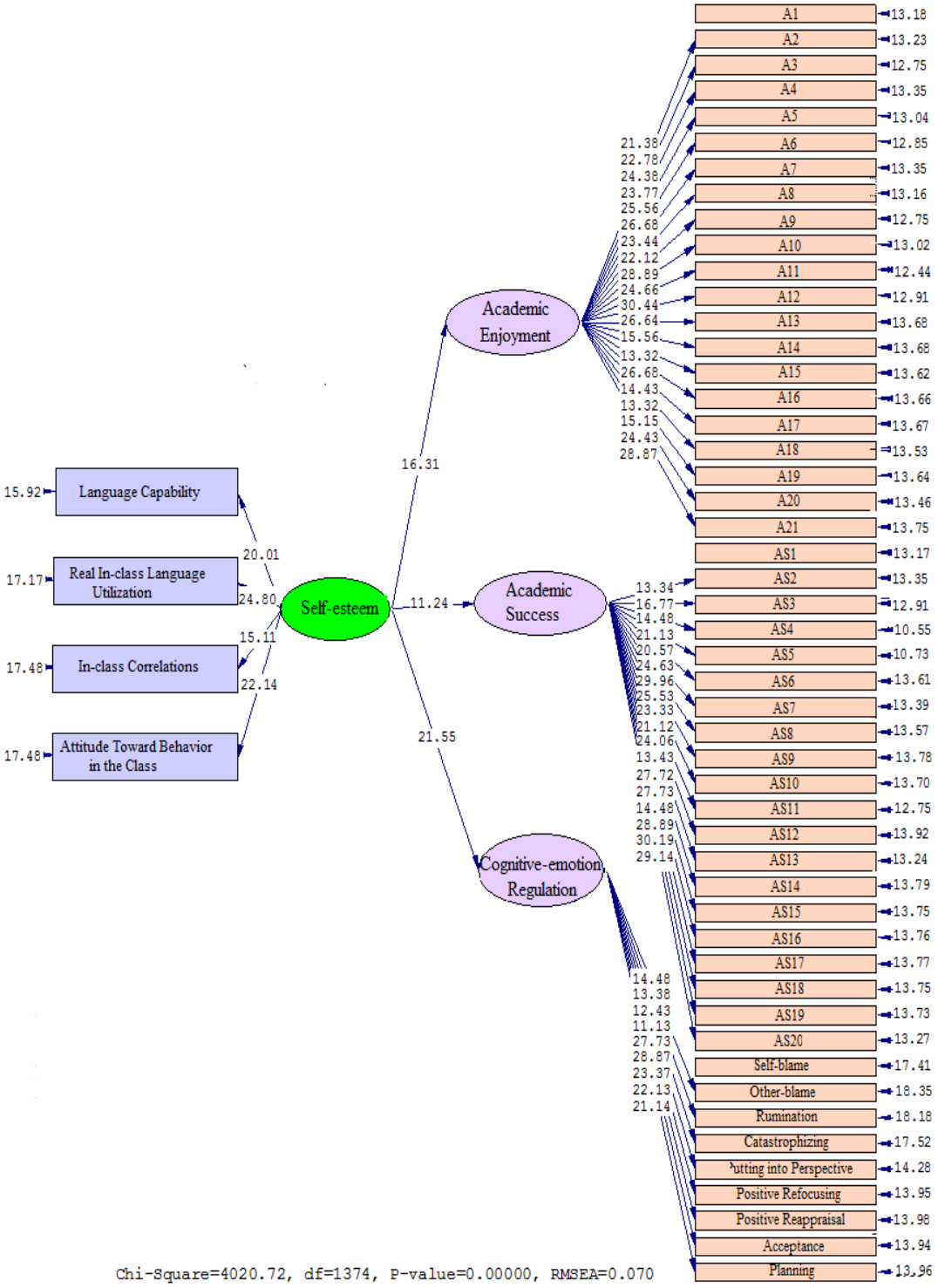

**Table 5**

*Synopsis of the Results Obtained From Model 1*

| Path | | | Path coefficient | *t*-Statistic | Test result |
|---|---|---|---|---|---|
| Self-esteem | → | Cognitive-emotion regulation | 0.82 | 21.55 | Supported |
| Self-esteem | → | Academic enjoyment | 0.71 | 16.31 | Supported |
| Self-esteem | → | Academic success | 0.60 | 11.24 | Supported |

Figures 1 and 2 provide a graphical illustration of the connections among the elements, and Table 5 provides additional information. The standard estimates and *t*-values mirror a notable connection between S-E and CER ($\beta = 0.82$, $t = 21.55$), AE ($\beta = 0.71$, $t = 16.31$), and AS ($\beta = 0.60$, $t = 11.24$).

**Figure 3**

*Schematic Visualization of the Path Coefficients' Values (Model 2)*

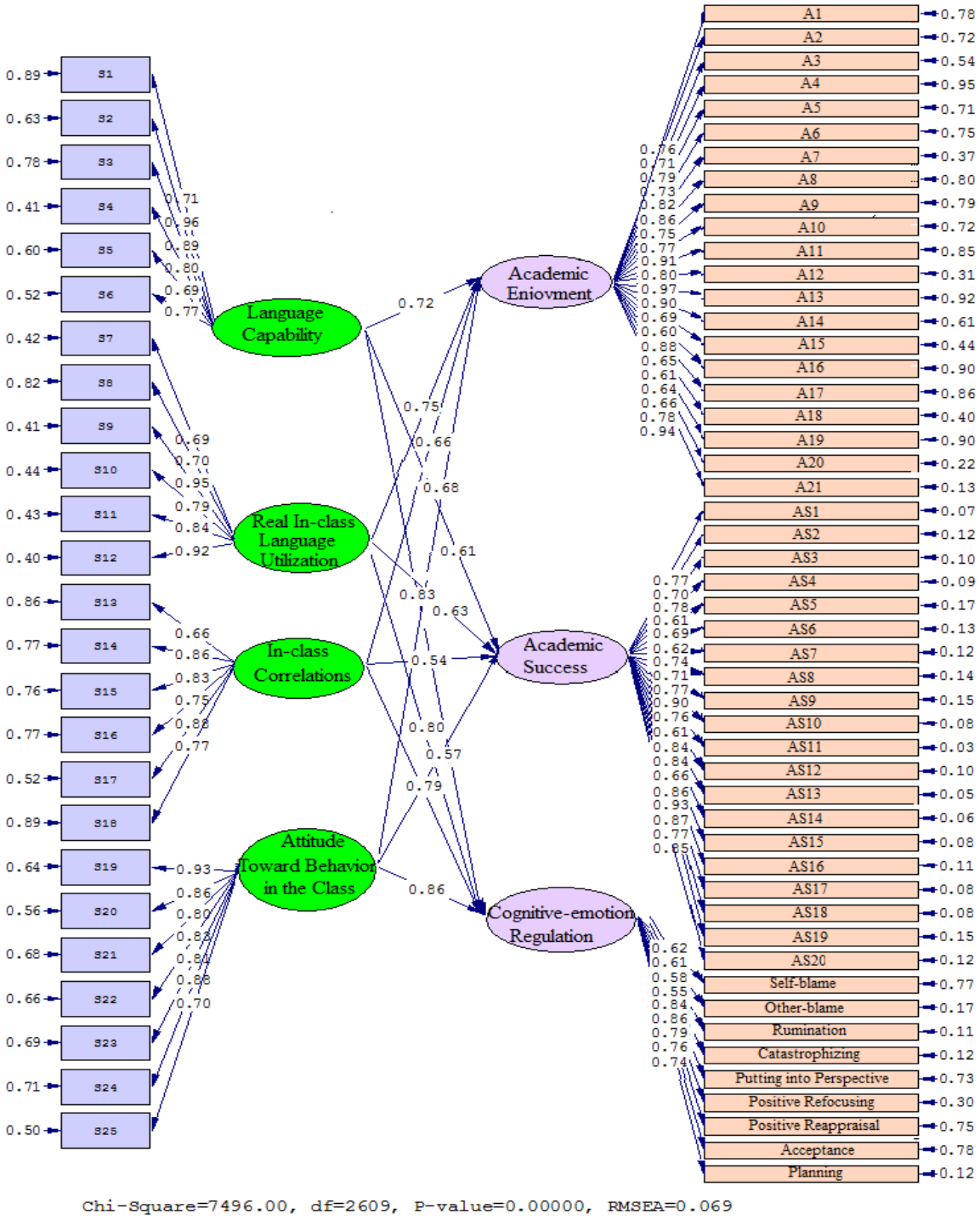

**Figure 4**

*Path Coefficient Importance t-Values (Model 2)*

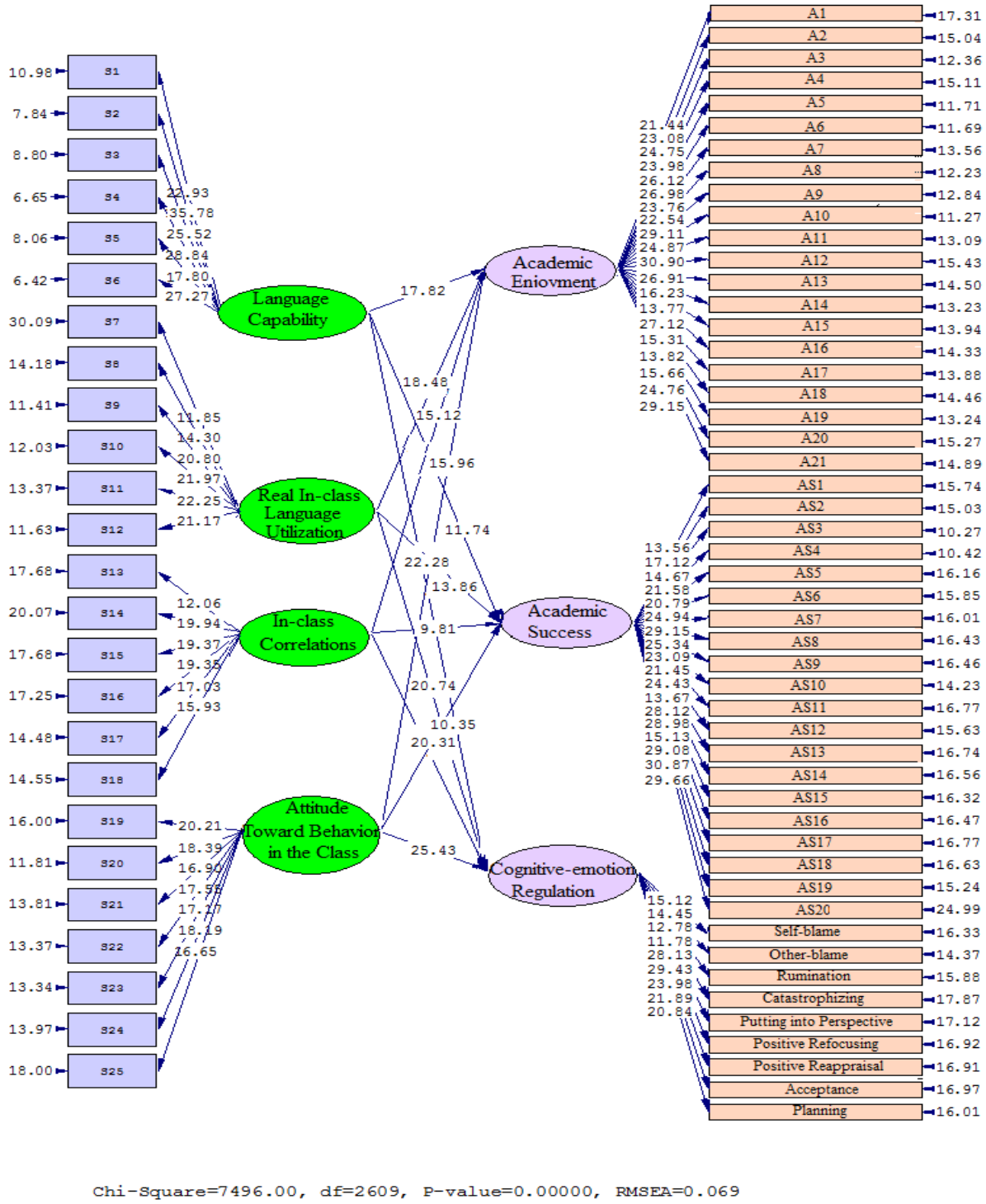

**Table 6**

*Synopsis of the Results Obtained From Model 2*

| Path | | | Path coefficient | *t*-Statistic | Test result |
|---|---|---|---|---|---|
| Language capability | → | Cognitive-emotion regulation | 0.83 | 22.28 | Supported |
| Real in-class language use | → | Cognitive-emotion regulation | 0.80 | 20.74 | Supported |
| In-class correlations | → | Cognitive-emotion regulation | 0.79 | 20.31 | Supported |
| Attitude toward behavior in the class | → | Cognitive-emotion regulation | 0.86 | 25.43 | Supported |
| Language capability | → | Academic enjoyment | 0.72 | 17.82 | Supported |
| Real in-class language use | → | Academic enjoyment | 0. 75 | 18.48 | Supported |
| In-class correlations | → | Academic enjoyment | 0.66 | 15.12 | Supported |
| Attitude toward behavior in the class | → | Academic enjoyment | 0.68 | 15.96 | Supported |
| Language capability | → | Academic success | 0.61 | 11.74 | Supported |
| Real in-class language use | → | Academic success | 0.63 | 13.86 | Supported |
| In-class correlations | → | Academic success | 0.54 | 9.81 | Supported |
| Attitude toward behavior in the class | → | Academic success | 0.57 | 10.35 | Supported |

The results indicated a significant and favorable correlation between CER and the subsequent sub-factors: language Capability (β = 0.83, *t* = 22.28), real in-class language Use (β = 0.80, *t* = 20.74), in-class correlations (β = 0.79, *t* = 20.31), and attitude toward behavior in the class (β = 0.86, *t* = 25.43). Likewise, a statistically significant relationship was observed between AE and various sub-scales, namely language capability (β = 0.72, *t* = 17.82), real in-class language use (β = 0. 75, *t* = 18.48), in-class correlations (β = 0.66, *t* = 15.12), and attitude toward behavior in the class (β = 0.68, *t* = 15.96). In line with the findings, there were positive and statistically noteworthy connections between AS and the following sub-components: language capability (β = 0.61, *t* = 11.74), real in-class language use (β = 0.63, *t* = 13.86), in-class correlations (β = 0.54, *t* = 9.81), and attitude toward behavior in the class (β = 0.57, *t* = 10.35).

# Discussion

The purpose of this research was to examine how S-E, CER, AE, and LS are connected. More specifically, the influence of S-E on CER, AE, and LS in AI-supported online language learning was explored. To achieve this objective, the study employed empirical research methods among EFL students who were enrolled in English-language institutions. These students used online classes to enhance their English language proficiency. The findings showed that students who developed and practiced S-E improved in CER and AE; they also achieved better scores on their language tests. These findings brought to light the significant role that AI-supported online classes can play in improving students' psychological well-being as well as their engagement in their academic work. The findings of the study are discussed in greater detail below.

This study had one key research question—do higher levels of self-esteem foster the cognitive-emotion regulation, academic enjoyment, and language success in AI-supported online language learning? Our findings suggested that S-E guided CER of EFL learners. That means the strategies encompassed within S-E contributed to a state of balance in students' educational experiences, enabling them to engage in critical evaluation of their learning process. This suggested that students were capable of enhancing their learning outcomes by engaging in critical evaluation of their learning processes. The outcomes of this study suggested that there was a beneficial connection between students' psychological well-being and their self-concept, in addition to their beliefs regarding their monitoring and meta-cognitive skills.

The cognitive and meta-cognitive learning experiences of students, and language learners in particular, can be enhanced when they are provided with emotional support and when they employ appropriate strategies for learning (i.e., AI) in the face of chaos and complexity. It was also agreed that S-E established the standard for language learning and evaluation (Ritonga et al., 2023). Accordingly, ensuring successful language learning and increasing learners' engagement requires an investment in providing related knowledge via efficient materials and applications.

The results also suggested that enhanced S-E increased EFL learners' engagement. In particular, model 2 of CER subfactors reflected S-E in the following areas: (a) course worth, (b) involvement with instructors, (c) involvement with classmates, (d) interactions with others, and (e) involvement with online evaluations. These are some of the attributes of students feeling they belong and are valued. This result aligned with Riswanto et al. (2022), who revealed a substantial influence of S-E and critical thinking on EFL students' motivation. It can be argued that facilitating students' autonomy through the use of online language learning courses contributes to the development of their linguistic abilities. Ismail and Heydarnejad (2023), as well as Soodmand Afshar and Jamshidi (2022), also established direct connections among S-E, learning autonomy, and personal best goals. The promotion of independence and autonomy among students can be facilitated by providing them with the necessary resources to achieve success in their future academic pursuits.

In general, the incorporation of AI applications into language curricula yielded a positive effect on students' academic performance, as evidenced by the successful attainment of the curriculum's intended learning outcomes. AI applications have the potential to alleviate the onerous workload of language educators by eliminating laborious duties like evaluation and feedback. Furthermore, AI applications have the potential to pique the generally apathetic interest of students in language through the provision of interactive and

amusing intelligent tutors or unconventional individualized educational settings. AI applications can also assist in optimizing instructional operations to boost generally poor educational results in language subjects.

Moreover, in accordance with Bandura's (1989) social cognitive theory, the process of learning takes place through the acts of observing, imitating, and modeling the behaviors exhibited by others. Within the realm of AI-supported relationships, students are afforded the chance to look into and actively participate in AI systems that exhibit self-regulatory behaviors. These behaviors include providing responsive input and assisting students in determining and planning their goals. Through the process of observing these behaviors, learners have the opportunity to internalize and subsequently replicate self-regulatory strategies. Consequently, this process enables individuals to foster the growth of their self-regulation abilities. Furthermore, AI technologies provide notable advantages, such as dynamic methods of learning and actual time analysis of data. These features allow learners to receive prompt feedback and track their progress. The provision of prompt feedback enables learners to assess their achievement, discover aspects requiring enhancement, and adapt their methods of learning correspondingly. Through the process of self-reflection and incorporating feedback obtained from AI systems, individuals can cultivate cognitive consciousness and self-regulatory practices (Zimmerman, 2002).

## Conclusion and Implications

Implementing an AI environment is advisable due to its ability to create an engaging and intriguing technical setting. This will enhance learners' ability to effectively interact with AI and their peers, eventually resulting in increased competence in autonomously evaluating and improving their oral communication skills. The findings of this research indicated that the interactive speaking activities, aided by AI, led to improvements in EFL learners' (a) speaking and listening skills, (b) critical thinking abilities, (c) affective engagement, and (d) language success. This implies that AI technology may help learners oversee and regulate their educational processes. These technologies may assist in establishing objectives, monitoring accomplishments, and implementing any necessary adjustments. AI-driven training empowers learners to take control of their educational process and enhance their oral communication skills by offering personalized coaching and adaptive tasks that promote the development of meta-cognitive strategies.

This research has certain drawbacks that should be noted, in addition to the implications. Nevertheless, it offers intriguing novel insights into the matter at hand. Participants in this research were Chinese EFL students at the intermediate level—future investigations could repeat this study in other classrooms and compare the results. It is recommended that additional areas of inquiry investigate the possible impacts of S-E on CER, AE, and LS. Students' self-reporting survey answers were the only source of data used in the research, raising concerns about generalizability. Integrating qualitative and quantitative approaches can be useful for future studies. Furthermore, it is suggested that the study's findings be pooled and that a future survey investigate how students' socioeconomic backgrounds might influence the correlations among AI-supported language acquisition, CER, AR, and S-E.

## Acknowledgments

The authors declare that they used AI applications (i.e., ChatGPT and QuillBot) to edit and proofread some sections to address language accuracy and fluency.

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