

The Impact of AI Virtual Teachers on Vocational Students' Thinking Patterns: The Mediating Role of Motivational Regulation

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Abstract

With the widespread use of artificial intelligence in education, AI virtual teachers have become interactive instructional tools. However, limited research has examined how they influence students' cognitive beliefs through psychological mechanisms, particularly the development of growth mindset in vocational education. Grounded in Growth Mindset Theory and Self-Regulated Learning Theory, this study proposes a mediation model of "AI Virtual Teacher--Motivational Regulation--Mindset" to investigate the impact of AI virtual teachers on five-year higher vocational college students. Survey data were collected from 350 students in a vocational college in Jiangsu Province. Structural equation modeling and Bootstrapping analyses revealed that AI virtual teachers negatively predicted fixed mindset and positively predicted growth mindset, significantly enhanced motivational regulation, and influenced mindset indirectly through motivational regulation. Motivational regulation fully mediated the relationship between AI virtual teachers and mindset. The findings indicate that AI virtual teachers foster growth mindset not directly, but by strengthening students' motivational regulation strategies and promoting sustained learning engagement. This study highlights the psychological pathway linking technological support and ability beliefs, offering implications for the design and application of AI virtual teachers in vocational education.

Keywords: AI Virtual Teacher; Motivational Regulation; Thinking Patterns; Five-Year Higher Vocational Students; Mediation Effect.

1. Introduction

In recent years, the rapid development of artificial intelligence (AI) has significantly reshaped the educational landscape. With the deep integration of intelligent technologies and teaching practice, AI has gradually evolved from a supportive tool into a teacher-like agent capable of interaction and instructional guidance. AI virtual teachers are increasingly used in online learning platforms and vocational education. Compared with traditional teaching approaches, they not only facilitate knowledge transmission but also provide learning support, emotional feedback, and motivational encouragement, making them an important topic in educational technology research.

Existing studies have mainly focused on the impact of AI virtual teachers on academic achievement [1], learning engagement [2], and learning satisfaction [3]. However, most of this research emphasizes observable learning outcomes, while relatively little attention has been paid to students' internal cognitive beliefs and psychological mechanisms.

The concept of growth mindset offers an important perspective for understanding learning beliefs. According to Dweck (1999) [4], individuals' beliefs about whether abilities can be developed influence their persistence and effort when facing challenges. Students with a growth mindset tend to adopt more positive learning strategies and show stronger persistence [5,6]. Moreover, growth mindset can be shaped through instructional feedback and learning environments. However, empirical evidence on whether AI virtual teaching environments can foster growth mindset remains limited.

Drawing on learning motivation theory and self-regulated learning theory, motivational regulation may serve as an important mediating mechanism. Motivational regulation refers to students' ability to maintain or enhance motivation through strategies such as goal reinforcement and self-regulation. Previous research suggests that supportive feedback environments can strengthen motivational regulation [7], which in turn influences learning engagement and belief structures [9]. Nevertheless, the mediating role of motivational regulation in AI-supported learning environments has not been fully explored.

Students in five-year vocational colleges represent a distinctive group in vocational education. Compared with students in general academic tracks, they often have lower academic confidence and are more likely to form fixed beliefs about ability. Exploring how supportive learning environments can promote a positive growth mindset among this group is therefore of practical significance.

Based on these considerations, this study proposes a mediating model of "AI Virtual Teacher - Motivational Regulation - Thinking Patterns" to examine how AI virtual teachers influence the thinking patterns of students in five-year vocational colleges and to explore the underlying mechanism of this relationship.

2. Literature Review

2.1 The Relationship Between AI Virtual Teachers and Mindset

With the integration of AI technology into education, AI virtual teachers now provide contextual responses, instant feedback, and personalized support. These functions not only influence academic performance but may also shape students' beliefs about the relationship between ability and effort. According to Growth Mindset Theory, repeated feedback emphasizing that effort leads to improvement fosters the belief that ability is malleable.

Although previous studies have shown that AI virtual teachers can promote specific types of thinking, such as legal thinking [10] and computational thinking [11], research examining how AI virtual teachers facilitate students' broader thinking patterns remains limited. Through personalized support and immediate feedback, AI virtual teachers can enhance students' sense of achievement and control, helping them attribute changes in performance to effort rather than fixed ability.

In vocational education, students in five-year vocational colleges often experience low academic confidence and doubts about their abilities. The supportive environment provided by AI virtual teachers may help these students develop a more positive growth mindset. Therefore, this study proposes Hypothesis H1: AI virtual teachers have a significant impact on the thinking patterns of students in five-year vocational colleges.

2.2 The Relationship Between AI Virtual Teachers and Motivational Regulation

Motivational regulation is an important component of self-regulated learning theory, referring to individuals' ability to sustain learning motivation through strategies such as goal reinforcement and emotional regulation [12]. AI virtual teachers can shorten the time gap between effort and outcomes through immediate feedback, enhancing students' awareness of progress and strengthening their self-efficacy. They can also provide emotion recognition and strategy prompts to reduce learning anxiety and support motivational regulation.

Previous studies have shown that AI can enhance junior high school students' motivation in English listening and speaking [13], secondary vocational students' motivation in mathematics learning [8], and adolescents' autonomous learning motivation [10]. However, most studies focus on basic education, while research on students in five-year vocational colleges remains limited. As these students often experience frustration during skill training and fluctuations in motivation, AI virtual teachers may help strengthen their motivational regulation through personalized feedback and emotional support. Therefore, this study proposes Hypothesis H2: AI virtual teachers have a significant impact on the motivational regulation of students in five-year vocational colleges.

2.3 The Relationship Between Motivational Regulation and Mindset

According to self-regulated learning theory, motivational regulation is an important ability that enables students to maintain goal orientation and emotional stability when facing difficulties. Students who effectively use strategies such as goal reinforcement, interest activation, and emotional regulation are more likely to persist after failure rather than attribute setbacks to a lack of ability.

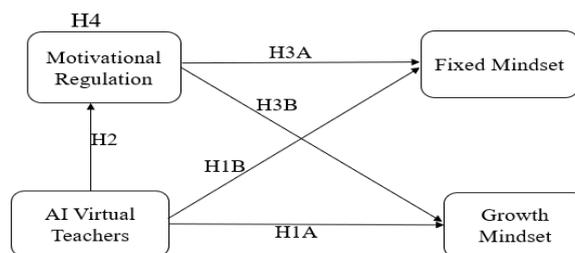
From the perspective of attribution theory, when students continue to invest effort through motivational regulation and eventually make progress, they are more likely to attribute their performance improvement to effort rather than fixed ability, which facilitates the development of a growth mindset. In contrast, students with poor motivational regulation are more likely to withdraw when encountering setbacks, thereby reinforcing a fixed mindset. Previous studies have also found relationships between these variables, such as the positive impact of growth mindset interventions on learning motivation [14], the influence of growth mindset on mathematics learning motivation [15], and the chain mediating role of future time perspective and achievement motivation between growth mindset and grit [16].

In vocational education, students in five-year vocational colleges often face repeated trial-and-error and delayed feedback during skill training, which requires strong motivational regulation to maintain persistence and emotional stability. Effective motivational regulation may help students develop the belief that ability can improve through practice. Therefore, this study proposes Hypothesis H3: Motivational regulation has a significant impact on the thinking patterns of students in five-year vocational colleges.

2.4 The Mediating Role of Motivational Regulation

Previous studies have shown that motivation can play a mediating role in different contexts. For example, achievement motivation mediates the relationship between kindergarten teachers' occupational well-being and work engagement [17], between self-control and academic procrastination among physical education graduate students [9], and between major identity and self-management among college students [18]. In addition, motivational regulation and strategies have been found to play a chain mediating role between learning experiences and deep learning in Chinese among high school students [19].

AI virtual teachers can enhance students' sense of control and competence in challenging situations through immediate feedback and tiered support, thereby encouraging the use of motivational regulation strategies such as goal reinforcement and emotional regulation. Through this process, students may attribute progress to effort and strategy use rather than fixed ability, which helps strengthen the belief that ability can develop and thus promotes a growth mindset. Therefore, this study proposes Hypothesis H4: Motivational regulation mediates the relationship between AI virtual teachers and the thinking patterns of students in five-year vocational colleges. The research framework is as follows:



(Source: made by the author)

Figure 1: Research model.

3. Participants and Methods

3.1 Research Sample

This study targeted students from a five-year higher vocational college in Jiangsu Province. Using cluster sampling, 360 students were selected to participate in the survey. A total of 350 valid questionnaires were obtained, yielding a response rate of 97.2%. The sample consisted of 274 males (51.6%) and 257 females (48.4%). Students from the first to fifth years of the program numbered 108 (20.3%), 97 (18.3%), 111 (20.9%), 117 (22.0%), and 98 (18.5%), respectively. Liberal arts students accounted for 296 (55.7%) and science students for 235 (44.3%). In terms of background, 266 students (50.1%) were from rural areas and 265 (49.9%) from urban areas.

3.2 Research Instruments

3.2.1 AI Virtual Teacher Acceptance Scale

This study employed the AI Virtual Teacher Acceptance Scale adapted from the Technology Acceptance Model (TAM) proposed by Davis (1989) [20]. The scale was localized to fit the learning context of five-year higher vocational students and includes four dimensions: perceived usefulness, perceived ease of use, behavioral intention, and attitude, comprising 14 items in total. A five-point Likert scale was used (1=strongly disagree, 5=strongly agree), with higher scores indicating greater acceptance of AI virtual teachers. In this study, the overall Cronbach's α was 0.950, with subscale α coefficients ranging from 0.779 to 0.889, indicating good internal consistency.

3.2.2 Learning Motivational Regulation Scale

Motivational regulation was measured using the Learning Motivational Regulation Strategies Scale developed by Li (2009) [21]. The scale consists of 40 items covering eight strategies: interest enhancement, performance goal activation, mastery goal activation, self-reward, consequence imagination, task value enhancement, volitional control, and self-efficacy enhancement. A five-point Likert scale was applied (1=strongly disagree, 5=strongly agree), with higher scores indicating greater use of motivational regulation strategies. In this study, the overall Cronbach's α was 0.981, and subscale α coefficients ranged from 0.803 to 0.937, demonstrating strong reliability.

3.2.3 Thinking Patterns Scale

The scale was assessed using the Chinese version of the Growth Mindset Scale translated by Jia Xiaoyu (2018) [22], originally developed by Dweck (1999) [4] in *Mindset: The New Psychology of Success*. The scale measures beliefs about the malleability of ability and intelligence and includes two dimensions: fixed mindset and growth mindset, each with 10 items. A five-point Likert scale was used (1=strongly disagree, 5=strongly agree). In this study, the Cronbach's α coefficients were 0.804 for fixed mindset and 0.808 for growth mindset, indicating acceptable reliability.

4. Data Analysis and Results

4.1 Common Method Bias and Data Suitability Test

In this study, 10 principal factors were extracted, with the first principal component explaining 38.960% of the variance. Based on this, we can conclude that no significant common method bias was detected in this study. Additionally, the KMO value was 0.971, and the Bartlett's test of sphericity showed an approximate chi-square value of 50782.395, with 4095 degrees of freedom and a significance of 0.000 ($p < 0.001$), indicating that the data is suitable for factor analysis.

4.2 Assessment of the Direct Effect

To examine the structural relationships among AI virtual teachers, motivational regulation, and mindset, structural equation modeling (SEM) was conducted for path analysis. The results are presented in Table 1.

First, AI virtual teachers significantly negatively predicted fixed mindset ($\beta = -0.717$, $t = -14.524$, $p < 0.001$), supporting H1a. This indicates that higher levels of AI virtual teacher support are associated with lower levels of fixed mindset, suggesting that in AI-supported learning environments, students are less likely to perceive ability as immutable. Meanwhile, AI virtual teachers significantly positively predicted growth mindset ($\beta = 0.695$, $t = 15.132$, $p < 0.001$), supporting H1b. This finding suggests that greater AI virtual teacher support is associated with higher levels of growth mindset among five-year higher vocational students. Personalized feedback, process-oriented guidance, and continuous support provided by AI virtual teachers appear to strengthen students' beliefs in the malleability of ability.

Second, AI virtual teachers had a significant positive effect on motivational regulation ($\beta = 0.912$, $t = 22.873$, $p < 0.001$), supporting H2. The relatively high path coefficient indicates that AI virtual teachers play a substantial role in promoting students' use of motivational regulation strategies. In AI-supported learning contexts, students are more likely to maintain engagement through goal reinforcement, interest activation, and emotion regulation, thereby demonstrating stronger motivational regulation abilities.

Further analysis showed that motivational regulation significantly negatively predicted fixed mindset ($\beta = -0.759$, $t = -16.252$, $p < 0.001$), supporting H3a. This suggests that students with higher levels of motivational regulation are less likely to endorse fixed beliefs about ability. In addition, motivational regulation significantly positively predicted growth mindset ($\beta = 0.727$, $t = 16.842$, $p < 0.001$), supporting H3b. Students with stronger motivational regulation are more likely to persist in the face of challenges and attribute outcomes to strategic effort and sustained engagement, thereby reinforcing beliefs in the malleability of ability and promoting the development of a growth mindset.

Table 1: Summary of Path Analysis Results for the Relationship

Hypothesis	Path	Hypothesized Relationship	Path Coefficient (β)	t-value	Hypothesis Supported
H1A	AI Virtual Teachers → Fixed Mindset	Negative	-0.717	-14.524***	Yes
H1B	AI Virtual Teachers → Growth Mindset	Positive	0.695	15.132***	Yes
H2	AI Virtual Teachers → Motivational Regulation	Positive	0.912	22.873***	Yes
H3A	Motivational Regulation → Fixed Mindset	Negative	-0.759	-16.252***	Yes
H3B	Motivational Regulation → growth mindset	Positive	0.727	16.842***	Yes

(Source: made by the author)

Note : *p < 0.05; **p < 0.01; ***p < 0.001

4.3 Identification of the Mediating Effect

Bootstrapping was employed to examine the mediating effects. As shown in Table 2, AI virtual teachers had a significant indirect effect on fixed mindset through motivational regulation ($\beta = -0.594$). The Bias-Corrected 95% confidence interval was $[-0.818, -0.375]$, and the Percentile 95% confidence interval was $[-0.810, -0.370]$, neither of which included zero ($p = 0.001$), indicating a significant mediating effect. After controlling for motivational regulation, the direct effect of AI virtual teachers on fixed mindset was not significant ($\beta = -0.125$, 95% CI included zero, $p > 0.05$), whereas the total effect remained significant ($\beta = -0.718$, 95% CI did not include zero, $p = 0.001$). These results suggest that motivational regulation fully mediates the relationship between AI virtual teachers and fixed mindset.

Similarly, AI virtual teachers had a significant indirect effect on growth mindset through motivational regulation ($\beta = 0.535$). The Bias-Corrected 95% confidence interval was $[0.335, 0.758]$, and the Percentile 95% confidence interval was $[0.321, 0.747]$, both excluding zero ($p = 0.001$). After including motivational regulation in the model, the direct effect of AI virtual teachers on growth mindset was not significant ($\beta = 0.160$, 95% CI included zero, $p > 0.05$), while the total effect remained significant ($\beta = 0.695$, 95% CI did not include zero, $p = 0.001$). These findings indicate that motivational regulation also fully mediates the relationship between AI virtual teachers and growth mindset.

Table 2: Summary of Bootstrapping Mediation Effect Analysis.

Parameter	Estimate	95% Confidence Interval				
		BC/PC	Bias-Corrected		Percentile	
		P value	Lower	Upper	Lower	Upper
Indirect Effect AI Virtual Teachers → Motivational Regulation → Fixed Mindset	-0.594	0.001\0.001	-.818	-.375	-0.810	-0.370
Direct Effect AI Virtual Teachers → Fixed Mindset	-0.125	0.301\0.304	-0.369	0.116	-0.369	0.116
Total Effect AI Virtual Teachers → Fixed Mindset	-0.718	0.001\0.001	-0.127	-0.648	-0.779	-0.648
Indirect Effect AI Virtual Teachers → Motivational Regulation → Growth Mindset	0.535	0.001\0.001	0.335	0.758	0.321	0.747
Direct Effect AI Virtual Teachers → Growth Mindset	0.160	0.209\0.187	-0.085	0.384	-0.083	0.389
Total Effect AI Virtual Teacher → Growth Mindset	0.695	0.001\0.001	0.630	0.754	0.628	0.753

(Source: made by the author)

Note : *p < 0.05; **p < 0.01; ***p < 0.001

5. Discussion

Based on growth mindset theory and self-regulated learning theory, this study examined the mechanism through which AI virtual teachers influence the thinking patterns of students in five-year vocational colleges, with a particular focus on the mediating role of motivational regulation. The results supported all the initial hypotheses and revealed that AI virtual teachers reshape students' beliefs about ability by empowering their motivational regulation capabilities. The major findings are discussed below.

5.1 Direct Effects of AI Virtual Teachers on Thinking Patterns

This study found that AI virtual teachers significantly predicted the thinking patterns of students in five-year vocational colleges. Specifically, AI virtual teachers significantly and negatively predicted fixed mindset ($\beta=-0.717$, $p<0.001$) and significantly and positively predicted growth mindset ($\beta=0.695$, $p<0.001$). These results support Hypothesis H1 and extend research on the educational effects of AI from specific cognitive skills (e.g., legal thinking and computational thinking) to deeper levels of beliefs about ability.

According to Dweck's (1999) [4] growth mindset theory, individuals' beliefs about ability are strongly influenced by environmental feedback. In traditional educational contexts, evaluation is often delayed and outcome-oriented, which may lead students--especially those with relatively low academic confidence, such as students in five-year vocational programs--to attribute failure to their lack of ability, thereby reinforcing a fixed mindset. In contrast, AI virtual teachers provide immediate feedback, personalized guidance, and process-oriented encouragement, creating a "low-threat, high-support" learning environment. Within such an environment, students can frequently experience the immediate loop of "effort--progress--feedback." This positive reinforcement not only enables students to see concrete pathways for improving their abilities but also implicitly conveys the message that ability can develop through effort. This finding is consistent with previous studies [23,11], while further revealing the shaping role of AI technology in the deeper belief system related to ability.

Moreover, students in five-year vocational colleges constitute a unique group. As they are situated in the context of vocational education, their academic self-confidence is often relatively weak, making them more likely to develop fixed beliefs about ability. The results of this study suggest that the supportive learning environment created by AI virtual teachers can effectively address the psychological needs of this group. Continuous positive feedback can help alleviate students' doubts about their abilities and promote the development of more positive beliefs about ability.

5.2 The Promoting Effect of AI Virtual Teachers on Motivational Regulation

This study found that AI virtual teachers have a strong positive predictive effect on motivational regulation ($\beta=0.912$, $p<0.001$), supporting Hypothesis H2. The relatively high path coefficient indicates that among students in five-year vocational colleges, AI virtual teachers play a particularly significant role in promoting students' motivational regulation abilities.

Specifically, AI virtual teachers shorten the time gap between "effort" and "outcome" through immediate feedback, thereby enhancing students' perception of their own progress.

In addition, through emotion recognition and strategy prompts, AI virtual teachers help alleviate learning anxiety and facilitate the use of motivational regulation strategies. This finding is consistent with previous studies [13,8], but it extends the research focus from "motivation level" to "motivational regulation ability," highlighting the role of AI technology in cultivating students' meta-motivational capabilities.

From the perspective of the characteristics of students in five-year vocational colleges, this finding is particularly meaningful. Skill training in vocational education often involves repeated trial and error and delayed feedback, which may lead students to experience frustration and fluctuations in motivation. AI virtual teachers function as "tireless companions," capable of intervening when students' motivation declines. Through interest activation, goal reinforcement, and emotional regulation support, AI virtual teachers provide targeted assistance, thereby effectively activating students' internal motivational regulation mechanisms. This interactive process between external technological support and internal psychological capability represents a typical pathway through which technological support facilitates psychological development.

5.3 The Influence of Motivational Regulation on Thinking Patterns

The results show that motivational regulation significantly and negatively predicts fixed mindset ($\beta=-0.759$, $p<0.001$) and significantly and positively predicts growth mindset ($\beta=0.727$, $p<0.001$), supporting Hypothesis H3. These findings reveal the important role of motivational regulation, as an internal psychological capability, in shaping students' beliefs about ability.

From the perspective of attribution theory, this finding carries important theoretical implications. When students are able to sustain effort in challenging situations by applying motivational regulation strategies and eventually achieve progress, they are more likely to attribute their success to strategic adjustments and persistent effort, rather than to fixed ability. This "effort--success" attribution pattern constitutes the cognitive foundation of a growth mindset. Conversely, students who lack motivational regulation abilities are more likely to abandon effort when encountering setbacks, thereby missing opportunities to verify the malleability of ability, which in turn reinforces a fixed mindset.

These findings are consistent with previous studies [14,15]. Building upon these studies, the study further reveals that motivational regulation is not only an outcome variable influenced by thinking patterns but also an antecedent factor that shapes thinking patterns, indicating a bidirectional relationship between the two.

In the context of vocational education, this finding has important implications. Students in five-year vocational colleges frequently encounter repeated trial and error and delayed feedback in skill training. Effective motivational regulation can help them maintain goal persistence and emotional stability when facing setbacks. Through sustained effort, students gradually verify the belief that ability can be improved through repeated practice, thereby fostering the development of a growth mindset.

5.4 The Full Mediating Role of Motivational Regulation

A central finding of this study is that motivational regulation plays a full mediating role between AI virtual teachers and students' thinking patterns. Bootstrapping analysis showed that the indirect effect of AI virtual teachers on fixed mindset through motivational regulation was significant ($\beta=-0.594$, $p=0.001$), and the indirect effect on growth mindset was also significant ($\beta=0.535$, $p=0.001$), while the direct effects were not significant. These results support Hypothesis H4 and reveal a complete pathway: AI Virtual Teachers \rightarrow Motivational Regulation \rightarrow Thinking Patterns. The theoretical implication of this full mediation effect is that AI virtual teachers do not directly "tell" students that ability can develop. Instead, they empower students to become self-regulators of their own learning, enabling them to develop beliefs about the malleability of ability through successful self-regulation experiences. In other words, the key mechanism through which technology changes thinking lies not in the transmission of information but in stimulating learners' agency and metacognitive capabilities.

From the perspective of self-regulated learning theory, this mediating mechanism follows a clear logical chain. AI virtual teachers enhance students' sense of control and competence in challenging situations through immediate feedback and scaffolded support (external support). This, in turn, encourages students to adopt motivational regulation strategies such as goal reinforcement and emotional regulation (activation of psychological capability). Through this process, students experience progress through effort and attribute success to effort and strategic adjustments rather than fixed ability (attribution reconstruction). Ultimately, this strengthens the belief that ability can develop, thereby promoting the formation of a growth mindset (belief transformation). This chain clearly illustrates the process from technological support to psychological capability and ultimately to deep-seated beliefs.

The findings of this study are consistent with previous research on the mediating role of motivation [15,18]. The findings of this study are consistent with previous research on the mediating role of motivation [15,18]. Building on these findings, the study extends the mediating role of motivational regulation to the relationship between AI technology support and students' thinking patterns, thereby further enriching the explanatory power of motivational regulation as a mediating variable.

5.5 Theoretical Contributions and Practical Implications

At the theoretical level, this study extends research on the educational effects of AI from observable learning outcomes to deeper cognitive belief structures. It reveals the full mediating role of motivational regulation between AI virtual teachers and thinking patterns and constructs a mechanism chain of "technological empowerment - psychological capability - deep-seated beliefs." By focusing on students in five-year vocational colleges and integrating growth mindset theory, self-regulated learning theory, and attribution theory, this study provides a new mediating perspective and an integrative analytical framework for understanding how technology promotes human development.

At the practical level, the findings suggest that when applying AI virtual teachers in five-year vocational colleges, institutions should shift their role from mere knowledge delivery tools to platforms for cultivating psychological capabilities. Specifically, instructional design should incorporate interactive elements that stimulate motivational regulation strategies,

strengthen process-oriented feedback emphasizing the "effort-progress" relationship, and enable AI virtual teachers to function simultaneously as learning supporters and psychological companions. In addition, motivational regulation ability should be incorporated into student development evaluation systems. Such measures can better address the psychological characteristics of students whose self-confidence tends to fluctuate and ultimately promote the internalization and development of a growth mindset.

6. Conclusion

This study investigated the mechanism by which AI virtual teachers influence the mindset of five-year higher vocational students, focusing on the mediating role of motivational regulation. The findings extend AI education research from observable learning outcomes to deeper beliefs about ability and confirm the full mediating role of motivational regulation. Practically, the results provide implications for the implementation of AI virtual teachers in vocational colleges. Emphasis should be placed on cultivating students' motivational regulation through process-oriented feedback that reinforces effort-based attributions, thereby promoting the internalization of a growth mindset.

Due to the limited sample scope and cross-sectional design, the generalizability of the findings requires further validation. Future research may adopt longitudinal or experimental designs and incorporate multiple data sources, such as behavioral logs and interviews, to more comprehensively explore the dynamic process through which AI virtual teachers influence students' mindset development.

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