# The Internet of Parental Autonomy Support on Learning Engagement among Vocational Tourism Students in the Guangxi Zhuang Autonomous Region, China: Moderated Mediating Effect

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[**Abstract**] To investigate the impact of parental autonomy support on the learning engagement of vocational tourism students in the Guangxi Zhuang Autonomous Region of China, and its underlying mechanisms, this study integrated self-determination theory, developmental systems theory, and ecological systems theory to construct a moderated mediation model with intentional self-regulation as the mediating variable and AI literacy as the moderating variable. In September 2026, this study collected a sample of tourism students from five vocational schools in the Guangxi Zhuang Autonomous Region of China using purposive sampling and an electronic questionnaire, ultimately yielding 1,058 valid responses (a response rate of 88.16 percent). The results indicate that parental autonomy support in the Guangxi Zhuang Autonomous Region of China is positively correlated with the learning engagement of vocational tourism students; intentional self-regulation acts as a mediator; and both the direct effect of parental autonomy support on learning engagement and the first half of the mediation path via intentional self-regulation are moderated by AI literacy. The findings highlight the synergistic role of family support and individual digital literacy in promoting the learning engagement of vocational tourism students, offering practical insights for advancing family education guidance, the digital transformation of vocational education, and enhancing the level of learning engagement among vocational students.

[**Key words**] parental autonomy support; learning engagement; intentional self-regulation; AI literacy; vocational tourism students

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## 1 Introduction

As China's modern vocational education system continues to improve, the role of secondary vocational education in cultivating technically skilled talent, promoting students' career development, and contributing to regional economic and social development has become increasingly prominent (Zhang et al., 2024a; Zhu & Cao, 2024). Consequently, as a vital foundation for talent development in vocational education, secondary vocational students must not only master specialist knowledge and practical skills, but also develop the capacity for continuous learning and proactive development (Liu et al., 2024; Wang, 2024). However, influenced by factors such as past learning experiences, learning motivation, and future development goals, some secondary vocational students suffer from a lack of initiative and low levels of learning engagement in their studies (Yu & Du, 2024). Furthermore, a survey of 358 vocational students at a vocational school in Nanning, Guangxi, revealed that their overall level of learning engagement was only moderate, indicating significant room for improvement (Zhang et al., 2020). It is worth noting that learning engagement refers to the sustained, positive, and fulfilling psychological state exhibited by students during learning activities, and is closely linked to their academic performance, academic adaptation, and future development (Burns et al., 2021; Zhou et al., 2022). Consequently, how to enhance the learning engagement of secondary vocational students has become a matter of significant concern in the development and

talent cultivation of students within China's vocational education system (Liu et al., 2024).

The family is a key environment influencing adolescents' learning and development. Parental autonomy support refers to parents respecting their children's autonomy, understanding and accepting their feelings and thoughts, encouraging them to express their personal views and participate in decision-making, and supporting their children in undertaking activities independently and achieving their developmental goals by providing necessary information, guidance, and assistance, rather than resorting to coercive demands or excessive control (Wang et al., 2007). Self-determination theory posits that parental autonomy support can promote adolescents' intrinsic motivation and initiative in learning by satisfying their needs for autonomy, competence, and relatedness (Vasquez et al., 2016). Furthermore, research has found that parental autonomy support is a significant positive predictor of students' academic engagement (Jiang et al., 2022). However, the underlying mechanisms through which parental autonomy support translates into students' learning engagement remain to be explored in greater depth.

Intentional self-regulation refers to an individual's ability to proactively coordinate resources and adjust behaviour in accordance with goals and environmental demands; it encompasses processes such as goal selection, goal optimisation, and goal compensation (Gestsdóttir & Lerner, 2007; Wang & Gai, 2011). Furthermore, research indicates that intentional self-regulation bridges the link between external environmental support and students' developmental outcomes, and is closely associated with positive developmental outcomes such as learning engagement and future orientation (Chang et al., 2020; Lin et al., 2021; Zhou et al., 2022). Furthermore, parental autonomy support provides students with the space to make independent choices, explore and experiment, thereby facilitating the development of their self-regulatory abilities (Liu et al., 2020). Consequently, parental autonomy support may further enhance students' learning engagement by promoting intentional self-regulation. However, within the Guangxi Autonomous Region of China, the role of intentional self-regulation as a mediator in the relationship between parental support and learning engagement among secondary vocational students has yet to be investigated.

At the same time, generative artificial intelligence is transforming the way students learn, and AI literacy is gradually becoming a vital individual resource for adapting to intelligent learning environments (Zhang et al., 2024b). AI literacy refers to an individual's comprehensive ability to understand, use, evaluate, and create artificial intelligence technologies, and to collaborate effectively with AI (Ng et al., 2021). Recent research indicates that AI literacy is positively associated with students' learning attitudes, problem-solving skills, metacognition, and digital learning abilities (Kong et al., 2024; Lin et al., 2025; Zhong & Liu, 2025; Zhou et al., 2024). This suggests that students with higher levels of AI literacy may be better equipped to utilise digital resources for goal-setting, information integration and problem-solving, thereby more effectively transforming the autonomy and support provided by their parents into their own self-regulatory resources. However, existing research has paid little attention to whether AI literacy can moderate the relationship between parental autonomy support and intentional self-regulation, and there is a particular lack of studies focusing on students in secondary vocational education.

In summary, whilst existing research has examined the relationships between parental autonomy support, intentional self-regulation, and AI literacy with students' learning development separately, few studies have incorporated all three within a single research framework. Consequently, this study takes vocational tourism students at secondary schools in the Guangxi Zhuang Autonomous Region of China as its subjects to examine the relationship between parental autonomy support and learning engagement. It further tests the mediating role of intentional self-regulation and the moderating role of AI literacy in the relationship between parental autonomy support and intentional self-regulation, thereby revealing the underlying mechanisms and conditions through which family support influences the learning engagement of vocational tourism students.

## 2 Literature review and hypothesis development

### 2.1 Self-determination theory

According to self-determination theory, an individual's development and behaviour are jointly influenced by the social environment and the extent to which their basic psychological needs are met (Vasquez et al., 2016). Consequently, drawing upon self-determination theory, this study defines parental autonomy support as parents respecting their children's autonomy, accepting and acknowledging their feelings and thoughts, minimizing commands and control, and encouraging children to make their own choices and decisions by providing information and assistance (Wang et al., 2007), classifying it as a form of external environmental support influencing individual development. Furthermore, this study defines intentional self-regulation as a series of action processes through which individuals actively coordinate situational demands, resources and personal goals to enhance their own capabilities and achieve set objectives, whilst regulating their own behaviour; this typically includes goal selection, goal optimization and goal compensation (Gestsdóttir & Lerner, 2007; Wang & Gai, 2011), and is classified as an important internal regulatory resource. On the other hand, this study defines learning engagement as the sustained, positive and fulfilling psychological state exhibited by students during the learning process, typically comprising three dimensions: Vitality, dedication and focus (Fang et al., 2008), and classifies it as the behavioural and psychological state associated with students' active participation in learning activities. Consequently, parental autonomy support can further influence the learning engagement of vocational tourism students by promoting the development of their internal self-regulation resources.

### 2.2 Developmental systems theory

According to developmental systems theory, an individual's development is the result of continuous interaction between the individual and their external environment; a match between the individual's internal resources and external environmental support can promote positive development (Lerner et al., 2005). Therefore, this study regards parental autonomy support as an external environmental resource that promotes the positive development of vocational tourism students, and views intentional self-regulation as an important internal developmental resource for the students themselves. Existing research indicates that external environmental resources can influence an individual's developmental adaptation and positive psychological outcomes by promoting the development of self-regulatory abilities; for example, school resources can influence adolescents' well-being through intentional self-regulation (Chang et al., 2020), whilst the relationship between school attachment and future orientation is also moderated by intentional self-regulation (Lin et al., 2021). On the other hand, intentional self-regulation helps students formulate clearer learning goals and adjust their behaviour and learning strategies in a timely manner in response to the learning environment and requirements, thereby promoting learning engagement (Wang & Gai, 2011; Stefansson et al., 2018). Consequently, the combination of parental autonomy support and intentional self-regulation may further promote learning engagement among vocational tourism students at secondary vocational colleges.

### 2.3 Ecological systems theory

According to ecological systems theory, an individual's development is influenced by the combined effects of multi-level systems such as the family, school and social environment; the continuous and dynamic interaction between the individual and their environment is a key mechanism in promoting individual development (Bronfenbrenner & Morris, 2006). As a crucial micro-environment in the growth of adolescents, the family's parenting style can directly influence an individual's psychological development and learning behaviour. Parental autonomy support—achieved by respecting children's autonomy, reducing control, and providing choices and assistance—creates a favourable family environment for students to develop positive learning motivation and self-regulation skills (Wang et al., 2007; Liu et al., 2020). At the same time, the learning environment for vocational tourism students at secondary vocational colleges is highly practical, service-oriented and context-

dependent, placing high demands on students' communication and expression skills, practical participation and digital technology application abilities. Consequently, autonomy-supportive family environments and students' own self-regulation resources may jointly influence their level of learning engagement.

### 2.4 Learning engagement

Learning engagement refers to the sustained, positive and fulfilling psychological state exhibited by students during the learning process, and typically comprises three dimensions: vitality, dedication and focus (Fang et al., 2008). Learning engagement not only reflects students' current state of learning but is also regarded as a key predictor of academic achievement and future development (Burns et al., 2021). Compared with students in general secondary schools, vocational secondary school students place greater emphasis on acquiring professional skills and practical abilities; their learning engagement is evident not only in classroom learning but also in vocational training, practical activities and career preparation (Tan & Sun, 2024). Tourism-related programmes are highly service-oriented, practical and context-dependent, placing high demands on students' communication and expression skills, adaptability, and proficiency in using digital tools. Therefore, examining the learning engagement of vocational tourism students is of great significance for understanding their professional learning and career preparation.

### 2.5 Parental autonomy support and learning engagement

Parental autonomy support refers to parents' ability to respect their children's autonomy, accept and acknowledge their feelings and thoughts, minimise commands and authoritarianism, and encourage children to make their own choices and decisions by providing information and assistance (Wang et al., 2007). As a positive parenting style viewed through the lens of self-determination theory, the core of parental autonomy support lies in support rather than control, and its function is to meet children's basic psychological needs (Peng et al., 2021). Furthermore, research indicates that parental autonomy support is significantly and positively correlated with students' academic engagement, academic achievement and psychosocial adjustment (Vasquez et al., 2016). Among Chinese adolescents, parental autonomy support is found to be a significant positive predictor of their positive emotional adjustment and academic-related performance (Liu et al., 2020; Peng et al., 2021). At the same time, research has also found that the influence of parental involvement on the academic engagement of vocational secondary school students is moderated by parenting style (Wu & Yao, 2013). A recent large-scale study of Chinese vocational secondary school students further found that parental autonomy support is significantly positively correlated with learning engagement (Jiang et al., 2022). This suggests that parental autonomy support provides students with a positive family environment, enabling them to experience greater autonomy of choice, emotional acceptance and behavioural support during the learning process, thereby promoting their learning engagement.

Furthermore, parental autonomy support can stimulate students' intrinsic motivation and initiative in learning by satisfying their three basic psychological needs: autonomy, competence and relatedness (Wang et al., 2007; Vasquez et al., 2016). Parents who provide autonomy support for their children are also able to convey encouragement and trust, which helps to enhance students' self-efficacy and positive learning attitudes, thereby leading to higher levels of learning engagement (Liu et al., 2020). Consequently, parental autonomy support can provide vocational tourism students with a favourable home environment and psychological resources, promoting their active participation in learning activities. Hence the hypothesis:

H1: Parental autonomy support is positively correlated with the learning engagement of vocational tourism students.

### 2.6 The mediator role played by intentional self-regulation

Intentional self-regulation refers to a series of behavioural processes whereby an individual, in order to enhance their own capabilities and achieve set goals, actively employs various strategies to coordinate the

relationship between situational demands, resources and personal goals, whilst exercising control over their own behaviour. It typically comprises three processes: Goal selection, goal optimisation and goal compensation (Gestsdóttir & Lerner, 2007; Wang & Gai, 2011). Adolescence is a critical period for the development of an individual's self-regulatory abilities, and intentional self-regulation is a key manifestation of self-regulation during this stage (Wang & Gai, 2011). Existing research indicates that intentional self-regulation serves as a key mediating variable through which external resources influence an individual's adaptive development; it plays a significant mediating role in the relationships between school resources and adolescents' early well-being (Chang et al., 2020), school engagement and future orientation (Lin et al., 2021), and social anxiety and learning engagement (Zhou et al., 2022). At the same time, research has found that the establishment and development of intentional self-regulation abilities are influenced by the external environment and parental rearing behaviours. Parents with parental autonomy support are able to provide their children with more opportunities to try, explore and exercise their self-regulatory abilities, whilst offering support and guidance when needed (Liu et al., 2020; Vasquez et al., 2016). On the other hand, intentional self-regulation helps students formulate more long-term learning goals and develop stronger learning motivation, whilst enabling them to adjust their learning strategies in a timely manner in response to changes in the learning environment and requirements; it can therefore serve as an important predictor of learning engagement (Wang & Gai, 2011; Stefansson et al., 2018).

Developmental systems theory further suggests that self-regulatory ability is a crucial internal resource for promoting an individual's healthy development and adaptation, whilst support from the external environment can sustain and enhance this internal resource, thereby guiding the individual onto a positive developmental trajectory (Lerner et al., 2005; Chang et al., 2020). Consequently, positive family support can create favourable conditions for students to develop internal self-regulatory resources. Parental autonomy support may enhance students' levels of learning engagement by promoting the development of intentional self-regulation among vocational tourism students, enabling them to set learning goals, adjust learning strategies and engage in learning activities more proactively. Consequently, the hypothesis is as follows:

H2: Intentional self-regulation mediates the relationship between parental autonomy support and learning engagement among vocational tourism students.

### 2.7 The moderator role played by AI literacy

AI literacy refers to an individual's comprehensive ability to understand, use, evaluate and create artificial intelligence technologies, and to collaborate effectively with artificial intelligence (Ng et al., 2021). Existing research indicates that AI literacy is closely associated with students' academic performance and learning attitudes (You et al., 2024), and that levels of AI literacy are influenced by factors such as practical experience, attitudes and interests (Li et al., 2025); it has become a key individual resource influencing students' ability to utilise intelligent technologies to access information, integrate resources and engage in learning activities (Zhang et al., 2025).

Parental autonomy support provides adolescents with autonomy in choice, emotional acceptance, and access to information and assistance, enabling them to explore in a less controlled environment and gain opportunities to develop self-regulatory abilities (Wang et al., 2007; Vasquez et al., 2016). Intentional self-regulation, by its very nature, is a process whereby individuals proactively coordinate internal and external resources around a goal and adjust their behaviour according to situational demands; it encompasses processes such as goal selection, goal optimisation and goal compensation (Gestsdóttir & Lerner, 2007; Wang & Gai, 2011). Consequently, whether the external resources provided through parental autonomy support can be further transformed into students' intentional self-regulation depends not only on the level of support provided by the family environment but may also be influenced by the students' own abilities and resources.

On the other hand, against the backdrop of artificial intelligence technology being increasingly integrated into

learning activities, students with higher levels of AI literacy are able to understand, use and evaluate AI tools more effectively, and utilise them as important learning resources for accessing information, integrating resources and solving problems (Carolus et al., 2023; Li & Zhang, 2026). Consequently, when students receive parental autonomy support, a higher level of AI literacy may enable them to utilise the information, autonomy and support provided by the home environment more effectively, and to transform these external resources into their own abilities in goal management, resource coordination and behavioural adjustment. Conversely, students with lower AI literacy have relatively limited abilities in understanding, using and evaluating AI resources, and their capacity to further transform external support into learning resources and self-regulation resources may be somewhat constrained.

From the perspective of intentional self-regulation, this ability emphasises an individual's proactive coordination of resources in accordance with their own goals and environmental demands, whilst adjusting their behaviour through goal selection, goal optimisation and goal compensation (Wang & Gai, 2011). Students with higher AI literacy are able to utilise AI tools to access more information and learning resources, and to enhance their information processing and problem-solving abilities through human-computer collaboration (Carolus et al., 2023). Consequently, within an environment of parental autonomy support, higher AI literacy may enable students to make fuller use of the autonomy, information and support provided by their families, thereby enhancing their abilities in goal selection, goal optimisation and goal compensation, and further promoting the development of intentional self-regulation. It can thus be seen that AI literacy may not directly replace the role of parental autonomy support in students' self-regulation development, but rather influences the extent to which students transform external family support into internal self-regulation resources. Hence the hypothesis:

H3: AI literacy has a positive moderating effect between parental autonomy support and secondary vocational students' intentional self-regulation.

On further analysis, AI literacy moderated the relationship between parental autonomy support and intentional self-regulation, as well as the relationship between parental autonomy support and learning engagement, and the present study hypothesized that the mediating role of intentional self-regulation between parental autonomy support and learning engagement was also moderated by AI literacy. Hence the hypothesis:

H4: AI literacy moderates the indirect effect of parental autonomy support on learning engagement, i.e., the higher the level of AI literacy is, the higher the indirect effect of parental autonomy support on learning engagement through intentional self-regulation will be.

## 3 Methodology

### 3.1 Research framework

Construct the framework based on the assumptions, as shown in Figure 1 below:

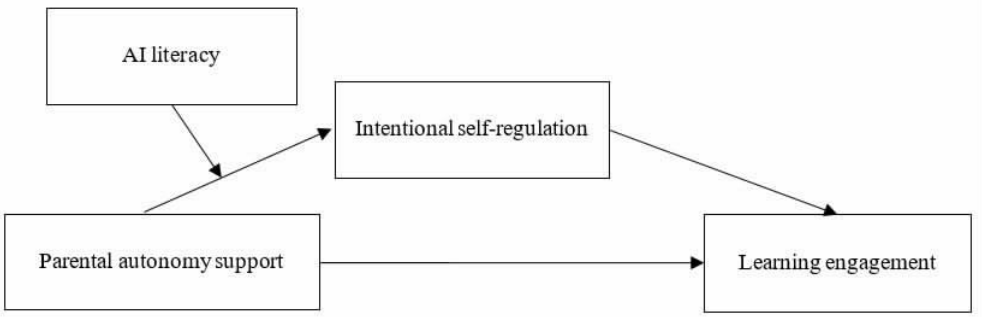



Figure 1. Research framework

### 3.2 Samples and procedures

The respondents were all vocational tourism students at secondary vocational schools in the Guangxi Zhuang

Autonomous Region of China. They were recruited through purposive sampling with the assistance of teachers from the relevant secondary vocational schools. The survey was conducted in September 2026, using purposive sampling and an online questionnaire to survey vocational tourism students at five secondary vocational schools in the Guangxi Zhuang Autonomous Region of China, measuring their perceptions of parental autonomy support, intentional self-regulation, learning engagement, and AI literacy. A total of 1,058 valid responses were obtained, representing a valid response rate of 88.16 percent. All respondents were current vocational tourism students enrolled in secondary vocational schools and participated in this study on an informed and voluntary basis.

### 3.3 Measures

Parental autonomy support scale: Developed by Wang et al. (2007), it comprises two factors: choice-making and opinion exchange, with a total of 12 items ($\alpha = 0.91$). It is defined as a positive parenting style in which parents respect their children's autonomy during their growth and learning, provide them with opportunities for independent choice and decision-making, actively listen to and accept their children's views and ideas, and encourage them to express their own wishes and participate in decision-making (Wang et al., 2007).

Intentional self-regulation scale: Designed by Chang et al. (2017), it comprises three dimensions: goal selection, goal optimisation and goal compensation, with a total of nine items ($\alpha = 0.85$). It is defined as a self-regulatory process whereby individuals, in order to achieve their own developmental goals, proactively select appropriate goals, optimise existing resources and strategies, and adopt alternative measures when faced with difficulties or resource constraints, thereby reconciling personal goals with environmental demands and promoting their own positive development (Chang et al., 2017).

AI literacy scale: Designed by Zhong and Liu (2025), it comprises three dimensions: AI knowledge, AI emotional intelligence and AI thinking, totalling 48 items ($\alpha = 0.954$). It is defined as an individual's comprehensive ability to understand the basic knowledge and technical principles of artificial intelligence, actively recognise the relationship between artificial intelligence and the individual and society, and apply relevant knowledge to analyse, judge, solve problems and engage in human-machine collaboration (Zhong & Liu, 2025).

Learning engagement scale: Designed by Fang et al. (2008), comprising three dimensions—vitality, dedication and focus—with a total of 17 items ($\alpha = 0.96$). It is defined as the positive, fulfilling and sustained psychological state exhibited by students during the learning process, specifically manifested as high levels of energy and psychological resilience whilst studying (vitality), enthusiasm for learning and a sense of its significance (dedication), and the ability to engage in learning activities with full concentration (focus) (Fang et al., 2008; Schaufeli et al., 2002).

Demographic variables included gender, age, year of study, field of specialisation, place of origin and family socio-economic status, which were used to control for relevant variables (Burns et al., 2021); the questionnaire employed a 5-point rating scale.

## 4 Results

### 4.1 Distribution of population traits

As shown in Table 1, the sample in this study consisted predominantly of female students, totalling (666, 62.95%); the majority were aged 17, totalling (415, 39.22%); and second-year students accounted for the highest proportion, totalling (374, 35.35%). In terms of programme distribution, the largest group comprised students studying Tourism Management, totalling (319, 30.15%), followed by those studying Tour Guide Services, totalling (281, 26.56%). In terms of place of origin, a high proportion of students came from rural areas, totalling (590, 55.77%). Furthermore, the majority of students had no practical experience in the tourism industry, totalling (632, 59.74%), whilst (426, 40.26%) had such experience.

Table 1. Distribution of population traits

| Variables | Category | N | % |
|---|---|---|---|
| Gender | Male | 392 | 37.05 |
| | Female | 666 | 62.95 |
| Grade | First Grade | 351 | 33.18 |
| | Second grade | 374 | 35.35 |
| | Third grade | 333 | 31.48 |
| Age | 15 and under | 82 | 7.75 |
| | 16 | 327 | 30.91 |
| | 17 | 415 | 39.22 |
| | 18 and over | 234 | 22.12 |
| Major | Tourism Management | 319 | 30.15 |
| | Tour Guiding Services | 281 | 26.56 |
| | Hotel Management | 249 | 23.54 |
| | Other Tourism-related Majors | 209 | 19.75 |
| Place of residence | Urban | 468 | 44.23 |
| | Rural | 590 | 55.77 |
| Practical experience in the tourism industry | Have | 426 | 40.26 |
| | No | 632 | 59.74 |

Note: n=1058.

### 4.2 Model fit

As shown in Table 2, the model has an SRMR=0.03, a good match.

Table 2. Root mean square error

| | O | M | 95% | 99% |
|---|---|---|---|---|
| Saturated model | 0.03 | 0.026 | 0.029 | 0.032 |
| Estimated model | 0.03 | 0.026 | 0.029 | 0.032 |

Note: n=1058.

### 4.3 Correlation analysis

The correlation matrix (Table 3) shows that the parental autonomy support was significantly correlated with learning engagement among vocational tourism students ($r=0.198^{***}$, $p<0.001$), and H1 is valid.

Table 3. Narrative and correlation coefficient matrix

| Variant | M | SD | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1. Parental autonomy support | 3.386 | 0.964 | 0.758 | | | |
| 2. Intentional self-regulation | 3.438 | 0.960 | 0.435 ** | 0.806 | | |
| 3. AI literacy | 3.421 | 0.771 | 0.324 ** | 0.358 ** | 0.799 | |
| 4. Learning engagement | 3.591 | 0.895 | 0.198 *** | 0.256 ** | 0.165 ** | 0.794 |
| α | | | 0.932 | 0.940 | 0.901 | 0.875 |
| CR | | | 0.664 | 0.74 | 0.939 | 0.722 |
| AVE | | | 0.576 | 0.63 | 0.618 | 0.611 |

Note: ***p<0.001.

### 4.4 Mediating and moderating effect analysis

The intentional self-regulation had a mediating effect (0.168 ***, p<0.001) on the path of parental autonomy support to learning engagement, and H2 holds (parental autonomy support→intentional self-regulation→learning engagement); AI literacy has a significant positive moderating effect in the pathway parental autonomy support to the intentional self-regulation (0.136 ***, p<0.001), and H3 holds (parental autonomy support×AI literacy→intentional self-regulation) (Table 4).

Table 4. Mediating and moderating effect analysis

| Effect | Path | Coefficients |
|---|---|---|
| Mediating | Parental autonomy support→ intentional self-regulation→ learning engagement | 0.168 *** |
| Moderating | Parental autonomy support×AI literacy → intentional self-regulation | 0.136 *** |

Note: ***p<0.001.

### 4.5 Moderated mediation effect analysis

This study used bootstrap as a validation tool for the process plugin, as shown in Table 5, the indirect effect of parental autonomy support through intentional self-regulation on learning engagement of secondary vocational students is significant (0.0921 ***, 0.1125 ***, 0.1271 **, p<0.001) at different levels of AI literacy, and H4 holds.

Table 5. Moderating mediating effect analysis

| Effect | Sobel test | | 95% CI | |
|---|---|---|---|---|
| | Indirect effect | SE | LLCI | ULCI |
| AI literacy (low) | 0.0921 | 0.0316 | 0.0857 | 0.2641 |
| AI literacy (medium) | 0.1125 | 0.0372 | 0.1024 | 0.3168 |
| AI literacy (high) | 0.1271 | 0.0512 | 0.1083 | 0.3924 |

Note: ***p<0.001.

## 5 Discussion

### 5.1 Discussion, conclusion and proposal

The results indicate that parental autonomy support is positively correlated with learning engagement among vocational tourism students at secondary vocational colleges. This finding is consistent with previous research concluding that parental autonomy support promotes learning engagement (Vasquez et al., 2016; Jiang et al., 2022). As parents who provide autonomy-supportive parenting respect their children's autonomy and satisfy their basic psychological needs, thereby stimulating their intrinsic motivation to learn (Wang et al., 2007; Peng et al., 2021), an increase in the level of parental autonomy support helps vocational tourism students at secondary vocational schools demonstrate higher levels of learning engagement. This finding is further supported by the arguments put forward in self-determination theory regarding the fulfilment of basic psychological needs as a driver of intrinsic motivation, in developmental systems theory regarding the role of external resources in supporting individual development, and in the triadic interaction theory regarding the influence of the environment on behaviour (Bandura, 1986; Lerner et al., 2005; Wang et al., 2007).

The results indicate that intentional self-regulation plays a significant mediating role between parental autonomy support and learning engagement. This finding is consistent with research conclusions that intentional self-regulation serves as an important mediating variable through which external resources influence an individual's

developmental adaptation (Zhou et al., 2022). This is because parents who provide parental autonomy support offer their children more opportunities for autonomous exploration and self-regulation, thereby promoting the development of their intentional self-regulation abilities; in turn, higher levels of intentional self-regulation enable individuals to adjust their learning strategies in line with their goals and maintain their learning engagement (Wang & Gai, 2011; Stefansson et al., 2018). Consequently, intentional self-regulation acts as a mediating factor between parental autonomy support and learning engagement. This finding is further supported by developmental systems theory and the triadic interaction model (Bandura, 1986; Lerner et al., 2005).

The results indicate that AI literacy positively moderates the relationship between parental autonomy support and intentional self-regulation among vocational tourism students in the Guangxi Zhuang Autonomous Region of China; that is, the higher the level of AI literacy is, the stronger the promotional effect of parental autonomy support on intentional self-regulation will be. This finding is consistent with recent research conclusions regarding the role of AI literacy in promoting the development of students' digital learning, problem-solving and metacognitive abilities (Kong et al., 2024; Zhong & Liu, 2025; Lin et al., 2025). Students with higher AI literacy possess stronger abilities to understand, utilise, and evaluate artificial intelligence; they are able to make more effective use of digital resources to access information, solve problems, and plan their learning. Consequently, when receiving parental autonomy support, they are better able to transform external support into their own goal management and behavioural adjustment capabilities. Conversely, students with lower AI literacy have relatively limited abilities in utilising smart technologies and digital resources, and the promotional effect of parental autonomy support on their intentional self-regulation may be relatively weak. This finding suggests that students' own digital literacy may constitute an important boundary condition through which the family environment influences their development.

Further analysis of moderating and mediating effects revealed that AI literacy may modulate the influence of parental autonomy support on intentional self-regulation, thereby altering the indirect effect of parental autonomy support on learning engagement. Specifically, the higher the level of AI literacy is, the more parental autonomy support facilitates the development of students' intentional self-regulation abilities, thereby enhancing their level of learning engagement. This suggests that the impact of parental autonomy support on the learning engagement of vocational tourism students is not only related to the external support provided by the family environment but may also be influenced by the students' own levels of AI literacy. This finding further reveals the interrelationship between family support, individual self-regulation resources, and AI literacy, providing a new perspective for understanding the mechanisms underlying the formation of learning engagement among vocational tourism students in the context of artificial intelligence.

### 5.2 Research contribution

This study contributes to the field of parental autonomy support and the academic development of secondary vocational students. Firstly, this study extends research on parental autonomy support to vocational tourism students and identifies its influence on learning engagement, and also finds that intentional self-regulation plays a mediating role and AI literacy plays a moderating role in the above-mentioned relationship. This advances the understanding of the antecedents of learning engagement and also expands the mechanisms of its formation, which is important for the future long-term development of vocational tourism students in China.

### 5.3 Limitations and directions

Firstly, the sample size of this study is less than 2,000 and was conducted only in Guangxi Zhuang Autonomous Region, China, and the conclusions may not be widely generalizable. Therefore, it is suggested that future studies could further expand the sample size or select other regions in China for comparative analyses, thus enhancing the adaptability of the study.

Secondly, this study only chose parental autonomy support as the antecedent, with intentional self-regulation and AI literacy as the underlying mechanisms, which is not yet able to fully capture the antecedents and facilitators affecting secondary vocational students' digital learning and learning engagement. Therefore, future research could further explore other antecedents and process mechanisms, such as digital family capital, teachers' autonomy support, and peer support, and adopt a longitudinal tracking design to examine the dynamic causal relationships among these variables, so as to further advance research on the academic development of secondary vocational students.

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