

Full Length Research Paper

Research on metacognition and innovation behavior of vocational college students in Hainan

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Strengthening the cultivation of students' innovation ability is an urgent requirement for the construction of China's innovation system, and vocational colleges are a crucial driving force for cultivating technical innovation talents. Therefore, this study aims to explore the influence of metacognition on innovative behavior among vocational college students in Hainan, China and the differences between the behavior of boys and girls. Five vocational colleges were selected by purposive sampling. A total 600 students and 577 valid questionnaires were obtained, with 285 male and 292 female respondents. The results of the study found that the metacognition of boys and girls in vocational colleges has a positive and substantial impact on innovative behavior, and that the effect of metacognition on the innovative behavior of girls is higher than that of boys.

Key words: Vocational school students, metacognition, innovative behavior.

INTRODUCTION

Strengthening the cultivation of students' innovation ability is urgently required to construct China's innovation system and an important measure to promote higher education reform and higher-quality innovation of college graduates (Jia and Wang, 2018). Education is an essential core of cultivating innovative ability and innovative skills development. Innovative skills are skills that students must prepare for in the face of increasingly complex living and working environments (Keinänen et al., 2018). Therefore, college students need to have innovative abilities, and higher education is essential in cultivating college students' innovative skills

(Ovbiagbonhia et al., 2019).

In their research, Kim and Lee (2018) pointed out that metacognition is a critical dominant factor in enhancing innovative behavior because it involves planning, monitoring, and regulating specific actions to create and introduce new ideas. Schraw and Dennison (1994) defined metacognition as "the ability to reflect on, understand, and control one's learning." Metacognition is described as thoughts about one's knowledge and control over one's cognitive processes and includes both awareness of cognition and understanding of strategies to change cognition (Flavell, 1979). Kuhn (2000) noted

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that metacognition developed early and asserted that the more explicit metacognitive thinking is, the more effectively can one engage in metacognitive thinking and control cognitive processes.

However, when people face a new situation, they go through a social cognitive process in which they recognize available alternatives (Martinsen et al., 2011). Some people are more cognitively flexible than others, who can only remember one suitable option. In addition, higher cognitive flexibility is adapted more actively by exploring and selecting various ways of effective adaptation (Rubin and Martin, 1994). Students' metacognition can also improve their innovative behavior (Ericsson, 1996; Kim and Lee, 2018). Therefore, understanding the influence of students' metacognition on innovative behavior is of great significance to developing students' innovative behavior.

Relationship between metacognition and innovative behavior

Flavell (1979) proposed the concept of metacognition and defined metacognition as knowledge or cognitive activities that reflect or regulate any aspect of mental conditioning, which is "cognition about cognition" (Sternberg, 1994). Learning is a lifelong and thinking process in which the most important structure is an individual's awareness of his own learning and learning process, in other words, an individual's metacognition (Goksu, 2021). Metacognition is the ability to think about our thoughts, and to be more precise, evaluate our thoughts' views (Goksu, 2021). This paper defines metacognition as the psychological process of self-awareness and self-regulation of one's cognitive activities. The macroscopic thinking process of metacognition includes critical thinking, creative and reflective thinking, and problem-solving. Metacognitive skills are part of this process, along with metacognitive knowledge. The sub dimensions of metacognitive skills include oriented activities, systems sequence, evaluation, and refinement activities (Prins et al., 2006).

Drucker (1985) pointed out that innovation is to endow resources with a new ability to create wealth and turn resources into natural resources. It emphasizes the benefits of innovation and a complete and systematic system. Innovation is not a stroke of the sky. They are learning through educational methods. Innovation is a complex process of generating, promoting, and implementing new ideas (Brown and Duguid, 1991; Kazadi et al., 2016). Students' innovative behavior is the process in which they generate innovative ideas and strive to put them into practice in learning and participating in learning activities. A lack of intrinsic motivation to exhibit innovative behavior can lead to individual differences in innovative behavior. Those endowed with inherent reason are learning-oriented and

free from stereotypes, wherein they try to acquire new options and ideas for problem-solving (Kim and Lee, 2018).

During the learning process, student cognition critically impacts learning outcomes (Chang and Tsai, 2022). In the teaching process, the cultivation of cognitive strategies runs through all aspects of information processing, which will help the improvement and development of students' metacognition level (Nie and Xu, 2001); Teachers should guide students to use their metacognition to consciously monitor and adjust the learning process, which is not only conducive to mobilizing students' enthusiasm for learning but also conducive to improving their thinking quality and promoting the development of their intelligence. Metacognition plays a vital role in enhancing learning ability. It is of great significance to improve the learning effect and to pay attention to cultivating students' metacognition ability in the teaching of new chemistry courses, improving their metacognition level, enabling them to master the relevant theories of metacognition, and applying metacognition theory to learning reflection (Ma, 2009). Moreover, effective metacognitive strategies can improve students' academic performance (Anthonysamy, 2021).

Moreover, students who have received metacognitive instructions will acquire entrepreneurial skills faster than those who have not (Mitchell et al., 2006). Metacognition means learning strategies for active, innovative behaviors such as self-directed learning. For an individual to have the ability to set and implement goals, they need a mechanism to monitor and control the dreams themselves. In the case of self-directed learning, a voluntary program assumes that metacognition must precede an individual's strategic behavior to enable autonomous learning through cognitive traits (Bae and Lee, 2010). Moreover, Cognition and metacognition are essential components in the creative process of generating, evaluating, and selecting ideas (Puentes-Díaz et al., 2021). Metacognition is the most crucial dominant factor in strengthening innovative behavior because it involves planning, checking, and controlling specific actions in creating and introducing new ideas (Janssen, 2000). In addition, reflective evaluation introduces metacognitive processes and strategies such as monitoring, reflection, and planning into students' creative practice activities, pays attention to the students' subjective status and initiative in the evaluation process, and enables students to continuously cooperate with the learning process and results. Monitoring and reflection encourage students to constantly solve deeper problems, create knowledge (Yang et al., 2016), and help them to generate innovative behaviors.

This study intends to explore the influence of metacognition on the innovative behavior of students in vocational colleges in Hainan, China, and investigates the difference between the impact of metacognition of

Table 1. Descriptive statistics of variables.

Variable	Metacognition	Innovative behaviors
Boys	3.355	3.371
Girls	3.305	3.292
All	3.330	3.331

Source: Author.

boys and girls on innovative behavior.

MATERIALS AND METHODS

Research objects and sampling

This study mainly explores the influence of metacognition on the innovative behavior of students in vocational colleges in Hainan, China. It separately investigates boys and girls to understand whether there is a difference in the impact of metacognition on their innovative behavior. The research participants in Hainan, China are students from vocational colleges. These colleges focus on training students to become applied professionals, with the majority of graduates entering the job market. Hence, innovation behavior is significant for vocational colleges. Five vocational colleges in Hainan, China, were selected through purpose sampling, surveying 60 boys and 60 girls in each of the colleges (total, 600 students). With invalid questionnaires eliminated, a total of 577 valid questionnaires were obtained, with 285 male and 292 female respondents.

Research instruments

The metacognition scale constructed by Manzar et al. (2018) was used, which includes nine questions for two dimensions, namely, metamemory (5 questions) and meta-attention (4 questions). The 5-point Likert scale was used to assess the level of metacognition on a scale of 1–5 points. In terms of the reliability analysis, the Cronbach's α was .887. Furthermore, confirmatory factor analysis (CFA) was conducted to test the metacognition scale. The factor loading for all questions was between .623 and .774.

The construct reliability (CR) value was 0.901, exceeding the evaluative criteria of 0.60. The average variance extracted (AVE) value was .503, exceeding the evaluative criteria of .50. This indicates that the scale has a high level of discrimination. As for the goodness of fit test of the scale, $\chi^2/df = 5.675$, RMSEA = 0.090, GFI = 0.944, AGFI = 0.903, SRMR = 0.0408, CFI = 0.944, IFI = 0.945, NFI = 0.934, PNFI = 0.674, and PGFI = 0.545 (Bagozzi and Yi, 1988), which indicate that the scale has a satisfying goodness of fit.

The innovative behavior scale constructed by Chang and Jaisook (2021) was used, which includes nine questions for the following three dimensions: "opportunity exploration," "generativity and formative investigation," and "championing and application." The 5-point Likert scale was used to assess the level of innovative behaviors on a scale of 1–5 points. In terms of the reliability analysis, the Cronbach's α was 0.932. CFA was conducted to test the innovative behaviors scale. The factor loading for all questions was between .661 and 0.840. The CR value was .948, exceeding the evaluative criteria of 0.60. The AVE value was 0.624, exceeding the evaluative criteria of .50. This indicates that the scale has a high level of discrimination. As for the goodness of fit test of the scale, $\chi^2/df = 5.205$, RMSEA = 0.085, GFI = 0.936, AGFI = 0.898, SRMR = 0.0347, CFI = 0.957, IFI = 0.957, NFI = 0.948, PNFI = 0.707, and PGFI = 0.582 (Bagozzi and Yi, 1988), which indicate that the scale

has a satisfying goodness of fit.

RESULTS AND DISCUSSION

Descriptive statistical analysis

The average score of metacognition and innovative behavior of students in vocational colleges can be seen from the descriptive statistics in Table 1. Students' average score of metacognitions is 3.330, and the average score of innovative behavior is 3.331. The average number of metacognition of boys (3.355) was higher than the average number of metacognition of girls (3.305), and the average number of innovative behaviors of boys (3.371) was also higher than the average number of innovative behaviors of girls (3.292).

SEM analysis

Male students

The overall adaptability test of the overall model for male students was conducted. Measures of absolute fit χ^2/df , 4.025; RMSEA, 0.103; GFI, 0.803; and SRMR 0.0574 were close to the criterion value of 0.05 (Hu and Bentler, 1999). Incremental fit measures, namely, CFI, IFI, NFI, and NNFI were 0.861, 0.862, 0.824, and 0.800, respectively. Parsimonious fit measures, namely, PCFI, PNFI, and PGFI were 0.757, 0.724, and 0.639, respectively. As such, the fit between the theoretical model and observation data is acceptable (Table 2).

As seen from Figure 1, the path coefficients the structural between metacognition and innovative behavior is 0.831 ($p < 0.05$). It means that the metacognition of male students was a positive and significant impact on innovative behavior, and when the students' metacognition is higher, the innovative behavior also increases.

Female students

The overall adaptability test of the overall model for female students was conducted. Measures of absolute fit, namely, χ^2/df , 3.436; RMSEA, .091; GFI, .830; and SRMR, .0498, were close to the criterion value of 0.05 (Hu and Bentler, 1999). Incremental fit measures, namely, CFI, IFI, NFI, and NNFI were 0.882, 0.883, 0.843, and

Table 2. Suitability indicators of the models.

Identify items	Male students	Female students
χ^2/df	4.025	3.436
RMSEA	0.103	0.091
SRMR	0.0574	0.0498
GFI	0.803	0.830
AGFI	0.752	0.786
NFI	0.824	0.843
NNFI	0.800	0.821
IFI	0.862	0.883
CFI	0.861	0.882
PCFI	0.757	0.776
PNFI	0.724	0.741
PGFI	0.639	0.660

Source: Author.

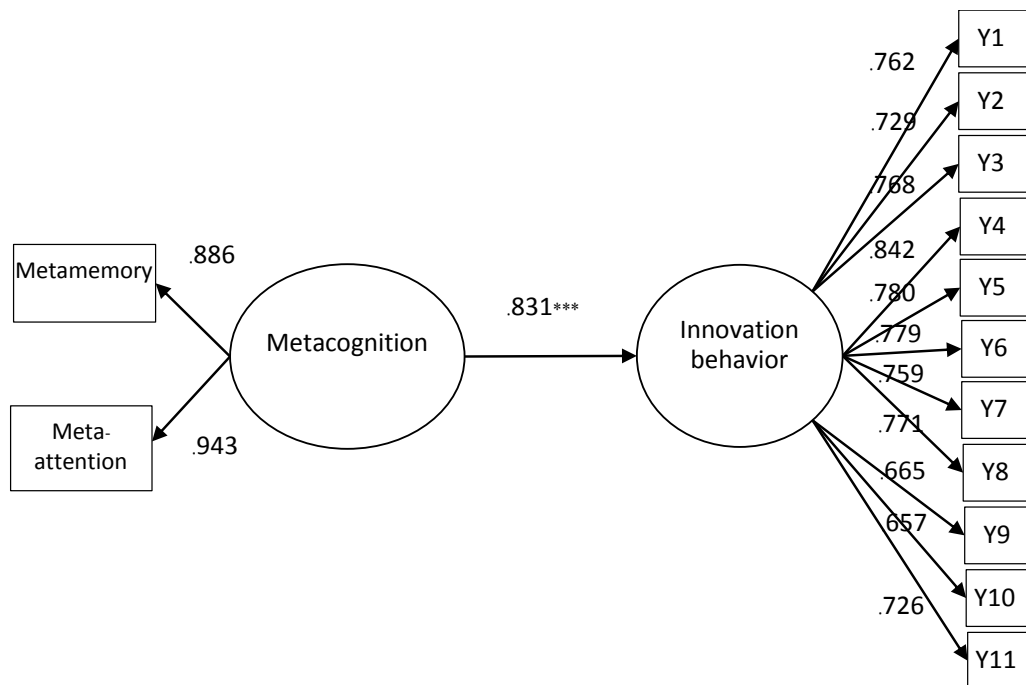


Figure 1. Analysis of male students' metacognition on innovation behavior path *** $p < 0.001$. Source: Author.

0.821, respectively. Parsimonious fit measures, namely, PCFI, PNFI, and PGFI were 0.776, 0.741, and 0.660, respectively. As such, the fit between the theoretical model and observation data is acceptable (Table 2).

As seen from Figure 2, the path coefficients the structural between metacognition and innovative behavior is 0.898 ($p < 0.05$). It means that the metacognition of female students has a positive and significant impact on innovative behavior, and when students' metacognition improves, it is conducive to innovation behavior

improvement.

Conclusion

The research results show that the metacognition of boys and girls in higher vocational colleges has a positive and significant impact on innovative behavior, which means that higher metacognition of students in higher vocational colleges, will result in higher innovative behavior. In

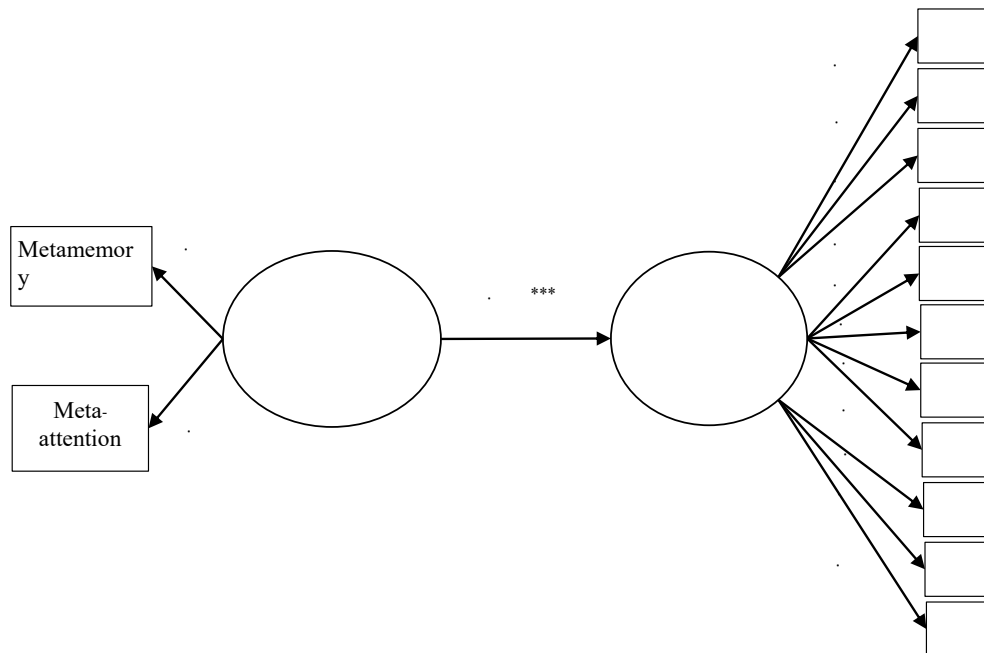


Figure 2. Analysis of female students' metacognition on innovation behavior path *** $p < 0.001$.
Source: Author.

addition, the improvement of students' metacognition in vocational colleges is conducive to developing their innovative behavior. This result is consistent with the research results of Ericsson (1996) as well as Kim and Lee (2018).

In terms of metacognition, students in higher vocational colleges can concentrate in class, read, participate in lectures and internships, can understand all concepts and practical cases taught in class, remember some critical specific concepts from teachers, and be able to use these concepts in exams or tests, such as metacognitive memory and attention ability, so that you can help yourself to cut into the core of the problem from more angles, propose new methods to solve problems and make innovative ideas come true. In addition, Georgsdottir and Getz (2004) also believe that cognitively flexible people can find ways from new perspectives, propose innovative solutions in various ways, and find new solutions and when students recognize that they have opportunities to develop their abilities, they can engage in innovative activities (Goldsby et al., 2006). Therefore, students in higher vocational colleges should strengthen their metacognitive abilities, such as metamemory and meta-attention, to obtain more professional knowledge and abilities in professional learning and propose new solutions from different angles when encountering problems.

However, in terms of path analysis, girls (0.898) have a more significant impact on innovative behavior than boys (0.831), which means that girls' metacognition is more

helpful to innovative behavior than boys. However, from descriptive statistical analysis, it can be found that the average scores of metacognition and innovative behavior of girls are lower than boys; thus, improving the metacognition of female students is more important.

Therefore, students in higher vocational colleges should concentrate in class, understand and remember all the concepts and practical cases taught by the teacher in the classroom and other essential concepts, and apply these concepts in the test or practice. Cognitive memory and attention ability can propose innovative solutions, find new solutions, and make innovative ideas come true.

Research contributions and research implications

This study found from the results of the influence of metacognition on the innovative behavior of students in vocational colleges in Hainan, China, that both boys' and girls' metacognition can improve their innovative behavior, which shows the importance of metacognition for vocational colleges students' innovative behavior. However, the influence of girls' metacognition on innovative behavior is higher than that of boys. On the other hand, the overall average score of girls' metacognition is lower than that of boys, which is worth noting. Vocational colleges should enhance the metacognition of female students. Moreover, it can be seen from this that metacognition is a critical factor that must be paid attention to, whether in the actual

development of students' innovative behavior in Chinese vocational colleges or related research.

Research limitations

This study aims to investigate Vocational College Students in China, but only 5 Vocational Colleges in Hainan were investigated, and the research results may not extrapolate to other regions. Therefore, it is suggested that future research investigate different regions or different types of Vocational Colleges.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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