Impact of Metacognitive Reading Strategies and Reading Literacy

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Scientific literacy refers to an individual's ability to engage in science-related activities, such as describing scientific phenomena, analyzing and planning scientific investigations and processing data and evidence scientifically.

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1. The Impact of Metacognitive Reading Strategies

Different scholars put forward different definitions of metacognition, but they all include two key features, control and knowledge, about cognitive states and processes. The former refers to the use of metacognitive strategies, while the latter includes personal knowledge, task knowledge and strategy knowledge. Flavell (1979) first proposed the concept of metacognition and defined it as the awareness of one's cognitive processes and products, as well as the control and regulation of these mental activities and strategies. Schraw and Dennison (1994) believed that metacognition included metacognitive knowledge and metacognitive skills. Metacognitive knowledge refers to individual cognition, including declarative knowledge, procedural knowledge and conditional knowledge. Declarative knowledge is the factual knowledge and information that an individual knows, procedural knowledge is the knowledge that an individual knows how to perform certain activities, and conditional knowledge is the knowledge that an individual knows when and how to allocate resources when reusing declarative and procedural knowledge. Metacognitive skills include planning, monitoring and evaluating, which can be applied to reading-related tasks (Jacobs and Paris 1987). Planning refers to the selection of appropriate strategies and the effective allocation of resources to complete the task, monitoring refers to the observation of the progress of the task and the identification of the target for optimal performance, and evaluation refers to the assessment of the efficiency of the adjustment process and the completion of the task. According to Alexander (2008), metacognition consisted of three parts: students should make a plan before reading, monitor their understanding of the text during the process, choose appropriate strategies to deal with the text when encountering different problems and evaluate their thinking after reading. Zimmerman proposed the concept of self-regulated learning on the basis of metacognition, taking into account the regulation of behavior and motivation. Self-regulated learning refers to the process in which learners actively participate in their own learning activities from metacognitive, motivational and behavioral aspects to a certain extent (Zimmerman 1989). More and more researchers and practitioners attach importance to teaching students self-regulation learning strategies in the classroom (Schraw et al. 2006).

Brown first introduced the concept of metacognition into the field of reading, believing that the process of reading involved strategic knowledge and actions (Brown 1980). Metacognitive reading strategies refer to students' cognition and judgment of reading strategies (Callan et al. 2017), which are used to assess the extent to which students recognize the most effective reading strategies in different reading tasks. Many researchers believe that students with more metacognitive reading strategies are more strategic and aware of reading strategies in science reading, and they are more likely to monitor their understanding and use effective reading strategies in context (Fang and Wei 2010; O'Reilly and McNamara 2007), such as reading comprehension, text summary, reasoning, etc. On the contrary, the lack of metacognitive reading strategies can explain the inability of many young learners to become effective readers. Effective readers are often thought to be strategic or constructively responsive because they efficiently allocate cognitive resources while reading (Teng 2020). However, some researchers believe that young learners do not possess metacognitive knowledge or skills, thus making metacognitive teaching ineffective (Williams and Atkins 2009). Another explanation is that the executive function of children is limited and they are unable to effectively coordinate various cognitive processes to complete tasks. Students' learning and reflections on reading strategies will contribute to their metacognitive reading strategies, so the National Science Foundation of the United States and education researchers attach great importance to integrating reading strategies teaching into science classrooms. Fang et al. (2008) carried out an experiment on integrating reading strategies teaching into a science classroom in middle school. They worked with a school with 10 Grade 6 classes, and randomly chose six classes to act as the experimental group and four classes to act as the control group. The experimental group received one lesson per week that covered a different reading strategy, including 22 science lessons that covered reading strategies and two lessons that covered strategies summaries and reflection. However, the control group continued with the regular science teaching. The results of their practice showed that the scientific literacy of students in the science class integrated with the reading strategies teaching was more significantly improved than that in the control class.

The Programme for International Student Assessment in 2018 (PISA 2018) divides metacognitive reading strategies into three sub-dimensions: metacognitive understanding and remembering strategies, metacognitive summarizing strategies and metacognitive assessing credibility strategies (OECD 2019). The metacognitive understanding and remembering strategies measure students' awareness and ability to use effective strategies when they are completing the task of understanding and remembering the content of the article. The metacognitive summarizing strategies measure students' awareness and ability to use effective strategies when they are completing the task of information summarization. The metacognitive assessing credibility strategies measure students' awareness and ability to use effective strategies to identify suspicious or uncertain information, such as sourcing and corroboration. In different text-reading situations, learners often have a variety of reading strategies to choose from. For learners skilled in different tasks, they have metacognitive reading strategies corresponding to each sub-field. They master how to choose the most suitable and efficient reading strategies to solve different tasks. Callan et al. (2017) investigated the mediating role of metacognitive reading strategies in the relationship between socioeconomic status and reading, mathematics and scientific literacy by taking the PISA 2009 data as samples, and they found that metacognitive summarizing strategies had a greater impact on scientific literacy than metacognitive understanding and remembering strategies. Metacognitive assessing credibility strategies were not evaluated until the PISA 2018, so they had not appeared in the PISA 2009.

Although metacognitive reading strategies are mainly about the cognitive ability of reading strategies, their application in other fields is limited (Salomon and Perkins 1989; Stebner et al. 2022). However, no matter which field, text is its main form of expression, which requires students to have the ability to process the text in the specific field. In particular, various phenomena and laws in science will be recorded in the form of text (Fang et al. 2008), so metacognitive reading strategies can also play an important role in the understanding of scientific concepts and argumentations. O'Reilly and McNamara (2007) tested the relationship between subject knowledge, reading skills, metacognitive reading strategies and science achievement among 1651 high school students. The results showed that students' metacognitive reading strategies could compensate for the deficiency of subject knowledge to some extent and promote students' science achievement. Sperling et al. (2012) investigated the relationship between metacognitive strategies knowledge and scientific achievement in 97 Grade 7 students. The results showed that students' metacognitive strategies knowledge was an important predictor of their scientific achievement.

2. The Role of Reading Literacy and Reading Self-Efficacy

Students' reading literacy is predicted by metacognitive reading strategies, and there is a close relationship between reading literacy and scientific literacy. Reading literacy is understanding, using, evaluating, reflecting on and engaging with texts in order to achieve one's goals, to develop one's knowledge and potential and to participate in society (OECD 2019). It can be assessed by reading ability because it can be viewed as an expanding set of knowledge, skills and strategies. Thus, reading literacy is related to the comprehensive application of metacognitive reading strategies. Based on the data of 3289 middle school students in the German NEPS database, Miyamoto et al. (2019) tested the mediating relationship between metacognitive reading strategies and students' intrinsic motivation and reading comprehension ability, and the results showed that metacognitive reading strategies can significantly affect students' reading literacy. Phakiti (2003) examined the relationship between English reading cognition and metacognitive strategies and reading achievement of 384 Thai college students, and the results showed that the use of metacognitive reading strategies was positively correlated with reading achievement, and high-reading achievers reported more metacognitive strategies than medium-reading achievers. In addition, the relationship between reading literacy and scientific literacy was also examined by researchers. Zhu (2022) analyzed the relationship between reading literacy and scientific literacy based on the PISA 2018 database, and the results showed that reading literacy was an important predictor of scientific literacy, and the effect of reading literacy on scientific literacy was far greater than that of mathematics literacy on scientific literacy. However, other studies have shown different results. Caponera et al. (2016) analyzed the impact of Italian students' reading literacy on scientific literacy based on the TIMSS database, and the results showed that there was no apparent relationship between reading literacy and scientific literacy.

In addition to the above cognitive ability in reading, the non-cognitive ability of reading self-efficacy is also worthy of attention in science reading. Self-efficacy, proposed by American psychologist Bandura (1986), is an individual's subjective judgment on whether he can successfully carry out a certain achievement behavior. Self-efficacy is a domain-specific concept, so it is often preceded by a specific domain and is often closely related to the competence in that domain. Reading self-efficacy refers to students' evaluation of their reading ability. There is a one-way or reciprocal relationship between self-efficacy and ability, according to many different models, including the skill development model, the self-enhancement model, the reciprocal causality model, and so on (Chen et al. 2015). However, previous studies focused on the impact of self-efficacy on the use of reading strategies and found that students with higher self-efficacy were more willing to use reading strategies (Walker 2003). However, what this research focuses on is students' cognition of the effectiveness of reading strategies. Metacognitive and Affective model of Self-Regulated Learning (MASRL model) showed that students' metacognitive strategies could affect students' self-efficacy and further affect students' cognitive ability (Efklides 2011). This was mainly because students with metacognitive reading strategies mastered the strategies to process texts in different tasks, they would also have more confidence in their reading skills, and promoted the development of reading literacy.

3. Gender Difference in Reading and Science

The gender difference of students' academic ability has always been an important issue in education. Although the gender gap in academic ability has narrowed or even reversed in recent years (Miller and Halpern 2014), gender differences were still found. In science subject, for example, boys' and girls' achievement in fairs was comparable, but boys outperformed girls at the Olympiads (Steegh et al. 2019). In reading comprehension, girls performed better than boys (Mau and Lynn 2000), and boys were more prone to dyslexia. When it came to the application of strategies, girls were better than boys (Callan et al. 2017; Slotte et al. 2001). The above differences may be due to the biological structure of male and female, but in addition to biological differences, sociocultural stereotypes were thought to reinforce these gender differences (Espinoza and Strasser 2020). Students would think that girls would definitely perform well in reading comprehension than boys (Nowicki and Lopata 2017), and girls would experience more difficulty to achieve good scientific literacy than boys. This stereotype would have different effects on the academic development of boys and girls, and also affected the path of reading related ability to scientific literacy.

References

1. Flavell, John H. 1979. Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. American Psychologist 34: 906.
2. Schraw, Gregory, and Rayne Sperling Dennison. 1994. Assessing Metacognitive Awareness. Contemporary Educational Psychology 19: 460–75.
3. Jacobs, Janis E., and Scott G. Paris. 1987. Children's Metacognition About Reading: Issues in Definition, Measurement, and Instruction. Educational Psychologist 22: 255–78.
4. Alexander, Patricia A. 2008. Why This and Why Now? Introduction to the Special Issue on Metacognition, Self-Regulation, and Self-Regulated Learning. Educational Psychology Review 20: 369–72.

5. Zimmerman, Barry J. 1989. A social cognitive view of self-regulated academic learning. Journal of Educational Psychology 81: 329–39.
6. Schraw, Gregory, Kent J. Crippen, and Kendall Hartley. 2006. Promoting Self-Regulation in Science Education: Metacognition as Part of a Broader Perspective on Learning. Research in Science Education 36: 111–39.
7. Brown, Ann L. 1980. Metacognitive Development and Reading. In Theoretical Issues in Reading Comprehension. New York: Routledge.
8. Callan, Gregory L., Gregory J. Marchant, W. Holmes Finch, and Lindsay Flegge. 2017. Student and school SES, gender, strategy use, and achievement. Psychology in the Schools 54: 1106–22.
9. Fang, Zhihui, and Youhua Wei. 2010. Improving Middle School Students' scientific literacy Through Reading Infusion. The Journal of Educational Research 103: 262–73.
10. O'Reilly, Tenaha, and Danielle S. McNamara. 2007. The Impact of Science Knowledge, Reading Skill, and Reading Strategy Knowledge on More Traditional "High-Stakes" Measures of High School Students' Science Achievement. American Educational Research Journal 44: 161–96.
11. Teng, (Mark) Feng. 2020. The benefits of metacognitive reading strategy awareness instruction for young learners of English as a second language. Literacy 54: 29–39.
12. Williams, Joanna P., and J. Grant Atkins. 2009. The Role of Metacognition in Teaching Reading Comprehension to Primary Students. In Handbook of Metacognition in Education. New York: Routledge.
13. Fang, Zhihui, Linda Lamme, Rose Pringle, Jennifer Patrick, Jennifer Sanders, Courtney Zmach, Sara Charbonnet, and Melissa Henkel. 2008. Integrating Reading into Middle School Science: What we did, found and learned. International Journal of Science Education 30: 2067–89.
14. OECD. 2019. PISA 2018 Assessment and Analytical Framework. Paris: Organisation for Economic Co-Operation and Development. Available online: https://www.oecd-ilibrary.org/education/pisa-2018-assessment-and-analytical-framework_b25efab8-en (accessed on 12 December 2022).
15. Salomon, Gavriel, and David N. Perkins. 1989. Rocky Roads to Transfer: Rethinking Mechanism of a Neglected Phenomenon. Educational Psychologist 24: 113–42.
16. Stebner, Ferdinand, Corinna Schuster, Xenia-Lea Weber, Samuel Greiff, Detlev Leutner, and Joachim Wirth. 2022. Transfer of metacognitive skills in self-regulated learning: Effects on strategy application and content knowledge acquisition. Metacognition and Learning 17: 715–44.
17. Sperling, Rayne A., Aaron S. Richmond, Crystal M. Ramsay, and Michael Klapp. 2012. The Measurement and Predictive Ability of Metacognition in Middle School Learners. The Journal of Educational Research 105: 1–7.

18. Miyamoto, Ai, Maximilian Pfost, and Cordula Artelt. 2019. The Relationship Between Intrinsic Motivation and Reading Comprehension: Mediating Effects of Reading Amount and Metacognitive Knowledge of Strategy Use. Scientific Studies of Reading 23: 445–60.
19. Phakiti, Aek. 2003. A closer look at the relationship of cognitive and metacognitive strategy use to EFL reading achievement test performance. Language Testing 20: 26–56.
20. Zhu, Yuanze. 2022. Reading matters more than mathematics in science learning: An analysis of the relationship between student achievement in reading, mathematics, and science. International Journal of Science Education 44: 1–17.
21. Caponera, Elisa, Paolo Sestito, and Paolo M. Russo. 2016. The influence of reading literacy on mathematics and science achievement. The Journal of Educational Research 109: 197–204.
22. Bandura, Albert. 1986. Social Foundations of Thought and Action. Englewood Cliffs: Prentice-Hall, Inc., pp. 23–28.
23. Chen, Bryan H., Wan-Ching Chiu, and Chih-Chuan Wang. 2015. The relationship among academic self-concept, learning strategies, and academic achievement: A case study of national vocational college students in Taiwan via SEM. The Asia-Pacific Education Researcher 24: 419–31.
24. Walker, Barbara J. 2003. The cultivation of student self-efficacy in reading and writing. Reading & Writing Quarterly 19: 173–87.
25. Efklides, Anastasia. 2011. Interactions of Metacognition with Motivation and Affect in Self-Regulated Learning: The MASRL Model. Educational Psychologist 46: 6–25.
26. Miller, David I., and Diane F. Halpern. 2014. The new science of cognitive sex differences. Trends in Cognitive Sciences 18: 37–45.
27. Steegh, Anneke M., Tim N. Höffler, Melanie M. Keller, and Ilka Parchmann. 2019. Gender differences in mathematics and science competitions: A systematic review. Journal of Research in Science Teaching 56: 1431–60.
28. Mau, Wei-Cheng, and Richard Lynn. 2000. Gender differences in homework and test scores in Mathematics, Reading and Science at tenth and twelfth grade. Psychology, Evolution & Gender 2: 119–25.
29. Slotte, Virpi, Kirsti Lonka, and Sari Lindblom-Ylänne. 2001. Study-strategy use in learning from text. Does gender make any difference? Instructional Science 29: 255–72.
30. Espinoza, Ana María, and Katherine Strasser. 2020. Is reading a feminine domain? The role of gender identity and stereotypes in reading motivation in Chile. Social Psychology of Education 23: 861–90.

31. Nowicki, Elizabeth A., and Joel Lopata. 2017. Children’s implicit and explicit gender stereotypes about mathematics and reading ability. Social Psychology of Education 20: 329–45.