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A Developmental Analysis of Cognitive/Metacognitive Skills in Male and Female Students in Mashhad

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ABSTRACT

Purpose: The present study aimed to compare cognitive and metacognitive skills among students in Mashhad.

Methods and Materials: This research employed a non-experimental comparative design. The statistical population comprised male and female students in two age groups (10–12 and 13–15 years) from the seven districts of Mashhad in 2023, totaling 4,618 students. The sample size was determined using Cochran's formula, resulting in a sample of 355 students, who were selected through multi-stage cluster sampling. Data were collected using the Cognitive and Metacognitive Strategies Questionnaire by Dawson and McInerney (2004). Independent sample *t*-tests and multivariate analysis of variance (MANOVA) were used to analyze the data and test the research hypotheses.

Findings: According to the findings, significant differences were observed between the studied age groups in all components of metacognitive skills (planning, monitoring, and regulation) and cognitive skills (semantic elaboration, rehearsal and practice, and organization). Students aged 13–15 had higher mean scores in cognitive and metacognitive skills compared to students aged 10–12.

Conclusion: Based on the results, cognitive and metacognitive skills increase with age in students.

Keywords: *Developmental analysis, cognitive skills, metacognitive skills.*

1. Introduction

Students, as the future builders of any nation, constitute a crucial segment of society, and the fundamental objective of every educational system is to foster their comprehensive growth and development (Sheffler et al., 2022). Adolescence is a highly complex stage characterized by creativity and a tendency to explore various issues; thus, it is essential to create an environment that allows adolescents to recognize and cultivate their talents (Aminjonovna, 2021). Educational researchers and theorists seek empirical and investigative evidence regarding the factors influencing academic performance and success across different cultures and educational systems. Consequently, numerous strategies have been employed over the years to address students' motivational, academic, behavioral, cognitive, and psychological challenges. In this regard, studies have shown that training in cognitive and metacognitive skills significantly affects students' academic variables (Pambudi et al., 2022).

The term cognition refers to internal mental processes or the ways in which information is processed. Cognitive skills enable individuals to comprehend concepts, solve problems, memorize, focus, and make decisions. Deficiencies in this domain may manifest as difficulty in understanding concepts, inability to generate written content, inattentiveness in class, and failure to follow daily life instructions (Ilma et al., 2022; Saputrı & Corebıma, 2020). Cognitive abilities are considered individual preferences that involve the structured organization, processing of information, and experience (Stanton et al., 2021). Learning styles, in contrast, pertain to individual abilities and preferences that influence how information is perceived, gathered, and processed.

Metacognition can be described as learning how to learn. More specifically, it refers to monitoring one's thinking and learning and applying this awareness in practice. In other words, the core meaning of metacognition is knowledge about cognition (Sheffler et al., 2022; Smith et al., 2020). The term metacognition denotes awareness of one's learning processes or how one learns. The originator of this term described it as thinking about thinking (Tatiana et al., 2022). Numerous studies have identified metacognition as a key predictor of emotions and affective responses, showing that metacognition is positively associated with self-efficacy perceptions and academic engagement (Shekh-Abed, 2024).

Metacognitive strategies help students recognize that concepts are constructed from observed patterns in objects or events and the symbolic labels used to define these structures. Many researchers argue that metacognitive skills play a crucial role in various cognitive activities, including reading comprehension, verbal exchange of information, verbal comprehension, achievement motivation, language acquisition, writing, attention, perception, problem-solving, memory, and social cognition (Discipulo & Bautista, 2022).

Overall, metacognitive skills provide an internal locus of control, facilitate academic engagement, enhance achievement motivation, promote positive attributions, encourage creativity and innovation, and foster self-responsibility. These skills strengthen self-confidence in life matters, enable individuals to identify problems, evaluate their activities, act independently, and propose optimal solutions for various situations (Merchán Garzón et al., 2020). Metacognition is a critical factor in distinguishing successful from unsuccessful students in the educational process. It also pertains to higher-order cognitive processes involved in learning, such as employing appropriate skills and strategies for problem-solving, planning for learning, assessing performance, and determining the extent of learning (Usman et al., 2021).

Metacognition is a strong predictor of academic success. Students with well-developed metacognitive abilities demonstrate superior academic performance compared to those with weaker metacognitive skills (Güner & Erbay, 2021). Cognitive and metacognitive strategies, as self-regulated learning strategies, facilitate learning and memory retention. Although these strategies can be learned, some students struggle to acquire them and require explicit instruction (Rivas et al., 2022).

Given that students play an active role in regulating their own learning, a lack of awareness regarding cognitive and metacognitive learning strategies can hinder effective education. Cognitive and metacognitive skills assist students in monitoring and controlling their learning processes, allowing them to address deficiencies. In essence, by developing metacognitive skills, students can manage their learning more effectively. This occurs through guiding students to consciously monitor their actions, recognize areas where they neglect effort, and reflect on their strengths and weaknesses in learning (Cer, 2019).

Students' developmental stages influence their cognitive and metacognitive skills. Older children are more aware of their memory capabilities and limitations than younger children. As they age, they become more accurate in assessing whether they have adequately learned material for

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retrieval (Güner & Erbay, 2021). Therefore, examining students' cognitive and metacognitive strategies is essential.

Nevertheless, cognitive and metacognitive skills are often overlooked, and they have not received the attention they deserve. Given the significance of cognition and metacognition in students' learning abilities and styles, this study seeks to contribute, albeit modestly, to the existing body of knowledge in this field. Practically, the findings of this research may provide valuable insights for educational policymakers and planners in designing curricula that incorporate cognitive and metacognitive skill training to enhance students' abilities. Accordingly, the present study aims to compare the cognitive and metacognitive skills of male and female students (from upper elementary to the end of secondary school) in public and private schools in Mashhad. In pursuit of this objective, the study seeks to answer the following research question: Is there a significant difference between the cognitive and metacognitive skills of male and female students in Mashhad?

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a non-experimental comparative research design. The statistical population consisted of male and female students (in upper elementary and final secondary school) enrolled in public and private schools across the seven districts of Mashhad in 2023, totaling 4,618 students (N=4618). The sample size was determined using Cochran's formula, yielding a total of 355 participants (n=355). Students were selected using a multi-stage cluster sampling method and categorized into two age groups: 10–12 years and 13–15 years. The data collection instrument was the Cognitive and Metacognitive Strategies Questionnaire developed by Dawson and McInerney (2004).

The inclusion criteria were:

- Parental consent for student participation
- Student willingness to participate in the study
- Students aged 10–15 years

The exclusion criteria were:

- Lack of willingness to continue participation in the study
- Presence of major psychiatric disorders diagnosed by a specialist

To ensure ethical compliance, participants were assured of the confidentiality of their information. At the beginning of the study, the purpose of the research was explained, and respondents were familiarized with the study procedures. Informed consent was obtained from all participants. Additionally, participants retained the right to withdraw at any stage, and every effort was made to minimize any potential harm to the students.

2.2. Measures

2.2.1. Cognitive and Metacognitive Strategies

The Cognitive and Metacognitive Strategies Questionnaire was developed by McInerney and Dawson (2004). The target population comprised students, and the study aimed to examine the relationship between cognitive and metacognitive strategies and students' academic performance in the classroom. The questionnaire consists of closed-ended items measured on a five-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree). Research findings indicate that this questionnaire possesses satisfactory validity, which has been confirmed through factor analysis. The internal consistency of the instrument, as measured by Cronbach's alpha, ranges from 0.73 to 0.77 for cognitive strategies and from 0.75 to 0.78 for metacognitive strategies. This questionnaire comprises 36 items, divided into two scales: cognitive strategies (18 items) and metacognitive strategies (18 items). The cognitive strategies scale includes three subscales: repetition and practice, semantic elaboration, and organization, while the metacognitive strategies scale consists of three subscales: planning, monitoring, and regulation. Abedi et al. (2014) reported a Cronbach's alpha coefficient of 0.92 for this instrument. Their study also demonstrated that factor loadings for the subscales (repetition and review, semantic elaboration, organization, planning, monitoring, and regulation) confirmed the appropriateness of the items in relation to the corresponding factors, indicating the construct validity of the questionnaire (Discipulo & Bautista, 2022).

2.3. Data Analysis

After data collection and classification, data analysis was conducted in two stages based on the nature of the study. Descriptive statistics and inferential statistics (multivariate analysis of variance [MANOVA]) were used for data analysis, employing SPSS version 24.

3. Findings and Results

Based on the collected data, it was determined that 165 participants (43.3%) were female, while 191 participants (53.7%) were male. The majority of students (180

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participants, 50.8%) were enrolled in the first year of secondary school, while 176 participants (49.2%) were in the upper elementary level. Additionally, most students (109 participants, 30.6%) belonged to District 2 of Mashhad.

According to the results presented in Table 1, the mean scores for cognitive and metacognitive skills and their components were higher among students aged 10–12 years compared to those aged 13–15 years.

Table 1

Descriptive Statistics for Cognitive and Metacognitive Skills and Their Components

Variable	Group	Min	Max	Mean	SD
Total Cognitive Skills	10–12 years	18	72	31.047	10.296
	13–15 years	18	79	33.945	10.469
Semantic Elaboration	10–12 years	6	25	9.700	3.638
	13–15 years	6	24	10.975	3.967
Organization	10–12 years	6	28	10.800	3.947
	13–15 years	5	30	11.393	4.160
Repetition and Practice	10–12 years	5	28	10.547	4.244
	13–15 years	6	30	16.190	5.641
Total Metacognitive Skills	10–12 years	18	64	31.240	9.358
	13–15 years	18	69	33.860	9.979
Planning	10–12 years	4	16	8.830	3.045
	13–15 years	4	25	8.712	3.320
Monitoring	10–12 years	5	22	9.916	3.384
	13–15 years	6	24	11.406	4.150
Regulation	10–12 years	6	30	12.612	4.221
	13–15 years	7	30	13.624	4.890

To assess the normality of the data, the Kolmogorov-Smirnov and Shapiro-Wilk tests were used, and the results for cognitive skills (semantic elaboration, organization, repetition and practice, and total cognitive skills) and metacognitive skills (planning, monitoring, regulation, and total metacognitive skills) were significant, indicating that the data followed a normal distribution.

To examine the equality of covariance matrices, Box's M test was applied, showing that the F-statistic for Box's M test was significant, indicating that the research variables had equal covariance matrices.

To assess the equality of variances, Levene's test was used, and the results showed that the F-statistics for research variables were significant at the 0.01 level, confirming equal variances in both groups. Thus, the research hypotheses could be tested.

Hypothesis 1: There is a significant difference in cognitive skills (semantic elaboration, organization, and repetition and practice) among students aged 10–15 years.

According to the findings in Table 2, Pillai's trace test indicated a significant effect of age on cognitive variables (semantic elaboration, organization, repetition and practice, and total cognitive skills), with a value of 0.292, $F = 12.145$, $df = 236$, and $p < 0.001$. This means that there was a significant difference between the mean values of the examined variables in the two age groups. Additionally, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root tests confirmed the presence of significant differences between the two age groups.

Table 2

Multivariate Analysis of Variance (MANOVA) for Cognitive Skills

Test	Value	F	df	p
Pillai's Trace	0.292	12.145	236	0.001

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Wilks' Lambda	0.928	12.145	236	0.001
Hotelling's Trace	0.078	12.145	236	0.001
Roy's Largest Root	0.075	12.145	236	0.002

The results regarding which cognitive variables were significantly affected by age are presented in Table 3.

Table 3

Analysis of Variance (ANOVA) for Cognitive Skills Components

Source	SS	MS	F	p
Total Cognitive Skills	286.12	26.34	12.38	0.001
Semantic Elaboration	28.12	13.46	5.48	0.001
Organization	45.39	8.68	3.22	0.000
Repetition and Practice	99.75	9.36	2.45	0.001

According to Table 3, the difference in mean cognitive skills between the two age groups was significant, as indicated by F = 12.38, p = 0.001. Furthermore, the differences in the mean values of semantic elaboration, organization, and repetition and practice between the two groups were individually significant.

Hypothesis 2: There is a significant difference in metacognitive skills (planning, monitoring, and regulation) among students aged 10–15 years.

According to the findings in Table 4, Pillai's trace test showed a significant effect of age on metacognitive skills (planning, monitoring, and regulation), with a value of 0.122, F = 8.342, df error = 351, and p < 0.001. This means that there was a significant difference between the mean values of the examined metacognitive variables in the two age groups. Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root tests also confirmed significant differences between the studied age groups.

Table 4

Multivariate Analysis of Variance (MANOVA) for Metacognitive Skills

Test	Value	F	Error df	p
Pillai's Trace	0.122	8.342	351	0.001
Wilks' Lambda	0.928	9.155	351	0.001
Hotelling's Trace	0.078	9.155	351	0.001
Roy's Largest Root	0.075	9.155	351	0.001

According to Table 5, the difference in total metacognitive skills between the two age groups was significant (F = 10.38, p = 0.002). Additionally, the differences in the mean values of planning, monitoring, and regulation between the two groups were individually significant.

Table 5

Analysis of Variance (ANOVA) for Metacognitive Skills Components

Source	SS	MS	F	p
Total Metacognitive Skills	327.12	27.21	10.38	0.002
Planning	104.27	19.38	5.59	0.001
Monitoring	97.26	7.49	3.17	0.000
Regulation	102.45	8.63	2.34	0.001

4. Discussion and Conclusion

The present study aimed to conduct a developmental analysis and comparison of cognitive and metacognitive skills and their components among students aged 10–12 years and 13–15 years in Mashhad. Data were collected using the Cognitive and Metacognitive Strategies Questionnaire developed by McInerney and Dawson (2004).

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After data collection and classification, data analysis was performed in two stages using descriptive statistics and inferential statistics (Multivariate Analysis of Variance [MANOVA]).

The results indicated a significant difference in cognitive skills (semantic elaboration, organization, and repetition and practice) and metacognitive skills (planning, monitoring, and regulation) among students in Mashhad, with higher scores in the 13–15-year-old group compared to the 10–12-year-old group. These findings are consistent with previous studies (Cer, 2019; Discipulo & Bautista, 2022; Güner & Erbay, 2021; Ilma et al., 2022; Merchán Garzón et al., 2020; Pambudi et al., 2022; Rivas et al., 2022; Saputrı & Corebıma, 2020; Sheffler et al., 2022; Shekh-Abed, 2024; Smith et al., 2020; Usman et al., 2021).

Developmental stages significantly influence students' cognitive and metacognitive skills. Older children have a better understanding of their memory abilities and limitations compared to younger children. As age increases, children become more accurate in estimating when they have learned information sufficiently for retrieval. The ability to monitor how well they perform on memory tasks also differs among learners. Older children are more precise in judging whether they have remembered all the information they intended to recall. Their ability to apply strategies improves with age, allowing them to use a greater variety of methods to aid in memory retrieval.

Cognitive and metacognitive strategies are interdependent, and to maximize academic performance, both must be utilized. Furthermore, the results revealed that without mastery of cognitive strategies, the impact of metacognitive strategies is minimal. Studies have consistently shown that both cognitive and metacognitive strategies play a critical role in academic achievement and success. Students who employ these strategies tend to outperform those who do not.

Cognitive strategies, such as mental rehearsal, first help students identify key points for retention. Secondly, these strategies facilitate the transfer of critical information into memory, where they are further processed and studied. Repetition and practice, as well as semantic elaboration strategies, engage learners actively, enhancing mental processing and information retention, ultimately improving learning outcomes.

Metacognitive strategies are highly constructive for achieving learning success and academic progress. This is because metacognitive strategies guide learners toward effective learning by leveraging their potential abilities and understanding how to apply them. In metacognitive strategies, learners develop self-regulation, improve their understanding of learning topics, and cultivate a sense of knowing.

The present study was conducted among students in Mashhad, focusing on two age groups (10–12 and 13–15 years); thus, caution should be exercised when generalizing the findings, and further research is necessary. Therefore, conducting similar studies in other cities and comparing the results is recommended.

Additionally, given the positive correlation between the development of cognitive and metacognitive skills with age, it is suggested that necessary training programs be implemented at an earlier age to strengthen students' cognitive and metacognitive skills.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the interview and participated in the research with informed consent.

References

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Aminjonovna, S. O. (2021). The Importance of the Spiritual Heritage of Uzbek Enlighteners in the Education of Youth. *International Journal on Orange Technologies*, *3*(6), 110-112. https://journals.researchparks.org/index.php/IJOT/article/view/2021

Cer, E. (2019). The instruction of writing strategies: The effect of the metacognitive strategy on the writing skills of pupils in secondary education. *Sage Open*, *9*(2), 2158244019842681. https://doi.org/10.1177/2158244019842681

Discipulo, L. G., & Bautista, R. G. (2022). Students' cognitive and metacognitive learning strategies towards hands-on science. *Int J Eval & Res Educ ISSN*, *2252*(8822). https://doi.org/10.11591/ijere.v11i2.22018

Güner, P., & Erbay, H. N. (2021). Metacognitive Skills and Problem-Solving. *International Journal of Research in Education and Science*, *7*(3), 715-734. https://doi.org/10.46328/ijres.1594

Ilma, S., Al-Muhdhar, M. H. I., Rohman, F., & Sari, M. S. (2022). Promoting Students' Metacognitive Awareness and Cognitive Learning Outcomes in Science Education. *International Journal of Evaluation and Research in Education*, *11*(1), 20-30. https://doi.org/10.11591/ijere.v11i1.22083

Merchán Garzón, D. F., Huertas Bustos, A. P., & Ugarte Lizarazo, J. O. (2020). Relationship between metacognitive skills, gender, and level of schooling in high school students. *Suma Psicológica*, *27*(1), 9-17. https://doi.org/10.14349/sumapsi.2020.v27.n1.2

Pambudi, G. D., Winangsih, F., Nunaki, J. H., Nusantari, E., & Damopolii, I. (2022). Encouraging students' metacognitive skills through inquiry learning. *Inornatus: Biology Education Journal*, *2*(1), 43-52. https://doi.org/10.30862/inornatus.v2i1.272

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive strategies and development of critical thinking in higher education. *Frontiers in psychology*, *13*, 913219. https://doi.org/10.3389/fpsyg.2022.913219

Saputrı, W., & Corebıma, A. D. (2020). The correlation between metacognitive skills and cognitive learning results of biology pre-service teachers on different learnings. *Journal of Turkish Science Education*, *17*(4), 487-503. https://doi.org/10.36681/tused.2020.40

Sheffler, P., Rodriguez, T. M., Cheung, C. S., & Wu, R. (2022). Cognitive and metacognitive, motivational, and resource considerations for learning new skills across the lifespan. *Wiley Interdisciplinary Reviews: Cognitive Science*, *13*(2), e1585. https://doi.org/10.1002/wcs.1585

Shekh-Abed, A. (2024). Metacognitive self-knowledge and cognitive skills in project-based learning of high school electronics students. *European Journal of Engineering Education*, 1-16. https://doi.org/10.1080/03043797.2024.2374479

Smith, A. K., Black, S., & Hooper, L. M. (2020). Metacognitive knowledge, skills, and awareness: A possible solution to enhancing academic achievement in African American adolescents. *Urban Education*, *55*(4), 625-639. https://doi.org/10.1177/0042085917714511

Stanton, J. D., Sebesta, A. J., & Dunlosky, J. (2021). Fostering metacognition to support student learning and performance. *CBE-Life Sciences Education*, *20*(2), fe3. https://doi.org/10.1187/cbe.20-12-0289

Tatiana, B., Kobicheva, A., Tokareva, E., & Mokhorov, D. (2022). The relationship between students' psychological security level, academic engagement and performance variables in the digital educational environment. *Education and Information Technologies*, *27*(7), 9385-9399. https://doi.org/10.33847/2712-8148.3.2_3

Usman, A., Susilo, H., Suwono, H., & Corebima, A. D. (2021). The Contributions of Metacognitive Skills towards the Retention of Different Academic Ability Students for the Implementation of Several Learning Models. *International Journal of Education and Practice*, *9*(3), 550-567. https://doi.org/10.18488/journal.61.2021.93.550.567

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