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Metacognitive Knowledge, Regulation, and Study Habits

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Abstract

The relationship between metacognitive knowledge, metacognitive regulation, depth of studying, and academic success was examined in university undergraduates. Further, age differences in these variables were compared between preadults (up to age 24) and adults (25 and older). Metacognitive regulation was found to be positively correlated with metacognitive knowledge, deep and strategic study habits, but no relationship was found between study habits or metacognition and GPA. Adults scored higher on all metacognitive knowledge subscales and the overall knowledge score, and all but the planning metacognitive regulation subscale. Explanations and application of findings are discussed.

Keywords

Metacognition, Metacognitive Knowledge, Metacognitive Regulation, Directed Learning

1. Introduction

Self-regulated learning can include several qualities and abilities, including metacognition, motivation, and behavioral aspects (Panadero, 2017). When the term "metacognition" was coined, Flavell (1979), was referring to "cognition about cognitive phenomena". Knowles (1975) observed that adult learning was different from that of children, suggested a more self-directed method. Knowles also suggested five assumptions regarding self-directed learning (SDL); self-awareness to allow for active direction of learning, experience to draw from, a readiness to learn, learning becomes problem centered, and motivation. If correct, these assumptions suggest that older adults may have an advantage over

younger students, when it comes to SDL because of enhanced metacognition and experience, especially is there is a strong motivation to learn.

When students have limited insight into their cognitive strengths and weaknesses, or have the insight, but lack the cognitive flexibility or ability to regulate these strategies, problems can arise in the ability to learn. In a meta-analysis of key factors related to student achievement, Hattie (2009) found that many students lack the cognitive awareness and regulation needed for academic excellence and many had a high uncertainty of their role as active learners. Also, Ruohoniemi & Lindblom-Ylanne (2009) had veterinary students identify key factors that were important in their learning and students identified faculty instruction methods and behaviors as being instrumental, but their personal efforts, motivation, and cognitive strategies were rarely mentioned.

According to Schraw & Dennison (1994), metacognitive awareness is a crucial piece that provides the initial template or cognitive map for further cognitive regulation techniques, like planning, sequencing, and monitoring of abilities. They developed the Metacognitive Awareness Inventory (MAI) to measure both metacognitive knowledge and regulation and examine the correlation between these two key cognitive abilities and how they drive SDL and classroom performance. Metacognitive knowledge includes the three main subtypes of information, including declarative, procedural, and conditional, while metacognitive regulation refers to the active techniques commonly used to increase learning, including planning, monitoring, and evaluating. These regulatory abilities can help direct study habits and depth of studying.

Students who have well-developed metacognitive knowledge and actively use their metacognitive regulatory skills should excel academically and achieve higher grades in their classes, or on an assignment, or have a higher overall GPA. The relationship between academic ability has been established with learning (Alamdarloo et al., 2013) and metacognition (Stephanou & Mpiontini, 2017), across disciplines and ages. Everson & Tobias (1998) examined the difference between student insight into their verbal abilities and their performance on a standardized verbal test and found that metacognitive knowledge and regulation was related to the final grade students received in their English class, overall GPA, and was a good predictor for college success.

MacKewn & Donavant (2021) found a positive relationship between metacognition and success in the online asynchronous and self-paced learning platforms, regardless of age, when metacognition was compared in adults (ages 25 and older) to preadults (under age 25). Brown et al. (1983) early in their studies, suggested that mature learners treat their study habits as purposeful, problem-focused, and flexible strategies that can change as task demands change.

This is especially promising in respect to the online delivery method because of the drastic increase in the number of courses and programs moving exclusively or partially to this style of SDL (Sloan III, 2018).

Since neural connectivity in the brain is not fully developed until around the mid-twenties, there should be age-related differences, not only in knowledge, but

in cognitive regulation. Longitudinal neuroimaging research demonstrates that neural impulses in the prefrontal cortex, an area responsible for higher-order cognitive processes and executive functions needed for goal directed behaviors, does not fully develop until the mid 20's (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Giedd, 2008). Young & Fry (2008) examined the metacognitive awareness of 5th and 6th graders, of both sexes, and found that they used declarative knowledge and applied planning as their main metacognitive regulation technique. Veenman et al. (2004) examined the metacognitive skills of students between the ages of 9 and 22 and found that these abilities showed a linear increase with age. These findings are supported by a thorough overview of the development of metacognitive knowledge and the educational implications (See Schneider, Tibken, & Richter, 2022).

Further research supports the finding that the regulation of cognition develops slowly and might not be completely operative, even in adults (Lai, 2011; Van der Stel & Veenman, 2014). MacKewn & Donavant (2021) found that adult students, once referred to as non-traditional students, scored higher than a group of traditional students, or preadults, on several metacognitive knowledge and regulation subscales. The adults demonstrated a better grasp on metacognitive regulation strategies, including planning, monitoring, controlling, and regulating, suggesting that they were using more strategic techniques when learning new information. Justice & Dornan (2001) also found that non-traditional students, between the ages of 24 - 64, reported greater use of higher-level study strategies compared to their younger traditional student counterparts. Other studies indicate higher education faculty acknowledge that adult students differ from their traditional-age counterparts, but often perceive no need to adapt instructional approaches to accommodate the needs or learning styles of the growing post-secondary demographic shift (Day, Lavato et al., 2011; Donavant et al., 2013). The researchers also discussed developmental differences, such as academic motivation, as possible reasons for the differences and should also be considered.

When considering the relationship between metacognition and self-regulation, and more recently, with SDL, other factors do need to be considered. Dinsmore, Alexander, & Loughlin (2008) reviewed various factors tied to student success and metacognition. They found that learners with developed metacognitive regulation strategies perceived their regulation strengths to serve them well by increasing their motivation and expectation for success, across different subjects. However, metacognitive knowledge was not a powerful predictor of regulatory learning style. Further research, however, is needed to examine this possibility and to examine other possible moderator variables in learning.

Niemivirta (1997) reported that males tend to use more superficial learning strategies compared to females, while Bidjerano (2005) reported that females use more self-monitoring, goal setting, and planning compared to males, starting at the middle school years, and continuing into college. Sex differences in perceived learning strategies are often linked back to a student's self-efficacy and

confidence for the subject material and may not be related to class performance (Schunk & Pajares, 2002; Meece et al., 2006). These sex differences were found to be more prevalent in content areas linked to sex-stereotypes, such as engineering or mathematics, but have been non-existent or mixed in content-neutral areas, like technology, and even certain STEM areas (Concannon & Barrow, 2012). Earlier studies found that females report greater intrinsic academic motivation, at the college level, compared to males (Ratelle et al., 2007; Vallerand & Bissonnette, 1992), while others found mixed results in contextual motivation (Vecchione et al., 2014).

The above results also complemented Efklides & Vlachopoulos's (2012) suggestion that metacognitive awareness of strategies does not sufficiently explain cognitive processing outcomes. In addition, they suggested that the content of the material, or the difficulty of a mathematics tasks played a key role in the metacognitive processes. Further, Efklides (2014) suggested examining the role that personal control has on cognition if it is to be effective. Since cognitive monitoring is not always accurate, metacognition may not always be accurate, and it is important to examine other cognitive, affective, and motivational strategies related to learning.

The present study examined the relationship between metacognitive knowledge, metacognitive regulation, depth of studying, and academic success of university undergraduates, across different disciplines. Academic success was measured using the current self-reported GPA.

Hypotheses

1) Those with greater awareness of their metacognition knowledge (including a total score and declarative, procedural, conditional subscale scores) would score higher on metacognitive regulation ability (total score, planning, information management strategies, comprehension monitoring, debugging strategies, and evaluation subscale scores)

2) Students with greater metacognitive self-regulation would have greater academic success, as measured by overall GPA.

3) Adult students (age 25 and older) would score higher in metacognitive knowledge and regulation abilities compared to their pre-adult (under the age of 25) counterparts.

4) The greater the metacognitive regulation, the greater the score on the deep and strategic study habits subscales.

2. Method

2.1. Participants

There were 363 university undergraduates recruited for the current study through on online Qualtrics survey posted on the SONA university research page, 72 adults (21 males, 51 females; $M = 36.86$, $SD = 8.24$) and 291 preadults (62 male, 223 females, 6 males, and 6 did not wish to reply; $M = 19.32$; $SD = 3.49$). There

were 85 STEM majors and 278 non-STEM majors. Data were collected from a mix of online and face-to-face classes.

2.2. Materials

Metacognition Awareness Inventory (MAI; Schraw & Dennison, 1994)—The MAI is a 52-question instrument that assesses general self-regulated learning skills across disciplines. An overall score was calculated in addition to the three subcategories of cognitive knowledge, including declarative, procedural, and conditional scores. The knowledge subscales indicate how aware people are of themselves and the strategies they use in different situations. The three subscales, procedural, declarative, and conditional, are the basis for conceptual knowledge or what students know about their learning. An overall regulation score was computed from the five subcategories of cognitive regulation, including planning, information management, comprehension monitoring, debugging, and evaluation strategies. The five metacognitive regulation subscale scores correspond to how well students monitor and control their learning.

Revised Approaches to Studying Inventory (RASI; Richardson, 2005)—The RASI is a shortened version of the 52-question ASSIST (Approaches and Study Skills Inventory for Students). This is an 18-question, 5-point Likert-style instrument asking students to reflect on the specific ways they study course material. There are three subscales measured in this instrument, deep, surface, and strategic study approaches. For example, in the deep approach for studying, it means a student is studying to seek meaning, relating ideas together, and they can monitor their studying effectiveness. If they use more of a strategic approach, it suggests that they focus on time management, organize their studying, and they are aware of the expectations. The surface approach can be seen as an apathetic approach where fear of failure may be a motivator and they may not tie the work together or see the purpose in learning the material and often feel overwhelmed. Participants received scores on all three subscales.

A description of the study and the corresponding link to an online Qualtrics survey was housed on SONA, the University wide research participation pool website. Participants first completed an informed consent followed by a brief demographic section followed by the MAI and finally the RASI.

3. Results

3.1. Metacognitive Knowledge and Metacognitive Regulation

To test the hypothesis that those with a greater awareness of their metacognition knowledge would use greater metacognitive regulation techniques, a Pearson correlation was performed between total metacognitive knowledge and metacognitive regulation scores and a significant correlation was found, $r = .731$, $p < .05$. When the separate correlations were examined between the three metacognitive knowledge subscale and the five metacognitive regulation subscale scores, significant correlations were found across the board (See **Table 1** for the

matrix table between the subscales of the MAI and the three study approach scores).

3.2. Metacognitive Regulation and Deep and Strategic Study Approach

The hypothesis that students with stronger metacognitive self-regulation abilities would also be able to use deep study techniques was supported, $r = .20$, $p < .05$, and strategic techniques, $r = .14$, $p < .05$, although self-regulation was correlated with academic success, as measured by current GPA (Hypothesis 2) (See Table 1).

3.3. Age Differences in Metacognitive Knowledge and Regulation

When examining whether adult students, those 25 years of age or older, would score higher in metacognitive knowledge and regulation abilities compared to their pre-adult counterparts, a series of independent samples t-tests were performed. Adult students scored higher on all knowledge and regulation categories (See Table 2).

4. Discussion

4.1. General Findings

The present study examined the relationship between metacognitive awareness, regulation, depth of study habits, and academic success across different disciplines in university undergraduates, taking either an online or face to face class. It

Table 1. Correlation matrix table between MAI knowledge and regulation scores and RASI study approach scores.

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Declarative	-												
2. Procedural	**.48	-											
3. Conditional	**.48	**.64	-										
4. Total Metacognitive Knowledge	**.85	**.81	**.82	-									
5. Planning	**.48	**.67	**.65	**.72	-								
6. Information Management	**.43	**.63	**.63	**.66	**.77	-							
7. Comprehension Monitoring	**.38	**.67	**.62	**.64	**.79	**.73	-						
8. Debugging	**.31	**.42	**.54	**.49	**.60	**.58	**.62	-					
9. Evaluation	**.41	**.61	**.66	**.65	**.76	**.76	**.80	**.62	-				
10. Total Metacognitive Regulation	**.47	**.70	**.71	**.73	**.92	**.90	**.91	**.72	**.91	-			
11. Deep Approach	.09	.05	*.10	.10	**.15	**.21	**.20	.10	**.18	**.20	-		
12. Strategic Approach	**.18	.07	.07	*.14	.08	.02	.05	.07	−.01	.04	**.30	-	
13. Surface Approach	**−.19	−.10	−.06	*−.15	−.10	−.04	−.05	−.01	−.07	−.07	.05	**−.31	-

*$p < .05$, **$p < .01$.

Table 2. Differences between preadults (n = 291) and adults (n = 72) on the MAI knowledge and regulation scales and the study approaches on the RASI.

	Preadult		Adult		t	*p*	Cohen's d
	M	SD	M	SD			
Declarative	6.22	1.72	6.76	1.37	2.46	.007	−.32
Procedural	3.53	1.09	4.01	.98	3.42	<.001	−.45
Conditional	4.41	1.17	4.92	1.12	3.29	<.001	−.43
Metacognitive Knowledge	14.17	3.31	15.69	2.73	3.61	<.001	−.47
Planning	5.67	2.39	6.94	2.31	4.81	<.001	−.54
Information Management	8.62	2.38	9.82	2.37	3.81	<.001	−.50
Comprehension Monitoring	5.98	2.05	6.75	1.76	2.93	.002	−.39
Debugging	4.74	.95	4.97	.84	1.93	.027	−.25
Evaluation	4.80	2.06	5.81	1.99	3.71	<.001	−.48
Metacognitive Regulation	29.81	8.70	34.29	8.31	3.95	<.001	−.51
Study Approach							
Deep	21.99	4.16	23.39	3.61	2.61	.005	−.34
Strategic	21.75	4.80	23.89	5.50	3.30	<.001	−.43
Surface	19.49	4.95	16.44	6.14	4.44	<.001	.58
GPA	3.25	.54	3.15	.49	1.45	.075	.20

was hypothesized, and statistically supported, that greater metacognitive knowledge would be correlated with stronger metacognitive regulation, supporting the past literature (MacKewn & Donavant, 2021; Schraw & Dennison, 1994).

In addition, the assumption that adult learners would have greater metacognitive knowledge and regulation and exhibit techniques used with deep and strategic study habits compared to the pre-adult learner, was also supported. This suggests that adult learners learned material by relating ideas together, used critical thinking more often and practiced time management and had greater self-awareness.

Deeper study habits and metacognitive regulation, however, was not related to overall semester GPA. The self-reported student GPA was not verified by official records and there may have been misremembering. It is the intention in a follow-up study to include the official semester GPA and course grades.

4.2. Limitations

Researchers who study SDL examine a range of variables related to academic success, either indirectly or directly, like academic motivation, self-efficacy, learning environment, and context (Efklides, 2014; Efklides & Vlachopoulos, 2012; Vecchione et al., 2014). Several students in the current study were enrolled in an online class and this type of delivery system may be desirable for the adult learner, who may have a full-time job or extensive family care because time is

limited but are better able to direct or manage their time and learning methods. The inclusion of academic motivation as it relates to, or possibly drives the relationship between study habits, metacognitive regulation, and academic success could be examined further (Vallerand & Bissonette, 1992).

4.3. Implications

Studying the relationship between metacognitive knowledge, metacognitive regulation, and academic performance is important. The findings can provide feedback to students who wish to develop active and deeper learning skills. This information could provide self-awareness of their strengths and weakness to help direct and improve learning efforts, possibly increasing motivation and academic success. On a larger scale, it can help to address a wide-spread concern of student retention in a class, a major, or at the university (McCoy & Byrne, 2017). Arum & Roksa (2011) found that students were poorly prepared for the academic demands and teaching styles in university, and unfortunate trend that seemed to increase after the recent pandemic. Additionally, students did not have positive attitudes towards the workload and expectations of higher learning.

4.4. Overview

Those who were more perceptive about their metacognitive knowledge were better at metacognitive regulation, across all regulation and knowledge subscales and total scores. In addition, metacognitive regulation was correlation with deeper and strategic study approaches. Statistical analysis demonstrated that adult learners were better at regulating their metacognitive strategies. Adult learners used deeper and more strategic study habits and tended to score higher on all metacognitive knowledge and regulation strategies. Whether the deeper study habits aided in the practice of the regulation strategies, or the other way around is not clear. Although, pre-adult students reported higher GPA's than adult learners but used shallow study habits, suggesting other variables may have played a role and further studies are needed, although the self-report nature of the grades must be considered.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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