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Metacognitive Development in Professional Educators

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Metacognition includes knowledge and regulation of one's thinking processes. Although there has been abundant research into the development of childrens' metacognition, relatively little research has focused on the development of adult metacognition. This study examined the metacognitive skills of adults as they develop naturally with age. The Metacognitive Awareness Inventory was completed by 214 pre-service and experienced teachers. Results indicated that metacognition improves significantly with age and with years of teaching experience. Male and female participants showed no significant difference in metacognition, and teachers of grades from preschool to post-secondary showed no significant difference in metacognition. Numerous suggestions for future research emerged from this study.

Keywords: *metacognition, adult learners, teacher education*

Over the last 35 years, many definitions have been proposed for the word metacognition, or "thinking about thinking". A recent definition describes metacognition as "one's knowledge and beliefs about one's own cognitive processes and one's resulting attempts to regulate those cognitive processes to maximize learning and memory" (Ormrod, 2006). Metacognition plays an important role in communication, reading comprehension, language acquisition, social cognition, attention, self-control, memory, self-instruction, writing, problem solving, and personality development (Flavell, 1979). Metacognition is a special type of knowledge and ability that develops with personal experience and with schooling. It is in a recursive loop with cognitive development in that it both produces and is a product of cognitive development (Paris & Winograd, 1990).

Influence Of Metacognitive Skills

A variety of studies has examined the influence of metacognitive skills on adult performance. Everson and Tobias (2001) report that research shows there is a difference in the metacognition of effective learners and ineffective learners. The effective use of metacognition has been shown to predict learning performance (Pintrich & DeGroot, 1990). Students with higher metacognitive

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skills outperformed those with lower metacognitive skills in problem-solving tasks, regardless of their overall aptitude. In a study comparing self-regulated learning in college undergraduates and graduate students (Lindner, Harris & Gordon, 1996), research showed a strong correlation between metacognition and degree completion. Research has consistently shown that students who are high achievers in academic learning domains such as reading, writing, math and science also exhibit higher levels of metacognitive knowledge about that domain, and have developed greater abilities in self-regulation (Baker & Cerro, 2000). Studies of adults in the work force have also shown a positive influence of metacognition on performance. Nurses and electronics technicians considered excellent at their jobs were found to have greater metacognitive awareness and strategy use than workers who were average performers (Baker, 1989).

DEVELOPMENT OF METACOGNITIVE SKILLS

A major trend in the 1980's was research into children's knowledge about their mental world. This body of work stretched over approximately 15 years and produced more than 800 publications known as "theory-of-mind" research. Many of these studies examined pre-school children's understanding of mental processes and the age-related developmental changes that occur in this understanding (Schneider & Lockl, 2002). Most theorists believe that the development of metacognitive knowledge begins at a young age, and continues at least through adolescence (Schraw & Moshman, 1995). A tacit assumption in much of the research has been that metacognitive skills are fully developed by adulthood.

This assumption can be questioned, since there have been a few studies examining age-related changes in metacognition after adolescence (Justice & Dornan, 2001; Rasnak, 1995). Instead, most of the research on adult metacognition focuses on the specific metacognitive processes used by adults (Flavell, 1979; Kluwe, 1982; Narens, Graf & Nelson, 1996; Sternberg, 1990). Schraw, Wise, and Roos (2000) summarized research about metacognition in adults. They concluded that adults typically monitor their own performance with a moderate degree of accuracy, and that accuracy of monitoring improves when tests are easier and cover more factual information. They also concluded that proficiency of monitoring seems to be independent of intellectual ability, domain knowledge and ease-of learning judgments and that monitoring ability appears to improve with practice.

The purpose of this study was to determine whether metacognitive awareness and skills increase naturally with age during adulthood. Pre-service and professional teachers were the participants in this study. The following research questions provided focus for this study:

1. Is there a difference in metacognitive awareness between pre-service teachers and practicing teachers?
2. Does metacognitive awareness increase with age during adulthood?
3. Does metacognitive awareness increase with years of teaching experience?
4. Is there a difference in metacognitive skills between males and females?
5. Do teachers working with different aged learners differ in their metacognitive skills?

METHODS

PARTICIPANTS

The purpose of this study was to discover whether adults' metacognitive awareness and skills naturally increase with age; participants were volunteers. Experienced teachers who were working toward a Master's degree at a Utah university were compared to undergraduate teachers-in-training at the same institution using a paper-and-pencil self-evaluation instrument to assess metacognition. Age, years of teaching experience, and grade levels taught were also variables of interest. Sample size was 91 participants from the undergraduate group and 123 participants from the graduate student group.

INSTRUMENTATION

A survey used in this study was the Metacognitive Awareness Inventory (MAI) designed by Schraw and Dennison (1994). While most metacognitive instruments have been designed for use with children and adolescents, the MAI was designed for use with adults. This instrument continues to be used in studies of adult metacognition (Hammann & Stevens, 1998; Sperling, 2004). The MAI instrument consists of 52 statements to which participants respond by marking a Likert scale. Average completion time is approximately ten minutes (Schraw and Dennison, 1994).

The MAI statements represent two component categories of metacognition: metacognitive knowledge and metacognitive regulation. Within the knowledge component are statements of declarative knowledge (knowledge about self and strategies), procedural knowledge (knowledge about strategy use), and conditional knowledge (when and why to use strategies). The regulation component covered planning (goal setting), information management (organizing), monitoring (assessment of learning and strategy), debugging (strategies to correct errors) and evaluation (analysis of performance and strategy effectiveness).

PROCEDURES

The survey packet was given to each of the participants. The survey packet contained three items:

1. A letter of introduction explaining the purpose of the study and the voluntary, confidential nature of participation;
2. A demographic survey requesting information about the participant's age, gender, graduate or undergraduate status, years of teaching experience and grade levels taught;
3. The MAI.

For each participant, scores for metacognitive knowledge, metacognitive regulation, and total MAI score were generated and used in the data analysis. Data from the questionnaire was analyzed using nonparametric statistical tests, since data were ordinal and could not be assumed to be normally distributed. Spearman's Rho was used to look for correlations between MAI scores and age and MAI scores and teaching experience. Mann-Whitney U was used to look for differences between pre-service and experienced teachers, between male and female participants, and among teachers of different grade levels. Alpha was set at 0.05 for all statistical tests.

Table 1. *Descriptive Statistics for Sample Groups*

Variable	Median	Minimum	Maximum
Undergraduate Students (N = 91)			
MAI Knowledge Score	71	43	88
MAI Regulation Score	125	76	163
MAI Total Score	195	126	251
Graduate Students (N = 123)			
MAI Knowledge Score	76	58	94
MAI Regulation Score	134	89	166
MAI Total Score	211	147	255
Undergraduate and Graduate Students (N = 214)			
MAI Knowledge Score	74	43	94
MAI Regulation Score	129	76	166
MAI Total Score	203	126	255

RESULTS

DESCRIPTIVE STATISTICS FOR THE SAMPLE GROUPS

Table 1 presents the descriptive statistics for the undergraduate and graduate participants in the research study. Two scales are reported: MAI knowledge consisting of 18 items and MAI regulation with 34 items. Results for the research questions will follow.

METACOGNITIVE AWARENESS: UNDERGRADUATE VS GRADUATE STUDENTS

The first research question looked for a difference in metacognitive awareness between undergraduate pre-service teachers and experienced teachers. The scores for metacognitive knowledge, metacognitive regulation, and total MAI score were compared to detect differences between the two groups. In all three sets of scores, experienced teachers had higher scores than pre-service teachers at a significant level ($p < .05$). Results are summarized in Table 2.

CORRELATION OF AGE WITH MAI SCORES

The second research question asked whether metacognitive awareness increased with age during adulthood. The mean age of undergraduates was 26.7 with a standard deviation of 8.0. The mean age of graduates was 39.1 with a standard deviation of 9.5. The age of all participants ranged from 19 to 57. For both pre-service and experienced teachers, the pattern of results was similar. For the undergraduate students, age was significantly correlated with metacognitive regulation but not with metacognitive knowledge or with total MAI score. Within the group of experienced teachers, age was significantly correlated with metacognitive regulation score and with total MAI score, but not with knowledge score. For the pooled group of 214 participants, metacognitive knowledge, regulation, and total MAI score were all strongly correlated with age. See Table 3.

Table 2. *Comparison of MAI Scores for Undergraduate and Graduate Students (Mann-Whitney U)*

Student Type & Variable	Cases	Mean Rank	*U*
Comparison for Metacognitive Knowledge Scores			
Graduate Student	123	125.8	
Under Graduate	91	82.7	7848.5 **
Comparison for Metacognitive Regulation Scores			
Graduate Student	123	124.6	
Under Graduate	91	84.4	7698.5 **
Comparison for Total MAI Scores			
Graduate Student	123	126.1	
Under Graduate	91	82.3	7886.5 **

Note. * Significant result ($p < .05$, 2-Tail); ** Significant result ($p < .01$, 2-Tail)

Table 3.*Correlation of Age with MAI Scores (Spearman's Rho)*

Student Type	N	Age Range	Metacognitive Knowledge	Metacognitive Regulation	MAI Total Score
Undergraduates	91	19 - 58	$r = 0.09$	$r = 0.22$*	$r = 0.19$
Graduates	123	22 – 57	$r = 0.15$	$r = 0.38$ **	$r = 0.34$**
All Participants	214	19 – 58	$r = 0.31$ **	$r = 0.42$**	$r = 0.41$**

Note. * Significant result ($p < .05$); ** Significant result ($p < .01$)

CORRELATION OF YEARS OF TEACHING EXPERIENCE WITH MAI SCORES

The third research question queried whether metacognitive awareness increases with years of teaching experience. The undergraduates were not included in this question because they had not yet begun teaching. The mean years of teaching experience for graduate students was 8.5 with a standard deviation of 6.5. Metacognitive knowledge did not show a significant correlation with years of teaching experience, but metacognitive regulation and total MAI score did show significant correlation with years of teaching experience. Metacognitive regulation appeared to be the component that contributed to increased metacognitive awareness among the experienced teachers. Metacognitive knowledge tended to remain stable, even with increased years of teaching. See Table 4.

Table 4. *Correlation of MAI Scores and Years of Teaching Experience (Spearman's Rho)*

Student Type	*r*	*t*
Metacognitive Knowledge	0.07	0.72
Metacognitive Regulation	0.26**	3.00
Total MAI Score	0.22*	2.49

Note. * Significant result ($p < .05$); ** Significant result ($p < .01$) ; N = 123

Table 5. *Gender Differences in MAI Total Score (Mann-Whitney U test)*

Student Type	Males	Females	*U*
Undergraduates	12	79	517.5
Graduates	21	102	1355.5
All Participants	33	181	3481

Note. * Significant result ($p < .05$); ** Significant result ($p < .01$)

MAI Scores for Males vs. Females

The fourth question examined differences in metacognitive skills between males and females. No significant gender differences were detected among the undergraduates, the graduate students, or the pooled group. Results are summarized in Table 5.

Table 6. *Comparison of Total MAI Scores for Teachers in Six Grade Levels (Kruskal-Wallis One-Way ANOVA)*

Grade Level	N	Rank Sum	Mean Rank
Pre-school	10	769.5	76.9
Grades 1 – 6	52	3450.0	66.3
Grades 7 – 9	17	1078.0	63.4
High School	26	1367.5	52.6
Post Secondary	11	582.0	52.9
No Classification	7	379.0	54.1

Note. X^2 =5.422 (df = 5), *Significant result (p < .05), ** Significant result (p < .01)

Comparison Of MAI Scores For Teachers Of Different Grade Levels

The final question compared the metacognitive skills of experienced teachers working with different aged learners. The graduate student participants were mostly experienced professional teachers. Only 7 of the 123 participants either had no teaching experience or did not report the grade levels taught. A few of the teachers had taught at several grade levels. Six categories were created to cover the range of grade levels from preschool to post-secondary. One of the categories represented graduate students without teaching experience. No significant differences were found among the teachers from different grade levels. This indicates that for the group of 123 graduate students, most of whom were experienced teachers, metacognitive skills were similar across the range of grade levels from preschool to post-secondary. Results are summarized in Table 6.

Discussion

The results of this study tend to challenge previous views that development of metacognition is complete by adolescence or early adulthood. This study suggests that metacognition, as measured by the Metacognitive Awareness Inventory (MAI) tends to increase with age and with teaching experience. Metacognitive regulation and total MAI, in particular, increase as a function of age and teaching experience. It is interesting that metacognitive knowledge did not increase with age in either group (undergraduates of graduates), but did show significant correlation with age in the pooled group. This is probably a result of the larger sample size for the pooled group. The increase in metacognitive regulation skills, however, seems to be a critical shift that occurs as people age and as they work with the learning process in others as professional teachers.

Another interesting result was the finding that teachers of all grade levels from preschool to post-secondary have similar MAI results. While the complexity and detail of content may increase with higher grade levels, it appears that the teachers' awareness of learning strategies is as robust among those who teach younger students as it is for those teaching in high school and college. For teachers, it may be as challenging and require as much metacognitive awareness to teach simple arithmetic as to teach calculus.

If experienced teachers have higher metacognitive awareness than those who are preparing to become teachers, it may justify

further research into metacognitive development in the practicing teacher. It may also support the inclusion of metacognitive awareness courses in college teacher training curricula and in a variety of other fields.

Promoting metacognitive awareness and skills could be a valuable method for improving learning and performance at all ages. Professional teachers work with the process of learning in their everyday activities. Curriculum development and classroom instruction implicitly involve working with metacognitive processes. As teachers plan classroom learning activities, delivery of course content, handouts and other learning materials, homework, and evaluation of students' progress, they consider how their students will learn. "Thinking about other people's thinking" may indeed be another category of metacognition. As teachers gain experience throughout their career, they develop an excellent sense of what works best for their students in the grade level and content area that they teach. This may represent a part of the process of increasing one's metacognitive awareness.

FUTURE RESEARCH

The following topics may be productive to further understanding metacognition in adults.

1. The study indicates that metacognition increases in college educated individuals. A similar study could be conducted on adults in the general population to determine if a similar trend holds for those who have not experienced college education.
2. Is there a difference between teachers who elect to return to graduate school and those who do not? Perhaps those who return for advanced degrees are more comfortable with the formal education process, more committed to a lifelong career in teaching, or have stronger metacognitive skills.
3. What natural processes cause metacognition to increase with age? Does everyone do it the same way? What factors, situations, or experiences foster or impede metacognition? Understanding the natural processes could be used to create training in metacognition. This would be prime territory for qualitative research to develop a grounded theory for the mechanisms by which metacognition changes with age.
4. Why does metacognitive regulation appear to increase with age and teaching experience, but metacognitive knowledge does not? Qualitative research using interviews, field observation of practicing teachers, case histories and other methods could produce penetrating insights into the development of metacognitive skills.
5. Is it possible to teach metacognitive skills to adults and to children? How much time is necessary to practice new skills and incorporate them into one's learning strategy repertoire? Designing curriculum for a workshop in metacognition, and then following up with performance monitoring, surveys, and qualitative inquiry could lead to greater understanding of how metacognition changes in the adult.
6. What are the effects of stress, fatigue and anxiety on adult metacognition? This could have practical implications for performance in a variety of situations including testing, job

interviews, job performance, and communication.

7. Do graduate students in education (mostly experienced teachers) tend to have better metacognitive skills than graduate students in other fields such as business, science, medicine, law, or the arts? Comparison of undergraduates and graduate students in these fields could help discern if the patterns are similar to teachers, or if teaching itself helps one develop better metacognition.
8. Is metacognition correlated with grades and grade point average in undergraduate students? Research with younger students indicates that academic performance is better in those with better metacognitive skills. Similar studies with college students could contribute to the understanding of these processes after adolescence.

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