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Examining the domain-specificity of metacognition using academic domains and task-specific individual differences[1]

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ABSTRACT

Metacognition refers to students' knowledge and regulation of cognition, as well as their accuracy in predicting their academic performance. This study addressed two major questions: 1) how do metacognitive knowledge, regulation and accuracy differ across domains?, and 2) how do students' individual differences relate to their reported metacognition across domains? Participants (N=644) completed a metacognitive questionnaire to assess metacognitive knowledge, regulation, and accuracy. Results suggest that metacognitive knowledge and regulation are domain-general while metacognitive accuracy is domain-specific. Perceived task difficulty and content interest are independently related to metacognitive knowledge, regulation, and accuracy, though the relationships vary among them across domains.

Keywords: Metacognition, Domain-Specific, Interest, Perceived Difficulty

INTRODUCTION

Metacognition is traditionally defined as thinking about thinking or monitoring one's own cognition (e.g., Flavell, 1979; Middlebrooks & Sommer, 2011). Over the past 30 years, much research has been conducted to circumscribe this somewhat elusive construct—fortunately, with considerable success. Major advances have been made in understanding the development of metacognition (e.g., Veenman & Spaans, 2005), its connection to intelligence (e.g., Alexander, Carr, Schwanenflugel, 1995, Jaccard, Dodge, & Guilamo-Ramos, 2005), and its educational implications (e.g., Schraw, 2001; Zaromb, Karpicke, & Roediger III, 2010). However, the generality or specificity of metacognition is not clear. That is, research has not provided enough evidence to know whether one's metacognition remains stable over time and across instances or whether it changes with contextual influences. Veenman, van Hout-Wolters, and Afflerbach (2006) proposed that one of the most important areas for development of metacognition as a theoretical construct is to determine whether it is a general or specific phenomenon.

Educational implications are important in that domain-specific (meta)cognitive skills tend to be more "teachable" with classroom activities and instruction potentially improving these skills, which are related to general academic achievement. Domain-general (meta)cognitive skills present a greater

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challenge for educators in that they tend to be more static and less malleable with instruction. Understanding which aspects of metacognition are domain-general or domain-specific would help educators focus their efforts on skills that have the greatest chance of improving with classroom instruction or activities.

Specifically addressing the educational implications of metacognition, Veenman et al. (2006) wrote: "General metacognition may be instructed concurrently in different learning situations and may be expected to transfer to new ones, whereas specific metacognition has to be taught for each task or domain separately" (p.7). The present investigation was designed expressly to address this by examining the domain-specificity of metacognition across academic domains and based on task-specific individual differences (i.e., interest and perceived difficulty).

There are conflicting results for the generality or specificity of metacognition. Some argue that metacognition is specific to the particular context in which it is manifested (e.g., Kelemen, Frost, & Weaver, 2000); others argue that it is a general, trait-like process (e.g., Schraw, 2001, van der Stel, & Veenman, 2008). Most researchers have taken a componential view of metacognition, rather than a one-dimensional view. However, most have focused on only one component of metacognition in their research. Few studies have assessed the generality-specificity of the components of metacognition together in one study.

Research on metacognition has predominantly focused on three components of metacognition: knowledge, regulation *or* accuracy (e.g. Neuenhaus, Artelt, Lingel, & Schneider, 2011) when examining domain-generality or specificity. Metacognitive knowledge refers to one's understanding of one's own and others' cognitive strengths and weaknesses. Metacognitive regulation is one's ability to monitor (in real time) one's learning and cognitive processes. Lastly, though many definitions are reported (Nietfeld, Cao, & Osborne, 2005; Thiede, Anderson, & Therriault, 2003), the current study defines metacognitive accuracy as one's ability to correctly predict performance, monitor whether individual answers are correct as one proceeds through a task, and correctly evaluate how well one has performed on a particular task. As an operational definition, we focused solely on students' accuracy for evaluating how well they performed after completing their final exam. More research needs to be done to incorporate the multiple aspects of metacognition and to understand how each component interacts with the others and with other variables (interest, perceived task difficulty, academic achievement, etc.).

Many have argued that metacognition is a domain-general process. Schraw, Dunkle, and Bendixen (1995) found that students' performance and accuracy judgments were correlated across all or most of the eight domains studied (e.g., geographical distance between major American cities in miles, the year that eight different American presidents assumed office, the caloric values of eight common foods, etc.). These results led the authors to support the domain-general hypothesis which states that "monitoring within a specific domain is governed by general metacognitive processes in addition to domain-specific knowledge" (p. 434). Additionally, Schraw (2001) asserted that metacognitive knowledge is domain-general in nature. Thus, based on the above evidence, Schraw and his colleagues concluded that metacognitive knowledge and metacognitive accuracy are both domain-general.

Similarly, Veenman, Elshout, and Meijer (1997), using a think aloud protocol, found that metacognition in novice domains (i.e., content areas that were new to the student) was domain-general in nature. The evidence was based upon a *principal components* analysis where multiple metacognitive scores loaded primarily on only one component, suggesting a unidimensional view of metacognition. The domains in which the students took part were three different simulation environments representing physics, statistics, and a fictitious domain. Veenman, Willhelm, and Beishuizen (2004) re-tested the domain-generality of metacognition within a developmental framework by examining fourth-, sixth-, and eighth-graders, and undergraduates. Again, Veenman et al. found that all metacognitive scores appeared to load only on one component. The authors interpreted this as representing general metacognition. However, as with Schraw, et al. (1995), Veenman et al. (1997) and (2004) determined domain-generality of metacognitive skill using either non-academic subjects or laboratory-based methods. Additionally, Veenman's (1997, 2004) findings of similarity of metacognition across domains could have been due to the fact that all domains were within computer simulations with similar interfaces. It is important to understand the domain-generality of metacognition in actual classroom environments with typical curriculum-based tasks.

Although there is evidence for metacognition as a general process, Kelemen et al. (2000) found supporting evidence for metacognition as a contextually specific process. Undergraduate participants were asked to perform four metacognitive tasks (ease of learning judgments, feeling of knowing judgments, judgments of learning, and text comprehension monitoring) in response to computer-based stimuli. Kelemen et al. found that only 8% of the metacognitive accuracy scores remained consistent between tasks. These findings suggest that metacognitive accuracy is a domain-specific process or skill. Additionally, Kelemen et al. found that metacognitive accuracy was variable in a one-week test-retest situation, especially in comparison to memory accuracy and confidence/prediction, which were reliable from time one to time two. In fact, a second experiment within the study replicated the results. These studies show, at least for metacognitive accuracy, that there is a domain-specific and task-specific nature to metacognition. Perhaps some components of metacognition are general processes while others are contextually specific.

Lastly, after several studies validating the hypothesis that metacognition is domain-general, Veenman et al. (2005) found conflicting results. Using systematic observation and computer log-files, results showed that a 12 year-old group showed a low correlation (r=.17) in their metacognitive skills between a mathematics task and a biology task (both computer-based). The 15 year-old group showed a much higher correlation (r=.58) between the two tasks. These results suggested that the younger group had more domain-specific metacognitive skills while the older group appeared to have more domain-general metacognitive skills. However, the sample sizes for the 12 year-old group and the 15 year-old group were 16 and 14, respectively, which is quite low. Despite the limited studies that legitimate the specificity hypothesis, there is some evidence for a mixed model where some components of metacognition are general and some are more specific to the context in which they are used. However, given that most studies examine one component of metacognition at a time, this model remains in question.

It is also possible that task-specific individual differences (in this case, students' interest in their class and perceived difficulty of their exam) may produce a situational specificity for metacognitive knowledge or regulation or show no relationship. If one's metacognition does not change based on these transient student differences, we will have greater evidence of metacognition generality. However, if one shows different metacognitive levels based on one's situational state, there is greater evidence of metacognitive domain-specificity. In this way, both task domains and student differences should be examined simultaneously in light of the metacognitive specificity versus generality debate.

However, few studies have been done with the explicit aim to examine the relationship between metacognition and interest (McWhaw & Abrami, 2001; Tobias, 1995; van Kraayenoord & Schneider, 1999), and similarly, few studies have directly addressed the issue of perceived difficulty and its relationship to metacognitive processes. The results from the existing literature are mixed with some finding that perceived difficulty has no bearing on metacognition (e.g., Coa and Nietfield, 2007) and others finding that there is a relationship between the two (e.g., Burson, Larrick, & Klayman, 2006; Vukman, 2005).

The concept of interest, for this study, is defined as the feeling of a person whose attention, concern, or curiosity is engaged by the content of their particular class (e.g., science, mathematics). The concept of perceived difficulty, for this study, is defined as an individual's view of how challenging the exam will be in relation to his knowledge and confidence.

This study investigated two research questions:

1. What is the nature of the domain-specificity or generality of metacognition?
2. How do the task-specific individual differences of interest and perceived difficulty relate to one's metacognition?

METHOD

A correlational study based on self-report measures was designed to address each of these questions, using multiple regression techniques.

Participants

The participants were undergraduate students from a large midwestern university. Six hundred forty four students participated within their regular final exam time in five subject areas: chemistry (1 class), biology (2 classes), astronomy (1 class), history (2 classes) and education (2 classes). The average self-reported high school Grade Point Average (GPA) for the sample was 3.59. Undergraduate GPA (UGGPA) was not used because students were at varying years in their higher education, and thus UGGPA would be less reliable, and, for some freshman, non-existent. The sample consisted of 53.6 % female and 46.4% male students.

Measures

Metacognitive Knowledge and Metacognitive Regulation

The Metacognitive Questionnaire (see Appendix B) used in this study is composed of 30-items measuring two components of metacognition: metacognitive knowledge and regulation (Scott & Levy, 2008). Participants were asked to complete the survey items based on how they were thinking during their exam. Participants were asked to respond to each item by selecting one of five options on a scale of *strongly agree* to *strongly disagree*. The items on the Metacognitive Questionnaire were adapted from the MAI (Schraw & Dennison, 1994), IMSR (Howard, McGee, Shia, & Hong, 2000), and the SAQ (O'Neil & Abedi, 1996). The Cronbach's alpha for internal consistency of the overall metacognitive questionnaire used in the current study was .90, and the Guttman split-half reliability is .83 (Table 1). Test-retest reliability was not performed because it is hypothesized that some of the components of metacognition change over time.

Table 1: Reliabilities of Metacognitive Knowledge and Metacognitive Regulation Factors

Metacognitive Factor	Cronbach's Alpha (reliability)
Metacognitive Knowledge	α=.85
Metacognitive Regulation	α=.87

Metacognitive Accuracy

Students were asked to provide metacognitive accuracy of their performance on their final exam. Professors provided the students' actual scores from the final exam. Predictions and actual grades from the exam were given in percent form (e.g., 93%). Metacognitive accuracy was defined as the difference between the student's predicted scores and their actual scores on the final exam. To make the metacognitive accuracy variable more clear and interpretable, the absolute value of the difference was subtracted from 100. For example, if a student predicted they would receive 75% on their exam but actually received a 62%, their metacognitive accuracy score would be calculated as: $100-|75-62| = 87$. That is, the student was 87% accurate in their prediction. Thus, metacognitive accuracy scores close to 100 predicted better accuracy than scores at some distance from 100.

Task-specific Individual Differences

Individual students' interest in the class in which they were currently taking a final exam and each student's perceived difficulty of the final exam were collected as measures of students' task-specific differences. Specifically, students were asked to rate their interest in the class via a single item on a four-point scale from "not interested at all" to "very interested." Further, students were asked to rate the perceived difficulty of the exam by comparing it to others they have taken, responding on a four-point scale from "easy" to "very difficult" (see Appendix A).

Procedure

Students in each class were introduced to the study by their instructor via email or in class two to three weeks prior to data collection. On the day of the final exam for each class, either the primary researcher or the instructor gave a brief announcement at the beginning of the exam to remind students of the opportunity for participation in the study. Data collection occurred during the students' regularly scheduled final exam period. All students were told that there was a consent form to be signed before they began their exam. Also, students were told that there was a questionnaire attached to their final exam (in most cases), and they had the option to complete it after they finished their exam. Students were assured that their participation in the study was optional and completely confidential. An incentive was offered to the students who participated. Within each class, one person who completed the survey would be randomly chosen to win a $50 Simon gift card.

After finishing their final exam, students completed the informed consent form and filled out the questionnaire. This process took approximately 5-10 minutes. Any questions that the students had about the survey were addressed by raising their hands and the researcher helped them individually with comprehension issues. Upon turning in their exam, students were given a debriefing letter explaining, in more detail, the purpose of the study. After the instructors graded the final exams in each class, the primary researcher collected the final exam scores and final class grades to compare with the students' initial predictions in order to compare the students' predictions with their actual performances.

RESULTS

Control Variables

Due to the correlational nature of the current study, controlling for potentially confounding variables was important. The control variables were high school GPA, test format, gender, major category, and class domain. High school GPA and gender were obtained through students' self-report on the questionnaire. Test format was obtained from the instructor. The formats fell into three categories (coding in parentheses): multiple choice (2), essay (1), and mixed (0). Because a three level categorical variable cannot be used in a multiple regression, two dichotomous variables were created: 1) mixed versus essay, and 2) multiple-choice versus essay.

Based on self-reported majors, the participants were divided into science versus non-science majors. Lastly, we combined courses from which we collected data into two types of domains. Students taking history and education classes were combined into a "humanities" domain and the students taking chemistry, biology, and astronomy were combined into a "science" domain.

Descriptive Statistics

The average scores for metacognitive knowledge, regulation, and accuracy are provided in Table 2. Also, participants from each of the eight classes used in this study predicted how well they would perform on their final exam in order to establish their metacognitive accuracy. The average predicted, and actual final exam grades are summarized in Table 3.

Table 2: Averages of Metacognitive Knowledge, Metacognitive Regulation, and Metacognitive Accuracy by Class

Class	Metacognitive Knowledge		Metacognitive Regulation		Metacognitive Accuracy	
	M	SD	M	SD	M	SD
Astronomy	27.92	5.24	49.10	10.65	91.36	6.76
Chemistry*	25.73	4.31	53.32	6.65	88.05	12.26
History 1	25.13	4.11	53.90	7.79	94.85	3.67
History 2	28.57	5.00	51.88	9.23	90.17	8.65
Biology 1	24.72	4.67	52.07	8.28	90.49	7.40
Biology 2	25.58	4.99	51.72	7.97	93.34	6.02
Education	29.12	2.87	51.59	7.77	94.34	4.70
Total	26.52	4.84	51.74	8.67	90.82	8.79

*=upper division class

Table 3: Means and Standard Deviations of Students' Predicted and Actual Final Exam Scores by Class

Class Name	Total N	Predicted Final Exam Score		Actual Final Exam Score		Mean Difference Final Exam
		M	SD	M	SD	
Astronomy	155	85.22	8.57	79.19	6.95	6.03
Chemistry*	159	79.21	13.15	72.25	23.45	6.96
History 1	52	85.83	7.16	85.78	5.75	0.05
History 2	51	89.36	6.01	83.73	12.55	5.63
Biology 1	149	80.74	8.81	76.57	12.43	4.17
Biology 2	19	82.95	8.66	78.82	11.82	4.13
Education	59	90.09	5.54	88.00	9.58	2.09
Total	644	83.40	10.23	78.57	16.08	4.83

*=upper division class

Preliminary Analysis.

High school grade point average (HSGPA), gender, test format, subject domain, and major category were examined to establish whether there were differences in metacognition among students taking classes in the two different domains under consideration. There was a significant difference between students in the humanities (history and education) and those in the sciences (chemistry, biology, and astronomy) on high school grade point averages, $F(1, 619) = 23.36$, $p < .01$. Students in the sciences tended to have higher high school GPAs ($M = 3.64$, $SD = .39$) than those in the humanities ($M = 3.46$. $SD = .44$). To test the differences in metacognition, high school grade point average was split into two categories (high and low) at the median of 3.66. Students with high HSGPAs did not differ from those with low GPAs on metacognitive knowledge or regulation or metacognitive accuracy, $F(3, 552) = 1.45$, $p >.05$.

For gender, there were no differences between males and females between the two domains (humanities and sciences), $\chi^2(1, N = 644) = 3.46, p > .05$. Also, there were no significant differences between males and females on the two metacognitive factors (metacognitive knowledge and regulation) and metacognitive accuracy, $F(3, 571) = 2.33, p > .05$.

For test format, there was a significant difference between the domains, $\chi^2(2, N = 644) = 87.51, p < .01$. Specifically, students in the humanities took either multiple choice or essay exams. Students in the sciences took multiple choice, essay, and mixed formats. Also, a multivariate analysis of variance (MANOVA) was performed on test format with metacognitive knowledge, metacognitive regulation, and metacognitive accuracy as the dependent variables. Results suggested that there were significant differences in metacognitive regulation and metacognitive accuracy based on test format, $F(6, 1140) = 6.74, p < .01$. Tukey post hoc analyses revealed that students who took an essay exam (M = 53.16, SD = 7.54) or a multiple-choice test (M = 52.06, SD = 7.88) reported significantly higher metacognitive regulation than those who took a mixed format test (M = 49.33, SD = 10.90). Also, those students who took essay exams experienced worse metacognitive accuracy on their exam grade (M = 1.03, SD = 1.08) than those who took multiple-choice tests (M = .83, SD = .67).

These results suggest that the variables showing significant differences between domains should be carried into multiple regressions as control variables since the two groups started out at varying levels. Considering these variables as control will help to establish a baseline of equality between the domain groups in further analyses.

3.2.2 Correlations. Table 4 presents correlations between all variables. Of note, metacognitive knowledge was moderately correlated with predicted exam scores and actual exam grades, whereas metacognitive regulation was not statistically significant. Metacognitive knowledge and regulation were moderately correlated to each other ($r = .32, p < .01$). Also of interest, metacognitive accuracy (exam) was slightly positively correlated with metacognitive knowledge ($r = .13, p < .01$) and interest in class material ($r = .09, p < .05$). This means that the more metacognitive knowledge or interest in a class, the more accurate the student's prediction. Metacognitive accuracy had a low, negative correlation with perceived difficulty of the exam ($r=-.17, p < .01$). That is, the more difficult students found the exam, the less accurate they were in their predictions of how well they would do on the exam. Surprisingly, metacognitive accuracy was not correlated with metacognitive regulation, especially since the prediction took place after they had taken the exam and regulated their progress throughout (see Table 4).

Table 4: Pearson Product-Moment Correlations for all variables

	1	2	3	4	5	6	7	8
1 HSGPA	-	ns	.14**	.10*	ns	ns	ns	ns
2 Predicted Exam Score	ns	-	.68**	.19**	-.49**	.26**	.51**	ns
3 Exam Score	.14**	.68**	-	.66**	-.33**	.24**	.38**	ns
4 Accuracy Exam	.10*	.19**	.66**	-	-.17**	-.10*	.13**	ns
5 Difficulty	ns	-.49**	-.33**	-.17**	-	ns	.42**	.10*
6 Interest	ns	.26**	.24**	-.10*	ns	-	.25**	.21**
7 Metacognitive Knowledge	ns	.51**	.38**	.13**	.42**	.25**	-	.32**
8 Metacognitive Regulation	ns	ns	ns	ns	.10*	.21**	.32**	-

Note. *p<.05, **p<.01

Differences between Domains and Task-Specific Individual Differences

The main research question within this study was the domain-specificity of the components of metacognition. Thus, data from the classes were allocated into two domains: humanities (Education and History) and sciences (Biology, Chemistry, Astronomy). Initial t-tests were conducted to examine the possible differences in metacognition between domains. For metacognitive knowledge, there was a significant difference between domains, t(638) = 3.53, $p < .01$. On average, students in the humanities (M = 27.67, SD = 4.38) report higher metacognitive knowledge than those in the sciences (M = 26.13, SD = 4.93). For metacognitive accuracy, there again was a significant difference between domains, t(576) = 3.95, $p < .01$). On average, students in the humanities (M = 93.21, SD = 6.28) have better metacognitive accuracy than those in the sciences (M = 89.97, SD = 93.21).

There were no significant differences between domains for metacognitive regulation. The differences between the domains could be considered spurious because there are many possible confounding variables. Thus, multiple regressions were performed to test for differences between domains while controlling for possible confounding variables. Within the same models, independent relationships of task-specific individual differences on metacognition were tested, while controlling for domain and other confounding variables.

Separate regression models were performed for metacognitive knowledge, metacognitive regulation, and metacognitive accuracy with all variables entering the model simultaneously. The model included several control variables (HSGPA, gender, test format, and major category) and three predictor variables (domain, difficulty of the exam, and students' interest in the class).

For metacognitive knowledge, the overall model was significant, F(8, 556) = 22.47, $p < .01$, adjusted $R^2 = .24$ (see Table 5). Most importantly, there was no independent relationship between domain and metacognitive knowledge. These results suggest that metacognitive knowledge is domain-general; it does not vary across domain. However, both measures of task-specific differences (perceived difficulty and interest) were each independent significant predictors of metacognitive knowledge. Students' perceived difficulty of the exam was the strongest predictor of metacognitive knowledge, almost one and a half times as strong as perceived interest. Interaction terms were tested between domain and task-specific differences (interest and perceived difficulty), but neither was significant. Results suggest that when perceived difficulty of the exam increased, students tended to report lower metacognitive knowledge. As interest in the class increased, students tended to report higher metacognitive knowledge. Based on these results, task-specific individual differences suggest a "context" specificity of metacognition. That is, different context, rather than content domain, leads to varying levels of metacognition.

Table 5: Coefficients for Metacognitive Knowledge Regression Model

	B	beta
Gender	.09	.01
HSGPA	.75	.07
Essay vs. Multiple Choice	-.57	-.06
Essay vs. Mixed	1.32*	.12*
Major Category	.14	.01
Domain	-.90	.51
Interest	1.30**	.26
Difficulty	-2.32**	-.36**
Adj. R^2	.24	

Note. Metacognitive knowledge as outcome variable.
* indicates p<.05, ** indicates p<.01

For metacognitive regulation, the overall model was again significant, F(8, 556) = 5.57, $p < .01$, adjusted $R^2 = .06$ (see Table 6). As expected from the initial t-tests, there was no significant relationship between domain and metacognitive regulation. Thus, it appears that both factors of metacognition are domain-general. However, students' interest in the class material did have an independent significant relationship with metacognitive regulation. Perceived difficulty was found to be non-significant. The interaction terms again were found to be non-significant. Similar to metacognitive knowledge, an increase in interest in the class predicted higher metacognitive regulation. Again, a potential “context” specificity of metacognitive is revealed based on task-specific individual differences, namely, interest in the subject-matter. However, these results from this model should not be overextended because the model only accounted for 6% of the total variance.

Table 6: Coefficients for Metacognitive Regulation Regression Model

	B	beta
Gender	.62	.04
HSGPA	-.25	-.01
Essay vs. Multiple Choice	-.87	-.05
Essay vs. Mixed	-2.53*	-.13*
Major Category	-.23	-.01
Domain	.55	.03
Interest	1.69**	.19**
Difficulty	.98	.09
Adj. R^2	.06	

Note. Metacognitive regulation as outcome variable.
* indicates p<.05, ** indicates p<.01

For metacognitive accuracy, the overall model was also significant, $F(8, 506) = 7.31$, $p < .01$, adjusted $R^2 = .09$ (see Table 7). Domain was found to have a significant relationship with metacognitive accuracy. Students in the sciences were less accurate in their predictions of exam performance than those in the humanities. The interactions between domain and task-specific differences (interest and perceived difficulty) were not significant. This result suggests that at least one aspect of metacognition, metacognitive accuracy, is domain-specific. Also, perceived difficulty of the exam had a significant relationship with metacognitive accuracy. Specifically, as the level of difficulty of the exam increases, predictions of performance on the exam were less accurate, again providing evidence of “context” specificity.

Table 7: Coefficients for Metacognitive Accuracy Regression Model

	B	beta
Gender	.64	.04
HSGPA	2.80**	.99**
Essay vs. Multiple Choice	1.45	.08
Essay vs. Mixed	3.39**	.16**
Major Category	.89	.05
Domain	-4.25	-.21
Interest	.92**	.43
Difficulty	-1.27**	-.10*
Adj. R^2	.09	

Note. Metacognitive accuracy as outcome variable.
* indicates p<.05, ** indicates p<.01

DISCUSSION

The overall purpose of the study was to explore the generality or specificity of metacognition. Research has not provided enough evidence to show whether one's metacognition remains stable over time and across instances or whether it changes with context. This study was designed to address two questions: first, are metacognitive knowledge, regulation, and accuracy domain-specific or domain-general?; and second, how do students' perceptions relate to their reported metacognition across academic domains? Results suggest a mixed view of the domain-specificity/domain-generality of the metacognitive components. A mixed view suggests that metacognitive accuracy was different across domains regardless of the perceived difficulty of the test, interest, test format, and demographic characteristics of the students. Further, although metacognitive knowledge and regulation were not different across domains, they were related to students' perception of their learning environment, in this case, their interest in the content and perceived difficulty of their exam.

Interest and Perceived Difficulty as a Function.

Interest. Students' interest in the material they were being tested on was a significant independent predictor of metacognitive knowledge and metacognitive regulation. In all cases, the more interested students were in class material, the higher their reported metacognitive knowledge and metacognitive regulation. This result makes conceptual sense in that interest in something should affect one's level of attention to detail and knowledge of personal strengths and weaknesses within an area of study. Therefore, higher interest in the content of a course may increase levels of focus in regulating and monitoring progress and understanding.. This contextual-specificity of metacognition brings a new perspective on the domain-generality or domain–specificity debate.

This finding is consistent with the few studies that explicitly link interest and metacognition. Van Kraayenoord et al. (1999) suggested that metacognitive knowledge was positively related to interest in the topic being studied. Also, McWhaw et al. (2001) revealed a positive relationship between metacognitive regulation and interest. Most literature has only examined one component of metacognition at a time with respect to interest. While the results from the current study match those of previous research, it is important to note that both metacognitive knowledge *and* metacognitive regulation were incorporated in the current study. A more convincing argument can now be made for the positive relationship between students' interest in a topic their reported metacognition.

It was also suggested (Tobias, 1995) that metacognitive accuracy would be positively related to interest. Metacognitive accuracy, for the current study, is the students' ability to predict their score on their final exam. The results of the current study support the argument. Students with high interest in their class, regardless of demographic differences, had considerably better accuracy in predicting their score on their final exam. Conversely, students with relatively low interest in their class had lower accuracy in predicting their score. It is important to note, however, that the relationship between interest and metacognitive accuracy was relatively small compared to relationship for metacognitive knowledge and metacognitive regulation. Therefore, although there is a positive relationship between interest and metacognitive accuracy, the relationship is not driving the overall model. Although the results provide a clear relationship between metacognition and interest, more research should be done in this area because there is a dearth of studies that address this association.

Perceived Difficulty. Perceived difficulty of students' final exams related negatively to metacognitive knowledge and metacognitive accuracy, similar to previous findings (Burson, et al., 2006; Vukman, 2005). Metacognitive regulation did not show an independent significant relationship with perceived difficulty, although it was trending toward significance (p = .07). As with interest, little research directly examines the relationship between perceived level of difficulty and metacognition and metacognitive accuracy. The results from the current study suggest that if students perceive an exam as being easy, they report greater metacognitive knowledge. That is, they feel they know more about their cognition when they are not overwhelmed by the difficulty of an exam.

In line with Vukman (2005), the results also suggest that students are less accurate in their predictions of their exam score when the exam is perceived as difficult. Students may have a hard time predicting their score accurately when they are overwhelmed by the difficulty of the exam. If the exam is perceived as easy, students may have a better chance to assess what score they would receive without the added burden of worrying about the difficulty of the exam. This context-specificity of one aspect of metacognition suggests that decreasing one's perceptions of difficulty in a course and increasing one's interest in the material may lead to enhanced metacognition (e.g., Everson & Tobias, 1998; Isaacson et al., 2006; Tobias, Everson, & Laitusis, 1999).

Domain-Specificity of Metacognition

One of the most contentious issues in the metacognitive literature is the domain-specificity or generality of metacognition. Few researchers have found support for the domain-specificity of metacognition (e.g., Kelemen, et al., 2000). Many have argued that metacognition is a domain-general process that remains constant among different learning contexts and environmental contexts (e.g., Schraw, 2001). However, the results of this study provide evidence for a mixed theory of domain-specificity/generality of metacognition. The personal "context" of students (perceived difficulty and interest) differentially predicts the two components of metacognition. If metacognition were a general characteristic that does not change across contexts, there would be no relationship between the task-specific individual differences and their reported metacognition.

More generally, the results support a mixed view of variability across domains. That is, metacognitive accuracy was different across domains regardless of the perceived difficulty of the test, interest, test format, and demographic characteristics of the students. These findings support the previous literature proposing domain-specificity (Kelemen, et al., 2000; Maki, Shields, Wheeler, & Zacchilli, 2005). In the current study, metacognitive accuracy was better for students in the humanities classes compared to students in the science classes. This provides evidence that at least metacognitive accuracy is not being reported at similar levels across domains.

However, later analyses indicated that the "actual" difficulty of the exam varied by domain as well. That is, accuracy was different as a function of domain, and the actual difficulty of the exam also varied by domain. Specifically, scores on the final exams were significantly lower in the sciences compared to the humanities. Thus, in examining differences in domain by students' accuracy in predicting their score, there is a confounding variable of the actual difficulty of the exam. Given the purpose of the study and the number of control variables examined, actual exam scores were not used in the regression model for metacognitive accuracy. However, it should be noted that the accuracy measure was constructed from actual scores. Future studies will need to examine this issue more deeply and take the actual difficulty of the exam into account.

Metacognitive knowledge and metacognitive regulation were found to be domain-general, supporting claims in the previous literature (e.g., Schraw, 2001; Veenman, et al., 2001). That is, these two components of metacognition did not differ across domains, after controlling for all relevant confounding variables. Most of the literature examining domain-specificity or domain-generality only focused on one component of metacognition. The current study examined three different types of metacognition with the same sample and across the same domains. This makes the results more consequential and provides stronger evidence.

Overall, the results point strongly to a mixed theory of domain-specificity/domain-generality and context-specificity of metacognition. One drawback in this study was the fact that the same students were not followed into various classrooms. If the same student showed different or similar levels of metacognition in each of his classes, the evidence would be stronger for domain-specificity or domain-generality. However, because care was taken to control for possible differences between the students in the different domains, it can be argued that there is evidence of difference in metacognitive *accuracy* across domains but more stable levels of metacognitive *knowledge* and *regulation* across domains.

Conclusions

There are two main conclusions from this study. Students' perceptions of difficulty and their level of interest in a class had strong relationships with metacognition. This points to context-specificity of metacognition. That is, the perception of a context (such as level of difficulty of an exam) may affect a student's level of metacognition. More research should be done to examine directly the context-specificity of metacognition. This could be done by following the same students from class to class, asking them about situational factors (such as interest and level of difficulty) and level of metacognition. Although their level of metacognition may stay the same across domains, their task-specific differences may have a marked relationship with their reported metacognition within and between domains.

These results have the potential to influence how educators attempt to increase students' metacognitive skills. Perhaps by focusing on the learning environment, enhancing students' interest in the course materials and increasing their confidence in taking exams, educators can increase students' ability to regulate their thinking and monitor their cognitive strengths and weaknesses. However, due to the correlational structure of the present study, it is not possible to show a directional relationship between interest and perceived difficulty and metacognition.

Metacognitive knowledge and metacognitive regulation were found to be domain-general, while metacognitive accuracy seems to be more domain-specific. Thus, a mixed model of domain-specificity/domain-generality should be explored further. Blanket statements about metacognition as domain-specific or domain-general should be reexamined in light of the results presented here.

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APPENDIX A

Student Information Questionnaire

1. Name _________________________ Date __________Email________________
2. Please indicate which class you just took your exam in: _______________ (ex. HIST-H105)
3. Gender: Male Female *circle one*
4. What was your high school GPA? ________ (4-point scale)
5. If you took the SAT, what was your total score? ________/ out of 1600 or 2400 *circle one*
6. If you took the ACT, what was your total score? _______
7. What percentage (score) do you think you earned on this exam? ______(ex. 86%)
8. What grade do you expect to get in this class? ______________ (ex. B+)
9. How difficult was this exam compared to others you have taken? *circle one*
   easy sort of easy difficult very difficult
10. How interested are you in the material you are learning in this class? *circle one*
    not interested at all sort of interested interested very interested
11. What is your major? (If undecided, please write "undecided" in the space provided)

APPENDIX B

Metacognitive Questionnaire

Directions. A number of statements which people have used to describe themselves are given below. Read each statement and indicate how you thought during the test. There are no right or wrong answers. Your teacher will not grade this. Do not spend too much time on any one statement. Please describe yourself as you are, not how you want to be or think you should be. Remember, give the answer which seems to describe how you thought during the test.

Students indicated their level of agreement with the following statements by ***circling*** a response on the following scale:

Strongly Agree Agree Unsure Disagree Strongly Disagree

1. I knew my strengths and weaknesses for this test.
2. I was good at organizing the information for the test.
3. I was good at remembering the information for the test.
4. I paced myself in order to have enough time.
5. I tried to determine what the test required of me.
6. I made sure I understood just what had to be done and how to do it.
7. I was able to make myself memorize something.
8. I stopped and reread when I got confused.
9. I asked myself if there was an easier way to do things after I finished the test.
10. I set specific goals before I began the test.
11. I went back and checked my work.
12. I looked back at the problems to see if my answers made sense.
13. I made sure I completed each step.
14. I changed strategies when I failed to understand.
15. I knew what information was most important to learn.
16. I stopped and re-thought about a step I had already done.
17. I asked myself if I considered all my options after I solved a problem.
18. I thought through the meaning of the test questions before I began to answer them.
19. I read the instructions carefully before I began the test.
20. I found myself pausing regularly to check if I understood.
21. I slowed down when I encountered important information.
22. I asked myself if what I was reading made sense.
23. I checked my work while I was doing it.
24. I asked myself how well I accomplished my goals when I finished.
25. I knew what the instructor expected me to learn.
26. I almost always knew how much of the test I had left to complete.
27. I had a specific purpose for each strategy I used.
28. I asked others for help when I didn't understand something.
29. I re-evaluated my assumptions when I got confused.
30. I stopped and went back over new information that wasn't clear.