Assessing and Further Exploring the Metacognitive Skills of Pre-service Teachers

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This study made use of cluster analysis in order to explore new themes of metacognition in the areas of test-taking, reading proficiency, and mathematical problem-solving. The sample came from 55 pre-service teachers in universities around the National Capital Region of the Philippines. Results showed that 10 new themes emerged, excluding one previously mentioned by other studies. These themes of metacognition are planning, mental imagery, motor skills, visuals, selective learning, concretizing, finding relationships, rehearsal and repetition, comprehension-monitoring, social support and self-improvement. There were nine themes emerged from the planning for a test category, eight for reading a book, and eight for solving a mathematical problem. One unique theme, which is self-improvement, emerged in the mathematical problem-solving category.

Keywords: Metacognition, test-taking, reading proficiency, and mathematical problem-solving

Metacognition refers to understanding of an individual about his/her systematic thinking and his/her own learning process. According to Flavell (1979), "metacognition" is a students' knowledge about and control over his or her own thinking process and learning activities. Furthermore, the thought of "metacognition" takes account of the thinking about the thinking process, self-awareness, understanding, memory techniques, and learning characteristics. Metacognitive strategies assist students to direct their attention, in an understanding of the subject matter, to link previous knowledge with new information and to code them in their memories (Paris & Jocobs, 1984). The endeavor of metacognitive strategies is to train students how to put objectives and how to be efficient and independent.

Metacognitive strategies are associated to how we think and learn (Ashman & Conway, 1993). Reviews on the strategies of metacognition include three similar skills: Planning, monitoring, and

evaluation (Cross & Paris, 1981). Ridley, Schutz, Glanz, and Weinstein (1992) distinguished that metacognition is composed of multiple skills that include taking conscious control of learning, planning, and selecting strategies, monitoring the progress of learning, correcting errors, analyzing the effectiveness of learning strategies, and changing learning behaviors and strategies.

Metacognition is generally defined from a western standpoint, there has been an attempt to investigate its nature and relevance in an Asian setting (Agler, Moore, & Zabrucky, 2009). In an effort to find if cultural factors influence metacognition, Taiwanese and Western students' metacomprehension and their ability to calibrate their reading performance were investigated. In connection with this, it has been shown that Asian students are more confident than western students in gauging how much they understand about general world knowledge (Agler, Moore, & Zabrucky, 2009). When it comes to knowledge about reading, it was found that Taiwanese college students are better than their Western counterparts in evaluating how they fared in a comprehension test and predicting their score in it (Agler, Moore, & Zabrucky, 2009).

In the aspect of metacognition and reading skills in the Asian context, a study revealed that the most used strategies were rereading, guessing, contextualizing, and visualizing (Atan, Ghafar, Hamdan, & Sihes, 2010). However, it was proposed that beyond these are more needed strategies such as differentiating facts from opinion, evaluating both sides of issue, and reflecting on the gist of the text. These were not too popular metacognitive skills among the Malaysian sample.

The fact that English is predominantly a second language in Asia has prodded researchers to find ways to seek for more metacognitive strategies that will improve the students' reading comprehension of English texts. Because second language learners are not able to attain proficient levels of reading without having solid proficiency in the language, Western students have an inherent leverage over Asian students in reading and more so, understanding English texts (Atan, Ghafar, Hamdan, & Sihes, 2010). This is supported by the idea that reading is a complex activity that requires not only cognitive but also perceptual and linguistic skills.

When it comes to reading a book or any reference, it is essential that before starting any reading assignment, students must be knowledgeable on how to develop and use their planning, monitoring and evaluation skills. It is of great importance to improve the questioning skills of students in the process of teaching (Hutt, 1997).

According to Blakey and Spence (1999), students have to ask themselves the following questions in order to be successful in reading comprehension: What is the main idea of reading text? How many supportive ideas are there in the reading text? How can supported details be explained? What kind of examples are given? Are the examples clear and understandable enough to enable me to understand the main idea? What are the important names, places and dates mentioned in the text? Do I need to read the text again? Should I check the dates, names, concepts, etc in the text again? Such questions will ensure that the students focus on the reading text.

By asking questions about the main idea of the text, its supporting details, crucial names and dates, students are able to direct their attention on understanding the text. Moreover, individuals who approach reading in a strategic manner by employing specific reading techniques are considered to be successful readers.

Because of these findings, it was proposed that students must be taught to "plan before any reading activity, how to prepare a monitoring plan during the reading activity and how to prepare an evaluation plan after the reading activity" (Senay, 2009).

Studies on metacognition and reading comprehension manifests strong relations concerning the use of strategies, awareness and reading comprehension. Successful readers are more attentive of premeditated reading and they probably use strategic reading techniques. The understanding and reading skills of students who are trained on metacognitive strategies improve (Garner, 1987). Awareness about reading strategies is an important cognitive gain.

Moreover, reading is the most fundamental tool for learning for students. Learning and implementing special reading strategies and specializing in the implementation of such strategies enable not only a more efficient use of time but also an easier and more sustained period of reading (Garner, 1987). Increasing brainpower at the time of reading is directly related to developing strategic reading skills. The student who is made aware that the thinking process requires the use of metacognitive strategies can develop strategic reading skills and think about the process of thinking.

Another study using a Singaporean sample delved into investigating metacognition's relationship with everyday problem solving (Bergin, Lee, & Teo, 2009). It was hypothesized that six factors, three from each component of Metacognition namely knowledge of cognition and regulation of cognition will emerge as different ways by which problem solving is related to metacognition. Under knowledge of cognition are procedural, conditional, and declarative while under regulation of cognition are planning, monitoring, and evaluating. These six factors did not prove to be emerging constructs among the Singaporean students' responses. However, it was established that Singaporean students clearly differentiated and practiced knowledge and regulation of cognition respectively (Bergin, Lee, & Teo, 2009). The gap in these studies would be the ways these components of metacognition are practiced specifically in problem solving. The researchers attributed the weak manifestation of the six factors in everyday problem solving among students to the claim that perhaps as individuals gain more content-specific knowledge over the time, the strategies employed to understand it also becomes more domain-specific. Because of this, a domain-general approach to metacognition does not relate clearly with a general concept like everyday problem-solving (Bergin, Lee, & Teo, 2009).

When it comes to problem solving, a person's cognitive style can persuade his performance and attainment in learning (Riding & Pearson, 1994). The ease that an individual experience solving a problem also depends on the study strategy engaged. According to Leahey and Harris (1997), a problem happens when there is a gap that separates a person from his goal. Problem solving is present in several aspects of problem solving, from games to real life problems. Leitze and Melser (2005) said that if students were able to connect what they have learned inside the class with the events outside, they were able to maintain and appreciate information better. It was also highlighted that strategies such as cooperative learning, peer interaction and

evaluation, monitoring through questioning, and think aloud techniques were also used in developing mathematical problem solving (Dull & Schleifer, 2009).

The specific elements of metacognition in problem solving are said to be the identification of goals, organization of the points in a problem, progress-monitoring of arriving at the solution, recognition of barriers that may hinder progress, and the confrontation of these barriers (Dull & Schleifer, 2009). Students who were trained in metacognitive orientation exhibited better performance than students in a control group in match achievement, math reasoning, and metacognitive knowledge of problem solving (Dull & Schleifer, 2009).

When it comes to preparing for a test, the ability to monitor the helpfulness of one strategy versus another develops with age. Adults discern the utility of a strategy spontaneously by using the strategy and through experiences with tests, and they will use this information to regulate subsequent study selecting more effective strategies (Son & Metcalfe, 2000). Older children, although less accurate than adults, also monitor the utility of a particular strategy by using it and gaining feedback through tests, however, they fail to use this information to regulate study without explicit feedback regarding test performance. Young children do not appear to accurately monitor the utility of a strategy even when given an opportunity to monitor their test performance.

The capability to monitor learning during study (prior to test) also develops with age. Dufresne and Kobasigawa (1998) showed that children as young as third grade recognized that it was easier to learn related items (e. g., bat and ball) than unrelated items (e.g., frog and table), whereas first graders fail to monitor the difference between these items. This difference in monitoring accuracy influenced regulation of study. Older children chose to restudy the more difficult items, whereas younger children appeared to randomly select items for re-study.

In some cases, adults moderately accurately monitor their own learning (e. g., when monitoring associative learning after a delay). That is, in these situations, adults precisely distinguish better-learned material from less-learned material (Dufresne & Kobasigawa, 1998). However, in other cases, such as attempting to monitor comprehension of texts, even adult's monitoring accuracy is less than remarkable. Nonetheless, adults use this monitoring to guide subsequent study, typically opting to restudy material perceived as less well learned over material perceived as better learned. Moreover, monitoring accuracy is related to learning - higher accuracy is associated with greater test performance.

Aside from monitoring, planning, evaluating, and control over strategies are also essential tools in preparing for an exam. It was affirmed that college students who exhibited through planning, monitoring, evaluating, and control over strategies used while preparing and taking the exam garnered higher test scores than those who did not (Dull & Schleifer, 2009). This also suggests the importance of being aware of self-regulatory skills and practicing them with constancy in order to be better test-takers (Dull & Schleifer, 2009).

Following Bergin, Lee, and Teo's (2009) claim, it can now be inferred that metacognition among older students is better seen and explained in domain and content-specific areas. Despite having an ongoing debate if metacognition is general or domain-specific and what are the ways they are said to be so. Metacognition can

still be expressed or studied within a specific discipline, thereby intensifying what we know about its nature and operation in that discipline. There are still metacognitive strategies that remain distinct from the others (Dull & Schleifer, 2009).

Because of this, it is the researchers' aim to add to the previous Asian studies by highlighting domain-specific and culture-specific similarities and differences of metacognition by investigating the different metacognitive strategies Filipino college students employ in reading comprehension, test-taking, and mathematical problem solving. Moreover, the fundamental presence of these three areas in the course of one's learning add to the importance of investigating how a higher-order thinking skill such as metacognition is practiced by students in higher education.

The goal of this research is to determine specific metacognition strategies used by hgher education students during problem solving, reading comprehension and taking a test. The themes that will come out can be compared to the type of metacognition used in previous studies. The present study determined whether the new themes that will emerge will converge with earlier findings.

Method

Participants

The participants were 55 pre-service teachers from different universities in the National Capital Region (NCR) in the Philippines. All participants are proficient in English and are from 16 to 21 years old taking a course related to psychology. Prior to answering the protocol, they already have taken a course that discussed metacognition.

Procedure

An open-ended protocol questionnaire composed of three items were administered to the respondents. The items were, "How do you prepare for an exam?", "What do you do in order to make sure that you understand what you are reading?", and "What are the steps you undergo in solving a math problem?" All responses were written in English and were answered under no time limit or class incentive. The three questions assessed the use of specific metacognition in the areas of taking a test, reading comprehension, and mathematics problem solving respectively.

Data Analysis

Following Creswell's (1998) cluster analysis, the answers in the form of short descriptions for each question were read. Afterwards, significant responses within each question were extracted and grouped according to its similarity of meaning. Once grouped into similar meanings, the responses were finally integrated under different themes.

Results

New themes of metacognition were generated that summarize the experience of using different skills in test-taking, reading proficiency, and solving a mathematical problem. Nine themes emerged from the test-taking category, eight for reading proficiency and eight for solving a mathematical problem.

Mental imagery, motor skills, selective learning, rehearsal and repetition are themes that manifested across all three categories.

Visuals, concretizing, and finding relationships emerged to be the similar between test-taking and reading proficiency while planning and social support are similar themes between test-taking and solving mathematical problems. Only the comprehension-monitoring theme appeared to be common between reading proficiency and mathematical ability. Lastly, self-improvement distinctly appeared in the mathematical ability.

Table 1
Similar Metacognitive themes across the three Academic Tasks

	Mathematics Problem Solving	Reading comprehension	Test-taking
Mathematics Problem Solving	---		
Reading comprehension	comprehension-monitoring	---	
Test-taking	planning and social support	Visuals, concretizing, and finding relationships	---

In preparing for an exam, while planning is a main component of regulation of cognition, it is interesting to note that it did come out as a students' strategy when reading a book. Moreover, planning has emerged as a strategy in solving a mathematics problem when students' follow the steps in outlining. Comprehension monitoring approach emerged to be similar for mathematics problem solving and reading comprehension. This method ensure one's understanding of a reading material for both literary and problem situations encountered.

For the other themes, mental imagery has been seen across the three different academic tasks. This theme establish the importance and frequency of using visual organizers whether it is to remember important concepts, understand a story better, or memorize math formulas. This is also enhanced by the students' strategy to develop their learning by resorting to visual clues by highlighting their handouts or texts.

Another way of making sure that all crucial concepts are stored in one's memory is through selective learning. Through this method, students take note of details among all the amassing information they are confronted with. Being aware of what to remember and of what to place importance on also reinforces one's ability to

make necessary connections to further one's learning. The ability to relate and bridge different knowledge gained also emerged as one of the dominant practices that students have.

Because motor skills can also be considered as one's deliberate performance of actions, it can be observed that students seem to imbibe the lessons when they engage in writing reviewers or taking down notes for themselves. When they continuously write about what they are learning, speed reading using their fingers, and practice solving mathematics problems, students also increase their familiarity with the given topic. This familiarity is further strengthened across the three tasks by strategies that foster rehearsal and repetition such as re-reading, re-writing, and re-solving.

Finding relationships also extends to creating or looking for links between academic knowledge and real life can also reinforce what has been rehearsed or repeated. It was found out that a metacognitive strategy used by students to regulate their cognition is concretizing or connecting what they learn in school with their experiences outside the academic setting.

Furthermore, there were also strategies that were not as explicit as those that were already mentioned and given emphasis in other studies. It was found out that social support and self-improvement were two concepts that students consider to be factors that govern regulation of cognition. While self-improvement maybe a constant mindset or reminder to pursue the three academic tasks, social support is more of an awareness that learning also flourishes when one has a partner, a group, or someone whom one can immediately seek assistance from.

Discussion

The purpose of this research is to compare the metacognitive themes that emerged in three academic tasks to previous studies that also explored the different themes of metacognition. The study intends to determine whether new themes will emerge and pinpoint which themes will remain consistent with use of cluster analysis.

It has already been established that metacognition involves managing one's cognitive skills. Through this study, the researchers were able to examine the different themes of metacognitive skills that college students employ in three different areas namely test-taking, reading proficiency, and solving mathematical problems.

Previous studies reported five dominant themes of metacognition namely planning, information management, monitoring, debugging and evaluating (Schraw & Denisson, 1994). However the present study aimed to explore other metacognitive skills that students employ and come up with more specific academic tasks. The present study was able to generate ten new themes that will hopefully enable educators to further understand the concept of metacognition.

Based on the cluster analysis, mental imagery, motor skills, selective learning, rehearsal and repetition are the themes that manifested across all three academic tasks. When each pair of categories were compared, visuals, concretizing, and finding relationships emerged to be the similar between test-taking and reading comprehension while planning and social support are similar themes between test-

taking and solving mathematical problems. Only the comprehension-monitoring theme appeared to be common between reading comprehension and mathematical ability. Self-improvement solely emerged in the mathematical ability category.

Both test-taking and reading comprehension tasks involve reading through text where the learner makes use of mental imagery in order to convey meaning. The individual thinks of concrete elaborations and finds relationship among ideas in order to fully understand the text.

Both test-taking and mathematical problem solving are common in finding the answer to a problem. Executing the answer is better facilitated when learners engage through careful planning and ask assistance from others (social support). Word problems are better solved when individuals accomplish the task in pair or in group (Briñol & DeMarree, 2012).

Learners use their reading comprehension in order to solve mathematical problems. Comprehension monitoring is needed in both tasks whether learners engage in reading a literary passage or reading word problems. Comprehension monitoring is needed to facilitate better performance in both tasks.

In relation to previous literature about the Asian perspective on metacognitive strategies, it has been claimed that Asians prefer re-reading, visualizing, and contextualizing (Atan, Ghafar, Hamdan, & Sihes, 2010). These strategies were in line with the current findings that repetition or rehearsal, mental imagery, and concretizing are some of the metacognitive skills that pre-service teachers utilize in order to better understand their reading assignments. With regards to test-taking and problem solving, self-monitoring is the main tactic that Asian students use. However, current results show that comprehension monitoring was only evident in both problem solving and test-taking.

Consistent with Shimamura's (2000) findings that monitoring one's learning is important when engaging in activities that require metacognitive skills and that selective attention and self-awareness do take place when people are confronted with metacognitive tasks. The present study was able to strengthen the idea that metacognitive skills do not only revolve around five categories as claimed by previous researchers. This implies that metacognition is a multidimensional construct and different metacognitive skills are dominant with specific academic tasks.

This present study only explored different strategic themes of metacognition, the next step is to verify how effective these strategies are and what role they play in the students' academic achievement. If these questions are answered through future research, then it will open a new perspective on how metacognition is utilized by students and what sets it apart from other cognitive strategies strategies.

In preparing for a test, reading a text, and solving a math problem, there were 11 main metacognitive processes by which students' strategies were classified under. Aside from Planning which was brought up by Schraw and Denisson (2010), there was the use of mental imagery, motor skills, visuals, selective learning, concretizing, finding relationships, rehearsal and repetition, comprehension monitoring, social support, and self-improvement. Out of these 11 processes, only one was task-specific. It was found out that respondents only engaged in comprehension-monitoring during reading activities. Given the clustering of strategies into different themes, this study explained the phenomena of regulating one's cognition in the context of three

important academic tasks that students face frequently. The assessment of metacognition can be further conducted by using more specific components for specific tasks. The assessment of metacognition should involve multiple criteria.

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