Thinking Beyond Thinking: Junior High School Students' Metacognitive Awareness and Conceptual Understanding of Integers

Janina C. Sercenia[1], Edwin D. Ibañez[2], Jupeth T. Pentang[3,4]

[1]De La Salle University, Manila, Philippines,

[2]Central Luzon State University, Science City of Muñoz,

[3]Western Philippines University, Puerto Princesa City, Philippines,

[4]Wesleyan University - Philippines, Cabanatuan City, Philippines

janina_sercenia@dlsu.edu.ph, edwindibanez@clsu.edu.ph, jupeth.pentang@wpu.edu.ph*

Abstract: The potential benefits of cognitive skills in enhancing mathematics ability have been claimed by numerous researchers. Since mathematics requires a complete understanding and grasp of abstract concepts, it is essential to explore how learning with metacognitive skills affects mathematics learning. Thus, the study investigates the students' metacognitive awareness and conceptual understanding of integers. A descriptive-correlational method approach was utilized, and it was carried out on 303 seventh-grade students. The data were obtained using a metacognitive awareness inventory and achievement test on integers. It was further revealed that the students have average metacognitive awareness and performed well in the fundamental operation of integers. Follow-up qualitative analysis revealed that students who were high achievers had the best understanding, average achievers had corrected or incomplete understanding, and low achievers had a functional misconception of integers. Moreover, the student's metacognitive awareness was significantly related to their conceptual understanding of integers. This indicates that student's higher-order thinking skills, such as metacognition, are essential since they are associated with building conceptual skills. Thus, teachers should encourage students' metacognitive awareness to improve students' conceptual understanding of integers. The study provides relevant information for educational managers on the potential factors to be considered in improving mathematics education practices, particularly in promoting metacognition among high school students.

INTRODUCTION

Students' ability to control, monitor, and comprehend their learning process has become one of the focused concepts in education. Students' acquisition of metacognition and conceptual understanding is essential, especially in mathematics (Ibañez & Pentang, 2021; Mariano-Dolesh et al., 2022). With this, educators recognize the importance of higher-order thinking skills such as metacognition and conceptual understanding of students in learning. Evaluating students' skills is best understood by determining how individuals acquire them. Metacognition was defined as "knowledge and regulation of one's cognition," "thinking about thinking", or "learning how to learn" (Flavell, 1979). Metacognition can be seen when a person involves active awareness and control over the cognitive processes engaged in learning. Being aware of one's cognition involves metacognitive awareness. Metacognitive awareness entails self-reflection on one's thought patterns to comprehend and develop them. However, young children are entirely unaware of their thinking and other aspects of metacognition. Furthermore, metacognition is associated with concepts, namely, metacognitive knowledge and metacognitive regulation. These two components were hypothesized to be connected (Brown, 1987; Schraw & Dennison, 1994).

On the other hand, mathematics educators emphasize conceptual understanding among learners as a critical component of mathematical ability. Conceptual understanding is associated with profound and flexible knowledge of abstract principles (Mariano-Dolesh et al., 2022; Star & Stylianides, 2013). It is evident as students become successful problem solvers, determined to persist until a rational solution is attained (Ibañez & Pentang, 2021; Santos et al., 2022). Conceptual knowledge enables students to apply and potentially adopt certain learned mathematical concepts to new contexts (Qetrani & Achtaich, 2022). Moreover, it was concluded that students face difficulties operating integers (Pentang, 2019). The errors seemed to be caused by a lack of access to mediating objects such as number lines or other real-world contexts when learning to work with integers. Makonye and Fakude (2016) also found that students struggled comprehending negative numbers or operations containing negative integers. Hence, exploring the conceptual understanding of integers and their operations among learners must be encouraged.

Several studies indicated the relationship between metacognition and conceptual understanding of learning (Fleming et al., 2012; Gunstone & Mitchell, 2005). Metacognition was used to explain an individual's ability to influence their learning strategically. Conceptual understanding entails identifying current conceptions, assessing them, and determining whether to create and update, both of which include sufficient metacognitive awareness and control. Still, the conceptual understanding of integers of Grade 7 students in the Philippines remains unexplored. Students nowadays show various levels of knowledge and understanding in different learning situations. Some may show awareness of their learning and know-how to monitor and reflect on their thinking. Others might have poor performance and difficulty monitoring and understanding their learning. Hence, the students possess different levels of metacognition and conceptual understanding, and conceptual knowledge or understanding is essential for explaining students' performance as metacognition does.

Relative to this condition, the role of both metacognition and conceptual understanding in the learning process has been identified. However, other researchers have claimed that the effects of metacognition are unrelated to academic success. More research needs to be done on the relationship between metacognitive awareness in mathematics instruction. The pedagogical grasp of metacognition needs to be improved, contributing to the gap between theory and practice. Thus, there is a need to reassess the relationship of metacognition in mathematics performance to serve as a guide and basis for conducting new studies, making institutional policies, and reviewing educational courses. With these, this study aimed to determine the metacognitive awareness and conceptual understanding of Junior High School students on integers and the relationship between them. This study provides teachers with insights and valuable information about its association with student conceptual understanding and integrating and implementing metacognition in mathematics education.

LITERATURE REVIEW

Metacognition has been conceived as a crucial component of learning. Many researchers have asserted its effects on academic performance. For instance, experts conducted several studies on cognitive abilities such as metacognition and what it could bring to mathematics performance. Learning mathematics involves critical thinking, problem-solving, analytical thinking, and reasoning. Learning mathematics effectively requires a deep understanding and comprehension of mathematical ideas and skills such as metacognition. With these scenarios, researchers concluded its association with learning mathematics.

Several researchers found that metacognition is associated with mathematics performance (Bernard & Bachu, 2015; Schraw & Dennison, 1994). Metacognitive knowledge and mathematical intelligence substantially impact academic performance, and there is an association between metacognitive knowledge and mathematical intelligence (Chytry et al., 2020). There is a strong positive association between metacognition and achievement in mathematics (Özsoy, 2011), indicating that students with higher metacognition tend to have excellent performance in mathematics, and students with low metacognition will likely have poor achievement in mathematics. This notion is also supported by Desoete and De Craene (2019), who found that poor learners were less accurate in metacognitive terms and more often underestimated their performances. Some misunderstandings were identified as logical shortcomings, mathematical confusion, misinterpretation of problems, and poor problem-solving skills. In addition, when the students face a test case, they have a significant challenge, which can be due to their weak math ability and inability to deal with complex situations (Pentang, 2019). It might be argued that teachers and educators should emphasize metacognition to develop and increase learners' mathematical performance abilities. The metacognitive component is crucial for learning since it aids students in organizing, monitoring, and evaluating their thought processes (Naufal et al., 2021). Students' mathematics performance is significantly and positively affected when teachers apply metacognitive strategies in their teaching approach (Alzahrani, 2017). Besides, metacognition was involved in conceptual change (Tickoo, 2012). Since metacognition includes planning, evaluating, and monitoring problem-solving activities, these processes are central to intelligence. The benefits of metacognition include increased awareness of mathematical instruction and improved learning outcomes (Salam et al., 2020). Metacognitive learners also include self-aware and reflective learners. Reflecting on a lesson's relevance gives didactic mathematical knowledge to aid the instructor in making judgments (Navarro & Céspedes, 2022). A learner who is metacognitively aware has a method of figuring out what they need to know.

Moreover, metacognition is beneficial in predicting academic achievement. According to Young and Fry (2008), "if the students have well-developed metacognitive knowledge and metacognitive regulatory skills and use their metacognition, they will excel academically" (p.2). Metacognitive ability proficiency in analyzing one's thought processes is related to correctly assessing an individual's mastery of a task (Dunning et al., 2003). Also, Asy'ari et al. (2019) emphasize the importance of declarative knowledge within the inquiry learning model, as these could potentially aid in constructing components that create thorough metacognition awareness. With these findings, studies have provided how metacognition affects mathematics performance. The studies also emphasize the importance of integrating strategies to improve metacognition since it impacts learning mathematics.

However, despite the positive effects of metacognition on students' academic performance, some studies asserted that the effects of metacognition are not related to academic performance. It has been found that being metacognitively aware of one's cognitive knowledge does not necessarily translate into higher academic performance, and mathematical performance cannot be predicted by metacognitive awareness levels (Smith, 2013). Educators have also included metacognitive strategies in their teaching to determine the effect of metacognition in mathematics. However, it was resolved that the average learners who do not perform well in mathematics do not improve from instructions integrated with metacognition (Artlet & Schneider, 2015). Students do not usually acquire metacognitive ability through instruction (Ahmad et al., 2018). It is due to the limited framework and planned cognitive activities in teaching. Additionally, Zohar and Barzilai (2013) discovered numerous instructional strategies available to promote metacognition in the classroom after reviewing 178 studies for their systematic review analysis. It brought attention to the growing role of metacognition in education. However, little is known about effective metacognitive strategies used in mathematics education. Aside from that, there is a gap between theory and practice because many teachers lack a pedagogical understanding of metacognition (Wilson, 2010). With this, several research has reached varying conclusions on the impact of metacognition on student performance.

METHODS

Research Design and Participants

This study employed a descriptive-correlational research design. The descriptive design focused on the quantitative assessment of the respondents' metacognitive awareness and conceptual understanding of integers. The correlation analysis determined the statistical relationship between the variables. Furthermore, the qualitative assessment focused on the follow-up analysis of the student's conception of operating integers.

A total of 303 Grade 7 students were chosen as the study's respondents using random cluster sampling. They were classified into three categories based on their mean percentage score on the summary of the first quarter's test results in mathematics: high achiever, average achiever, and low achiever. Moreover, the majority of these students were females (56.77%) and had an average of 12 years old. Most respondents also graduated from elementary public school (93.07%), and the mean grade of the respondents on mathematics subjects for the first quarter was 81.80, with a standard deviation of 5.285. Finally, for the follow-up interview, the researchers selected three students in each level (low, average, and high achiever), totaling nine students. This allowed the researchers to make conclusions about their conceptual understanding of integers.

Research Instruments

The study utilized a questionnaire with an adopted inventory and achievement test as an instrument, with their permission. The Metacognitive Awareness Inventory was adapted from Schraw and Dennison (1994). The inventory consisted of 52 statements that the students rated as 1-never, 2-seldom, 3-sometimes, 4-often, and 5-always (see Appendix). The items were translated into the Filipino language by a Filipino professor to be easily understood by the respondents. The internal consistency found the Cronbach alpha 0.869 and was considered reliable. The achievement test on the fundamental operation on integers was also adapted from Rubin et al. (2014). It was used to evaluate students' conceptual understanding of integers. The achievement test consisted of 40 items based on the fundamental operations on integers. The items were divided into seven (7) parts: definition of integers (items number 1 to 6), the concept of the number line (items number 7-11), comparing integers (items number 12-14), real-life application of integers (items number 15-16), operation of integers (item number 17-32), integers property (items number 33-35), and rules on operating integers (item numbers 36-40). The achievement test was developed using the table of specifications following the Department of Education's Minimum Learning Competencies on integers. Two College Mathematics Professors and a pilot validated the test tested on 40 Grade 7 students. The instrument was considered reliable, with a Cronbach Alpha reliability coefficient of 0.859.

Data Collection and Analysis

The researchers obtained prior approval from the school authorities and consent from the parents and students. Data were gathered in person for a week while the follow-up assessment was conducted the following week. The study utilized descriptive statistics such as percentage, mean, standard deviation, and Pearson's r. The metacognitive awareness and conceptual understanding of the integers of the respondents were described using percentage, mean, and standard deviation. Pearson product-moment correlation coefficient (Pearson's r) was utilized to determine the interrelationship between the socio-demographic characteristics of the respondents and their metacognitive awareness. This also determined the relationship between respondents' socio-demographic characteristics and their conceptual understanding of integers, as well as the relationship between respondents' metacognitive awareness and their levels of conceptual understanding.

Furthermore, the researchers analyzed the qualitative responses from the interview. The follow-up interview was conducted with the selected respondents to clarify their solutions or reasons on how and why they came up with their answers. This also served as a reflection on the performance of the respondents. The interviews were done after the achievement test was administered. A conceptual trace analysis based on Jensen and Finley's theory was used to determine the conceptual understanding of the respondents. It was done on the respondents' response and their corresponding solutions or explanations for the questions in the achievement test. These data were analyzed based on the following: (1) Best understanding (BU) when the respondent has a correct answer accompanied by a correct and complete explanation; (2) Partial understanding (PU) involves a correct answer but with incomplete reason; (3) Correct or incomplete understanding is observed when the answer is wrong but with correct and incomplete solution/ reason; (4)

Functional misconception (FM) when the answer is correct but has incorrect solution or reason; (5) No understanding (NU) when the answer is wrong, accompanied by incorrect solution or reason. In the study conducted by Ibañez (2009), he described the solution or reason of the respondents to each item based on the following descriptions: (1) Complete correct solution/ reason when the answer is complete and correct, and all parts of the question are addressed; (2) Correct but incomplete solution/ reason when the respondent gives a partially correct answer, or task is incomplete; and (3) Incorrect solution/reason when the respondent does not address task or has no answer.

RESULTS

Metacognitive Awareness of the Respondents

The overall mean of the respondents' metacognitive knowledge was 3.27 *(SD = 0.64),* which is described as average (Table 1). The respondents' declarative knowledge (*Mean = 3.23, SD = 0.67*), procedural knowledge (*Mean = 3.21, SD = 0.74*), and conditional knowledge (Mean = 3.36, SD = 0.84) were also average. This result implied that the students occasionally considered metacognitive knowledge in its component when doing their schoolwork or homework.-Also, the student's metacognitive regulation was average (*Mean = 3.33, SD = 0.63*). Their planning ability was above average (*Mean = 3.51, SD = 0.83*). However, the students have average regulation regarding information management strategies (*Mean = 3.29, SD = 0.69*), comprehension monitoring *(Mean of 3.28, SD = 0.74*), debugging strategy (*Mean = 3.37, SD = 0.76*), and evaluation (*Mean = 3.24, SD = 0.71*). It can be noted from the findings that the respondents occasionally monitored and assessed their knowledge.

Metacognitive Awareness	Mean	SD	Description
Metacognitive Knowledge	3.27	0.64	Average
Declarative Knowledge	3.23	0.67	Average
Procedural Knowledge	3.21	0.74	Average
Conditional Knowledge	3.36	0.84	Average
Metacognitive Regulation	3.33	0.63	Average
Planning	3.51	0.83	Above Average
Information Management Strategies	3.29	0.69	Average
Comprehension Monitoring	3.28	0.74	Average
Debugging Strategies	3.37	0.76	Average
Evaluation	3.24	0.71	Average

Table 1. Respondents' metacognitive awareness level (Legend: 4.21-5.00 = High, 3.41-4.20 = Above Average, 2.61-3.40 = Average; 1.81-2.00 = Below Average; 1.00-1.80 = Low)

Conceptual Understanding of Integers of the Respondents

Findings showed that the students' mean scores on the achievement test were 17.07 (*42.68%),* described as a "good" remark (Table 2). Besides, students did best in defining the integers with a mean score of 3.80 (*63.33%)* with a remark of "very good". Comparing the integers also got a "very good" remark with a mean score of 2.04 (*68.00%).* Also, results revealed that the ability to distinguish concepts in number lines got a remark of "good" with a mean of 2.01 (*40.20%*). The integer's real-life application was also considered "good", with a mean of 1.09 (*54.50%*). In terms of operating integers, students' performance in adding integers was good, with a mean score of 1.9 (*47.50%),* the ability to multiply integers with a mean score of 1.87 (*46.75%),* and the ability to divide integers with a mean score of 2 (*50%)*. However, the ability of the students to subtract integers got a remark of "fair" with a mean score of 1.4 (*35%*). On the other hand, students performed poorly in applying integer properties (*0.50 or 16.67%)* and rules on the operation of integers (*0.40 or 8%).*

Fundamental Operation on Integers	Mean	Percentage	Description
Definition of Integers (Items 1-6)	3.8	63.33	Very Good
Concept of Number Line (Items 7-11)	2.01	40.20	Good
Comparing Integers (Items 12-14)	2.04	68.00	Very Good
Real-Life Application of Integers (Items 15-16)	1.09	54.50	Good
Addition of Integers (Items 17-20)	1.90	47.50	Good
Subtraction of Integers (Items (21-24)	1.40	35.00	Fair
Multiplication of Integers (Items 25-28)	1.87	46.75	Good
Division of Integers (Items 29-32)	2.00	50.00	Good
Integer Properties (Items 33-35)	0.50	16.67	Poor
Rules on Operation of Integers Items (36-40)	0.40	8.00	Poor
Total	17.07	42.68	Good

Table 2. Respondent's conceptual understanding of fundamental operation on integers (Legend: 80.01– 100.00% = Outstanding; 60.01 – 80.00% = Very Good; 40.01 – 60.00%= Good; 20.01 – 40.00% = Fair; 00.00 – 20.00% = Poor)

The researchers conducted a follow-up assessment to discuss the respondents' conception further. The individual responses of the respondents were interpreted based on Jensen and Finley's (1995) Conceptual Trace Analysis (Table 3). Results show that the student respondents' level of metacognitive awareness was "average metacognition", with an overall mean of 3.34 and a standard deviation of 0.63. Specifically, the results also showed that the students in the high achiever group had the best understanding of integer concepts, with an overall mean of 3.27. The average achiever group showed a correct or incomplete understanding of integer concepts with an overall mean of 2.23. Students in the low achiever group had functional misconceptions with an overall mean of 0.80.

Respondents	Level of Understanding	
	Mean	Description
High Achiever	3.27	Best Understanding
Average Achiever	2.23	Correct/Incomplete
Low Achiever	0.80	Functional Misconception

Table 3. Respondents' Level of Conceptual Understanding of Integers (Legend: 3.20-4.00 = Best Understanding; 2.40-3.19 = Partial Understanding; 1.60-2.39 = Correct/Incomplete; 0.80-1.59 = Functional Misconception; 0.00-0.79 = No Understanding)

Summary of the Analysis of the Interview Results

The first part of the achievement test was about the definition of integers. Student 1 answered all the items on the first part of the questionnaire correctly with the corresponding reason or explanation. She explained her answer correctly on the first item as she stated, "*Integers include the natural number and their negatives; hence integers can be both positive and negative*". She also added, "*Integer is a rational number with no fraction...examples of numbers that are not integers are 1, 2, 3,...*". On the second item, she described that opposite numbers have the exact distances from zero because it deals with distances. The distance can never be negative; she stated, "*a straight line has two directions and can be used as a scale so that equal distances on the line always correspond to equal differences between numbers*". In item number 3, she explained that absolute value was always positive as she described the absolute value as "*it is like a number between 0 and a number and was denoted by two vertical lines*", but she never mentioned that the concept of absolute value was about measurement or distances. She also explained how to subtract integers and that the division and multiplication of integers have the same rule as she mentioned, "division and multiplication of integers are the inverse operations of one another". However, she explained item 5 using an example: "-(-5) – (3), and she said, "When you see a minus sign followed by a minus sign, the sign will turn into plus (+5), and then add the two numbers". Meanwhile, Student 2 from the high achiever group had the best understanding of the items in the first part except for item number 3, she got a correct answer, but stated that, "*absolute value was about weighing the numbers, and I just got confused with the statement*". On the other hand, Student 3 had the best understanding of the items except for items 2, 3, and 5. Student 3 discussed item 2 by giving examples and drawing a number line; he said they have the same scale. In item number 3, student 3 had the same explanation as student 1, and never mentioned the concept of distances or measurement. In item 5, he gave examples and illustrations like 5- (-1) = 6, 1- (-3) = 4 and said, "*when you subtract a negative from a positive, the subtrahend (-1) will become positive since the multiplication of like signs is positive, then add the numbers, and the answer will be positive 6*".

The second part of the achievement test was about the concept of a number line. Students 1, 2, and 3 best understood most of the items. They had almost the same explanation about the number line. Student 1 said, "*number line is a straight line with 0 between them, and if you move to the left of zero, that is a negative number, and to the right are the positive numbers*". Student 2 discussed that "*using the number line, if you move to the left of zero, the value of a number decreases, and if you move to the right, the number increase*". In item 7, students 1 and 3 discussed the absolute value again without mentioning the concept of measurement and distance, while student 2 incorrectly answered the item but discussed the concept of absolute value.

Part three of the achievement test was about comparing the integers. Students 1, 2, and 3 answered all of the items correctly and had the best understanding. Student 1 explained, "*Negative numbers are always greater than the positive number and using the number line, it can be seen that the number to the right is greater than the number to their left*". Student 2 explained, "*In positive numbers, the numbers to the right have bigger value than the numbers to the left same with the negative number*". Student 3 added, "*the negative sign was powerful, for example, in numbers 100 and 1… 100 is greater than 1, right*?... but if you put a negative sign to a 100 (-100), it decreases its value because negative means a loss... but in the case of 0 and a negative, we can always figure that in temperature -12 degrees Celsius was colder than 0 degree Celsius".

Part four was about the real-life application of integers. Students 1, 2, and 3 got almost the items correctly and had a partial understanding. Student 1 explained, "*a loss means to decrease or minus, and a deposit means to increase or plus*". Student 2 had the same explanation as Student 1. However, student 3 got item number 16 correctly but got confused and explained, *"₱2500 deposit in a bank means putting money in a bank, and this means that he will loss ₱2500*".

Part five of the achievement test was about operating integers. This was divided into four parts: addition, subtraction, multiplication, and division of integers. In addition to integers, students 1, 2, and 3 had either best, partial, correct, or incomplete understanding. In item numbers 17 and 18, student 1 got the item correctly and discussed, "*adding a negative number from a positive number is like subtracting the two numbers and then getting the sign of the number with the highest value*". Student 2 also got the correct answer and discussed, "*when you see a (+) plus sign followed by a (-) minus sign, turn the sign into a (-) minus, then subtract*". Student 3 got the answer incorrectly in the said items because she got confused with the sign but had the same explanation as student number 2. In item number 19, students 2 and 3 got the answer correctly and explained, "*Addition of like signs is just adding both the numbers and getting the sign of the number with the highest value*". However, student 1 got the item incorrectly because she was confused with the signs and had the same explanation as students 2 and 3. In item 20, students 2 and 3 showed the best understanding. In contrast, student 1 had partial understanding since she got the item correctly but explained, "*adding a negative number to a zero is like subtracting the number to zero by changing (+) plus sign to minus (-) sign*". In the subtraction of integers, students had different conceptions. In item 21, students 2 and 3 partially understood the answer correctly and explained, "*when a (-) minus sign was followed by a negative sign, turned the signs into a plus sign, then add the two numbers*". While student 2 got the item correctly and explained, "*In subtracting unlike signs, add the two numbers and get the sign of the number with the highest value*". In item 22, student 3 got the answer correctly and explained, "In subtracting positive to positive is just the usual subtraction". However, students 1 and 3 got the answer incorrectly because they got confused with the sign and had the same explanation as student 2. In item 23, students 2 and 3 got the answer correctly and explained, "*Subtraction of unlike sign is adding the two numbers and getting the sign of a number with the highest value*". While student 1 got the item correctly and explained, "*Adding a number to a zero is just getting the number added to the zero*". In multiplication and division of integers, students 1, 2, and 3 almost had the best understanding of each item. However, students 2 and 3 got confused with dividing and multiplying a 0 from a number. Student 2 explained that 0 has no value; hence her solution was "*0(-9) = -9" and "0† (-2) = 2*". Also, Student 3 discussed, "*0 has no value, and no number can be divided or multiplied to 0*".

Part six of the achievement test involved the application of the properties of integers. Students 1 and 3 partially understood item 33 since they correctly answered it and explained, "*The distributive property is the distribution of the number outside the bracket before adding the two numbers*". However, student 2 got the item incorrectly because she was confused by solving it instead of rewriting it using the distributive property. She explained, "*Distributive property usually use because the two terms inside the parentheses cannot be added because they are not like terms*". In items 34 and 35, student 1 showed partial understanding since she answered the items correctly and discussed briefly, "*The process of commutative is just swapping the two numbers, and they still have the same value, and the associative property was based on the concept of grouping or regrouping*". While student 2 got the item incorrectly by solving it instead of rewriting it in commutative form, but she discussed it briefly. However, Student 3 had no understanding of items 34 and 35.

Relationship between the Respondent's Socio-Demographic Characteristics and Metacognitive Awareness Respondents

Table 4 presents the relationship between the socio-demographic characteristics and the metacognitive awareness of the respondents. Results show that the respondents' first-quarter math grade was significantly related to the respondents' metacognitive awareness ($r = .267, p < .01$). The father's educational attainment was also related to metacognitive awareness ($r = .125, p < .05$), indicating that the students whose fathers have the highest educational attainment have more heightened metacognitive awareness. The respondents' monthly family income was also positively related to metacognitive awareness ($r = 0.131, p < .05$), implying that students with high monthly family income have more heightened metacognitive awareness. However, other characteristics such as age, sex, and the type of elementary school attended were unrelated to the student's metacognitive awareness.

Socio-Demographic Characteristics	Metacognitive Awareness	p-value
Age	-.099	.212
Sex	-.076	.137
Type of Elementary School Attended	.021	.276
Monthly Family Income	.131	.034*
First Quarter Math Grade	.267	.000**

Table 4. Relationship between Socio-demographic Characteristics and Metacognitive Awareness

Relationship between Socio-demographic Characteristics and Conceptual Understanding

Table 5 presents the relationship between socio-demographic characteristics and the conceptual understanding of the integers of the respondents. The respondents' type of elementary school attended ($r = .195$) was related to the respondents' conceptual understanding of integers at 0.01 levels of significance. Monthly family income was also significantly associated with the conceptual understanding of the integer ($r = .174, p < .01$). Moreover, the first quarter math grade of the respondents was positively related to the student's conceptual understanding of integers ($r = .711, p < .01$). This implied that students who performed well in their first quarter math subject had a high conceptual understanding of integers. Meanwhile, the respondents' age was negatively related to their conceptual understanding of integers ($r = -.127, p < .05$).

Socio-Demographic Characteristics	Conceptual Understanding	p-value
Age	-.127	.027**
Sex	-.010	.864
Type of Elementary School Attended	.195	.001**
Monthly Family Income	.174	.002**
First Quarter Math Grade	.711	.000**

Table 5. Relationship between socio-demographic characteristics and conceptual understanding of integers

Relationship between Students' Metacognitive Awareness and Conceptual Understanding of Integers

Primarily, the study determined the relationship between metacognitive awareness and conceptual understanding of integers in junior high school students (Table 6). The respondents' metacognitive awareness was significantly related to respondent's conceptual understanding of integers ($r = .407, p < .001$). Specifically, the metacognitive knowledge ($r = .410$) and metacognitive regulation ($r = .407$) were significantly related to respondents' conceptual understanding of integers.

Metacognitive Awareness	Conceptual Understanding	p-value
Metacognitive Knowledge	.410	.000
Declarative Knowledge	.343	.000
Procedural Knowledge	.394	.000
Conditional Knowledge	.400	.000
Metacognitive Regulation	.407	.000
Planning	.352	.000
Information Management Strategy	.375	.000
Comprehension monitoring	.287	.000
Debugging strategy	.411	.000
Evaluation	.322	.000
Total Metacognitive Awareness	.407	.000

Table 6. Relationship between metacognitive awareness and conceptual understanding of integers

DISCUSSION

This study investigated the students' metacognitive awareness and conceptual understanding of integers. It was revealed from the study that students had average metacognitive awareness. Specifically, they had an average level of metacognitive knowledge in terms of declarative knowledge, procedural knowledge, and conditional knowledge. This indicates that the respondents demonstrate average awareness of their tasks, thinking abilities, and ability to self-manage their associated cognitive responses. They also demonstrate occasional metacognitive knowledge when doing their schoolwork or homework, which shows that the students could reflect while learning their lessons which can be related to Jaleel and Premachandran (2016). The students in this study have shown critical awareness of their thinking and learning, showing their metacognitive knowledge as thinker-learner (Chick, 2013). Meanwhile, the student's metacognitive regulation was average. Their planning ability was above average, and their information management strategies, comprehension monitoring, debugging strategy, and evaluation were average. The respondents occasionally monitored and assessed their knowledge. The students are aware but not fully informed of the metacognitive strategies they can use in studying. In addition, they were characterized as possessing the capacity to prepare, track, and evaluate their comprehension and performance, as well as a critical knowledge of "one's thought and learning" and "oneself as a thinker and learner." This result is similar to the study of Yakubu et al. (2022), where students recognized these metacognitive regulations in solving problems. Moreover, the average metacognitive awareness of the students is attributed to their inadequate knowledge and regulation of cognition. They have limited skills to think beyond thinking and self-regulatory processes, thus, challenging them to develop understanding. Given that metacognition can be taught, math educators must focus on assisting their students in achieving a higher level of metacognitive awareness.

Relative to students' conceptual understanding, it was demonstrated based on their performance in the fundamental operation of integers. Based on the results, it was revealed that they have a good performance on the fundamental operation of integers. Specifically, students had very good remarks about defining and comparing the integers. This may be because the students acquire basic knowledge, such as defining and comparing concepts, before applying certain information or ideas. This result was followed by the ability to distinguish concepts in number lines and integer's real-life application, which got a "good" remark. This implies that one popular tool for teaching about numbers is the number line, and it may fit for early teaching of operations involving negative numbers. Also, students strongly prefer mathematics problems associated with mystery when they can relate them to their everyday lives (Premadasa & Bhatia, 2013). In terms of operating integers, students' performance in adding, multiplying, and dividing integers was good. However, the ability of the students to subtract integers got a remark of "fair".The study concluded that the most common error in operating integers fell under subtraction. This agrees with Vlassis (2002), who found that the common mistakes made when solving equations were caused by negative numbers or unlike signs and implied that negative numbers created a degree of abstraction. On the other hand, students had poor performance in applying integer properties and rules on the operation of integers. Errors in applying properties of integers occurred when the students understood what the question asked, and still, they could not identify the operation or sequence of processes needed to solve the problem (Ryan, 2007). This shows that the students struggle even with the basic knowledge they must have attained during the formative years of schooling. Their difficulty grasping concepts will eventually determine their future struggles with more complex math problems.

For further analysis, the researchers conducted a follow-up assessment on six selected respondents to discuss the respondents' conception of integers. The results showed that the students in the high achiever group had the best understanding of integer concepts, the average achiever group showed a correct or incomplete understanding of integer concepts, and the students in the low achiever group had functional misconceptions. This indicates that high-achiever students have established their conceptual understanding. Meanwhile, low to average achievers may have difficulties with conceptual knowledge due to their poor elementary mathematics background. Per Santos et al.

(2022), this may be attributed to their poor number sense competency. The generated responses from the interview provide further evidence of the student's strengths and struggle with the fundamental operation of integers. Students signified their understanding based on their verbatim responses on defining integer and number line concepts, comparing numbers, and real life-applications of integers. They also showed difficulty subtracting integers as negative numbers confused them when combined with positive numbers. Moreover, the respondents were quite familiar with the properties of the integers. The students were not given proper examples and real-life applications of closure, commutativity, associativity, distributive and identity property of integers. It may be because properties on integers were not correctly introduced in high school mathematics and were just emphasized to students taking higher mathematics. Since these students have misconceptions or incomplete understanding, remediations, and differentiated instruction must be conducted. Teachers must understand the students' conceptual knowledge challenges while employing appropriate interventions to help them with their difficulties.

For further analysis, the researcher explores students' socio-demographic profiles. The study investigated the relationship between students' socio-demographic profiles and metacognitive awareness. Results show that the respondents' first-quarter math grade was significantly related to the respondents' metacognitive awareness. This indicated that students with high first-quarter math grades are related to their metacognitive awareness. This supported the findings of Young and Fry (2008), who concluded that correlations were found between metacognitive awareness and course grades. Baltaci et al. (2016) also revealed a statistically significant relationship between metacognitive awareness levels and grades in mathematics. The father's educational attainment was also related to metacognitive awareness, indicating that the students whose fathers have the highest educational attainment have more heightened metacognitive awareness. The respondents' monthly family income was also positively related to metacognitive awareness, implying that students with high monthly family income have more heightened metacognitive awareness. This finding contradicted the study of Narang and Saini (2013), where the impact of socioeconomic status on metacognition was non-significant, which indicated that metacognition had other impacting factors apart from socioeconomic status, which separated the children crossways diverse levels of metacognition. The students' first-quarter math grades and monthly family income must be considered when dealing with metacognitive knowledge and regulation. Teachers with high hopes of empowering metacognitive awareness among their students must see to it that these personal characteristics must be considered. Nevertheless, other characteristics such as age, sex, and the type of elementary school attended are unrelated to the student's metacognitive awareness.

In terms of the relationship between socio-demographic characteristics and the conceptual understanding of the integers of the respondents, the respondents' type of elementary school attended was related to the respondents' conceptual understanding of integers. The result exposed that students from private institutes showed a more conceptual understanding of integers than those from public schools. This result coincided with Lubienski and Lubienski's (2005) findings, who found that Mathematics appeared to be a subject where public-school students outperformed their private school peers. Monthly family income was also significantly related to the conceptual understanding of the integer. This denoted that students with a high monthly family income had a high conceptual understanding. This finding has the same result as Kirkup (2008), who revealed that students with a higher socioeconomic status outperform those with a lower socioeconomic status. Moreover, the first quarter math grade of the respondents was positively related to the student's conceptual understanding of integers. This implied that students who performed well in their first quarter math subject had a high conceptual understanding of integers. This was related to the findings of Zakaria et al. (2010). They revealed that mathematics grade was related to conceptual understanding since Mathematics requires understanding certain principles and processes and the practice of carrying out practical activities and operations. Meanwhile, the respondents' age was negatively related to their conceptual understanding of integers. This indicated that younger students tend to have a higher conceptual understanding of integers than older students. This was contradicted by Shute et al. (2011), who concluded that older children fared better academically than younger ones. This result might explain why the older students are students who come from cases of dropouts, a temporary stop in school, and irregular academic standing. Similar to the results above, the teacher must learn from the background of their students while dealing with their conceptual knowledge. Investigating the profile of the learners while aiming to develop their conceptual understanding would be necessary. Still, sex characteristic is unrelated to the student's conceptual understanding, indicating that sex might not be a factor in obtaining a higher conceptual understanding.

Finally, the study determined the relationship between metacognitive awareness and conceptual understanding of integers in Junior High school students. The respondents' metacognitive awareness was significantly related to respondent's conceptual understanding of integers. The result indicated that the students with high metacognitive awareness have a high conceptual understanding of integers. This result was similar to Young and Fry (2008), who stated that students with well-developed metacognition would excel academically. Tickoo (2012) also concluded that metacognition has been heavily involved in the desire to create a conceptual change, while Gunstone and Mitchell (2005) revealed that the connections between conceptual change and metacognition seem to be an apparent result of the conceptual change definition. Recognizing prior conceptions and deciding whether to reconstruct and perform a self-evaluation requires metacognition comprehension and control. Specifically, the metacognitive knowledge and metacognitive regulation were significantly related to respondents' conceptual understanding of integers. The students' conceptual understanding can be enhanced by developing a firm metacognitive knowledge and regulation among them at a young age. When their metacognitive awareness is established in their primary years, they tend to display complete conceptual understanding. From lower to higher-order thinking, math teachers need to reframe their practices to help the students learn best about integers and other foundational topics in mathematics. Morover, with these associations, teachers should emphasize the use of metacognitive techniques in teaching mathematics. Teachers must help students become more aware of themselves by providing metacognitive exercises that prompt reflection on what they know and care about and can also provide valuable information for teachers. Such introspective exercises are additions that impede continuing analysis, revision, and planning, as well as strategic thinking. Teachers can have a long-lasting effect on how their students learn long after they leave the classroom by making learning and problem-solving processes apparent and assisting students in identifying their strengths and strategies.

CONCLUSIONS AND RECOMMENDATIONS

The study investigated the relationship between metacognitive awareness and students' conceptual understanding of integers. From the analysis of the data gathered, the following major findings were drawn: (1) students had an average level of metacognitive awareness in terms of metacognitive knowledge and metacognitive regulation, (2) students' had good performance in fundamental operation on integers, which indicates their good conceptual understanding of integers concepts, and (3) students' metacognitive awareness were significantly related with their conceptual understanding on integers. These results conclude that students in primary school have not fully developed their metacognitive awareness while learning mathematics. Consequently, it can be said that learning practices among students are still in the early stages and still requires improvements. Teachers could not help students in their primary years to use thinking strategies while learning. For instance, it is strongly recommended that methodologies, exercises, models, or learning modules integrated with thinking techniques based on metacognitive knowledge and regulation strategies be created to suit the needs of the 21st-century teaching approach. This will boost 21st-century learning and the student's ability to think while learning. Technology integration can also improve learning efficiency, increase student competence, and alter the learning environment.

Regarding their conceptual understanding, the result also revealed gaps in students' conceptions and skills in mathematics. Despite several studies on improving students' skills in mathematics, students still have misconceptions and errors in basic fundamental operations on integers. This is alarming as operating on integers is a prerequisite for higher mathematics. This may be because mathematics was still taught procedurally without helping students understand how these topics relate to one another and without necessary justifications for why particular concepts are implications for others. It is particularly challenging when rules and processes are presented to students extremely abstractly without using models to help students understand the concepts. Moreover, the significant relationships between metacognitive awareness and conceptual understanding of integers are exhibited as one factor teachers can consider in teaching mathematics. This demonstrated how metacognition strongly impacted the ability to make a conceptual change. In addition, deep understanding and flexible knowledge of integers may require appropriate metacognitive knowledge, awareness, and control. This only denoted that metacognition plays a significant role in successful learning. With this finding, students are suggested to learn how to be skilled thinkers and use their knowledge in innovative contexts to aid in learning and develop logical reasoning, decision-making, and, thus, conceptual understanding. Considering the relationship between metacognitive awareness and students' conceptual understanding, teachers and educators might adapt strategies and pedagogical metacognitive approaches to improve students' skills in mathematics learning. Additionally, further studies on exploring metacognition in different mathematics skills and emotional aspects of learners might be conducted for further conclusion. Future research may use a larger sample to investigate metacognition, and conceptual understanding since the generalizability of the present study's findings is constrained due to the short sample size. Other researchers might be considered drawing more in-depth analyses based on qualitative results from other mathematics disciplines. They could also be thoroughly investigated using an experimental design that includes both the control and experimental group to generate substantial results of the factors that might help improve mathematics teaching and learning practices.

References

[1] Ahmad, H., Ferbyanti, F., Fatimah, F., & Muthmainnah (2018). Description of student's metacognitive ability in understanding and solving mathematics problem. *IOP Conference Series: Materials Science and Engineering, 300*, 1-7. https://www.doi.org/10.1088/1757-899X/300/1/012048

[2] Alzahrani, K. (2017). Metacognition and its role in mathematics learning: An exploration of the perceptions of a teacher and students in a secondary school. *International Electronic Journal of Mathematics Education, 12* (3), 521-537. https://doi.org/10.29333/iejme/629

[3] Artelt, C., & Schneider, W. (2015). Cross-country generalizability of the role of metacognitive knowledge in students' strategy use and reading competence. *Teachers College Record, 117*(1), 1-32. https://doi.org/10.1177/016146811511700104

[4] Asy'ari, M., Ikhsan, M., & Muhali. (2019). The effectiveness of inquiry learning model in improving prospective teachers' metacognition knowledge and metacognition awareness. *International Journal of Instruction, 12*(2), 455-470. https://doi.org/10.29333/iji.2019.12229a

[5] Baltaci, S., Yildiz, A., and Ozcakir, B. (2016). The relationship between metacognitive awareness levels, learning styles, genders, and mathematics grade of fifth graders. *Journal of Education and Learning, 5*(4), 78-89. https://doi.org/10.5539/jel.v5n4p78

[6] Bernard, M., & Bachu, E. (2015). *Enhancing the metacognitive skill of novice programmers through collaborative learning*. In Metacognition: Fundaments, applications, and trends (pp. 277-298). Springer. https://doi.org/10.1007/978-3-319-11062-2_11

[7] Brown, A. (1987). *Metacognition, executive control, self-regulation, and other more mysterious mechanisms*. In Weinert, F., and Kluwe, R. (eds.), Metacognition, motivation, and understanding, Erlbaum, Hillsdale, 65-116.

[8] Chick, N. (2013). *Metacognition. Vanderbilt University Center for Teaching*. https://cft.vanderbilt.edu/guides-sub-pages/metacognition/

[9] Chytry, V., Rican J., Eisenmann, P., & Medova J. (2020). Metacognitive knowledge and mathematical intelligence - two significant factors influencing school performance. *Mathematics, 8*(6), 969. https://doi.org/10.3390/math8060969

[10] Desoete, A., De Craene, B. (2019). Metacognition and mathematics education: An overview. *ZDM Mathematics Education, 51*(4), 565-575. https://doi.org/10.1007/s11858-019-01060-w

[11] Dunning, D., Johnson, K., Ehrlinger, J., & Kruger, J. (2003). Why people fail to recognize their own incompetence. *Current Directions in Psychological Science, 12* (3), 83-87. https://doi.org/10.1111%2F1467-8721.01235

[12] Flavell, J. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34*(10), 906-911. https://doi.org/10.1037/0003-066X.34.10.906

[13] Fleming, S. M., Dolan, R. J., & Frith, C. D. (2012). Metacognition: Computation, biology and function. *Philosophical Transactions of the Royal Society*, 367, 1280¬-1286. https://doi.org/10.1098/rstb.2012.0021

[14] Gunstone, R., Mitchell, I. (2005). *Metacognition and conceptual change*. In J. J. Mintzes, J. H. Wandersee, & J. D. Novak (Ed.), Educational Psychology, Teaching Science for Understanding (pp. 133-163). Academic Press. https://doi.org/10.1016/B978-012498360-1/50006-4

[15] Ibañez, E., & Pentang, J. (2021). Socio-constructivist learning environment and teacher education students' conceptual understanding and attitude towards fraction. *Indonesian Research Journal in Education, 5*(1), 23-44. https://doi.org/10.22437/irje.v5i1.12187

[16] Jacobs, J., & Paris, S. (1987). Children's metacognition about reading: Issues in definition, measurement, and instruction. *Educational Psychologist, 22*(3-4), 255-278. https://doi.org/10.1080/00461520.1987.9653052

[17] Jaleel S., & Premachandran, P. (2016). A study on the metacognitive awareness of secondary school students. *Universal Journal of Educational Research, 4*(1), 165-172. https://doi.org/10.13189/ujer.2016.040121

[18] Jensen, M., & Finley, F. (1995). Teaching evolution using historical arguments in a conceptual change strategy. *Science Education, 7*(2), 147-166. https://doi.org/10.1002/sce.3730790203

[19] Kirkup, J. (2008). Middle-class children resentful at being pushed to succeed. The Telegraph. https://www.telegraph.co.uk/education/3330301/Middle-class-children-resentful-at-being-pushed-to-succeed-poll-shows.html

[20] Lubienski, S., & Lubienski, C. (2005). A new look at public and private schools: Student background and mathematics achievement. *Phi Delta Kappan, 86*(9), 696-699. https://doi.org/10.1177/003172170508600914

[21] Makonye, J., & Fakude, J. (2016). A study of errors and misconceptions in the learning of addition and subtraction of directed numbers in grade 8. *SAGE Open, 6*(4), 2158244016671375. https://doi.org/10.1177%2F2158244016671375

[22] Mariano-Dolesh, M. L., Collantes, L. M., Ibanez, E. D., & Pentang, J. T. (2022). Mindset and levels of conceptual understanding in the problem-solving of preservice mathematics teachers in an online learning environment. *International Journal of Learning, Teaching and Educational Research, 21*(6), 18-33. https://doi.org/10.26803/ijlter.21.6.2

[23] Narang, D., & Saini, S. (2013). Metacognition and academic performance of rural adolescents. *Studies on Home and Community Science, 7*(3), 167-175. https://doi.org/10.1080/09737189.2013.11885409

[24] Navarro, M. B., & Céspedes, M.J.C. (2022). Reflective competence in preservice teachers by analysing textbook lessons: The case of proportionality. *Mathematics Teaching-Research Journal, 14*(4), 165-191. https://commons.hostos.cuny.edu/mtrj/wp-content/uploads/sites/30/2022/12/09-Maria-v2.pdf

[25] Naufal, M. A., Abdullah, A. H., Osman, S., Abu, M. S., & Ihsan, H. (2021). The effectiveness of infusion of metacognition in Van Hiele model on secondary school students' geometry thinking level. *International Journal of Instruction, 14*(3), 535-546.

[26] Özsoy, G. (2011). An investigation of the relationship between metacognition and mathematics achievement. *Asia Pacific Education Review, 12*(2), 227-235. https://doi.org/10.1007/s12564-010-9129-6

[27] Pentang, J. (2019). *Determining elementary pre-service teachers' problem-solving performance and skills through sequential explanatory approach* [Master's Thesis, Central Luzon State University]. DOST Union Catalog. https://philpapers.org/rec/PENDEP

[28] Premadasa, K., & Bhatia, K. (2013). Real life applications in mathematics: What do students prefer? *International Journal for the Scholarship of Teaching and Learning, 7*(2), 1-15. https://doi.org/10.20429/ijsotl.2013.070220

[29] Qetrani, S., & Achtaich, N. (2022). Evaluation of procedural and conceptual knowledge of mathematical functions: A case study from Morocco. *Journal on Mathematics Education, 13*(2), 211-238. https://doi.org/10.22342/jme.v13i2.pp211-238

[30] Rubin, R., Marcelino, J., Mortel, R., & Lapinid, M.C. (2014, March 6-8). *Activity-based teaching of integer concepts and its operation* [Paper presentation]. DLSU Research Congress, De La Salle University, Philippines. https://www.dlsu.edu.ph/wp-content/uploads/2018/09/LLI-II-016.pdf

[31] Ryan, W. J. (2007). *Children's mathematics 4-15: Learning from errors and misconceptions.* McGraw-Hill Education (UK).

[32] Salam, M., Misu, L., Rahim, U., Hindaryatiningsih, N., & Ghani, A. R. A. (2020). Strategies of metacognition based on behavioural learning to improve metacognition awareness and mathematics ability of students. *International Journal of Instruction, 13*(2), 61-72. https://doi.org/10.29333/iji.2020.1325a

[33] Santos, R. A., Collantes, L. M., Ibañez, E. D., Ibarra, F. P., Pentang, J. T. (2022). Innate mathematical characteristics and number sense competencies of junior high school students. *International Journal of Learning, Teaching and Educational Research, 21*(10), 325-340. https://doi.org/10.26803/ijlter.21.10.18

[34] Schraw, G., & Dennison, R. (1994). Assessing metacognitive awareness. *Contemporary Educational Psychology, 19*(4), 460-475. https://doi.org/10.1006/ceps.1994.1033

[35] Star, J. R., & Stylianides, G. J. (2013). Procedural and conceptual knowledge: Exploring the gap between knowledge type and knowledge quality. *Canadian Journal of Science, Mathematics and Technology Education,13*(2), 169-181.

[36] Shute, V., Hansen, E., Underwood, J., & Razzouk, R. (2011). A review of the relationship between parental involvement and secondary school students' academic achievement. Education *Research International,* 2011, 915326. https://doi.org/10.1155/2011/915326

[37] Smith, M. J. (2013). An exploration of metacognition and its effect on mathematical performance in differential equations. *Journal of the Scholarship of Teaching and Learning, 13*(1), 100-111.

[38] Tickoo, S. (2012). *Metacognition as a predictor of conceptual change*. Cognitive Science Student Scholarship. http://scholar.oxy.edu/cog_sci_student/1

[39] Vlassis, J. (2002). The balance model: Hindrance or support for the solving of linear equations with one unknown. *Educational Studies in Mathematics, 49*(3), 341-359. https://doi.org/10.1023/A:1020229023965

[40] Yakubu, A., Bornaa, C. S., Kwakye, D. O., & Atepor, S. (2022). Examining college of education students' metacognitive consciousness in solving problems on geometric theorem. *Creative Education, 13*(6), 2070-2084. https://doi.org/10.4236/ce.2022.136128

[41] Young, A., & Fry, J. (2008). Metacognitive awareness and academic achievement in college students. *Journal of the Scholarship of Teaching and Learning, 8*(2), 1-10. https://scholarworks.iu.edu/journals/index.php/josotl/article/view/1696

[42] Zakaria, E., Chin, L. C., & Daud, M. Y. (2010). The effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. *Journal of Social Sciences, 6*(2), 272-275. https://doi.org/10.3844/jssp.2010.272.275

Appendix

Metacognitive Awareness Inventory

Directions: Check which is appropriate.

STATEMENTS	Always	Often	Sometimes	Seldom	Never
1. I ask myself periodically if I am meeting my goals.					
2. I consider several alternatives to a problem before I answer.					
3. I try to use strategies that have worked in the past.					
4. I pace myself while learning in order to have enough time.					
5. I understand my intellectual strengths and weaknesses.					
6. I think about what I really need to learn before I begin a task					
7. I know how well I did once I finish a test.					
8. I set specific goals before I begin a task.					
9. I slow down when I encounter important information.					
10. I know what kind of information is most important to learn.					
11. I ask myself if I have considered all options when solving a problem.					
12. I am good at organizing information.					
13. I consciously focus my attention on important information.					
14. I have a specific purpose for each strategy I use.					
15. I learn best when I know something about the topic.					
16. I know what the teacher expects me to learn.					
17. I am good at remembering information.					
18. I use different learning strategies depending on the situation.					
19. I ask myself if there was an easier way to do things after I finish a task.					
20. I have control over how well I learn.					
21. I periodically review to help me understand important relationships.					
22. I ask myself questions about the material before I begin.					
23. I think of several ways to solve a problem and choose the best one.					
24. I summarize what I've learned after I finish.					
25. I ask others for help when I don't understand something.					
26. I can motivate myself to learn when I need to					
27. I am aware of what strategies I use when I study.					
28. I find myself analyzing the usefulness of strategies while I study.					
29. I use my intellectual strengths to compensate for my weaknesses.					
30. I focus on the meaning and significance of new information.					
31. I create my own examples to make information more meaningful.					
32. I am a good judge of how well I understand something.					
33. I find myself using helpful learning strategies automatically.					
34. I find myself pausing regularly to check my comprehension.					
35. I know when each strategy I use will be most effective.					
36. I ask myself how well I accomplish my goals once I'm finished.					
37. I draw pictures or diagrams to help me understand while learning.					
38. I ask myself if I have considered all options after I solve a problem.					
39. I try to translate new information into my own words.					
40. I change strategies when I fail to understand.					
41. I use the organizational structure of the text to help me learn.					
42. I read instructions carefully before I begin a task.					
43. I ask myself if what I'm reading is related to what I already know.					
44. I reevaluate my assumptions when I get confused.					
45. I organize my time to best accomplish my goals.					
46. I learn more when I am interested in the topic.					
47. I try to break studying down into smaller steps.					
48. I focus on overall meaning rather than specifics.					
49. I ask myself questions about how well I am doing while I am learning something new.					
50. I ask myself if I learned as much as I could have once I finish a task.					
51. I stop and go back over new information that is not clear.					
52. I stop and reread when I get confused.					

Schraw, G. & Dennison, R.S. (1994). Assessing metacognitive awareness. Contemporary Educational Psychology, 19, 460-475.