Understanding the Relationship between Grade X Students' Metacognitive Skills and Mathematics Performance: A Correlational Study.

Nima Dorji and Purna Bdr. Subba

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Abstract
Although it has always been a required core subject in Bhutanese schools, underachievement in mathematics regularly shows that the requirement has very little impact on students. This study aims to examine the relationship between mathematics performance and metacognitive skills in grade X students. This study used 347 grade X students (M = 162, F = 185) from one of the schools in Sarpang Dzongkhag and a correlational survey design. The level of students' metacognitive skills was evaluated using the modified Metacognitive Awareness Inventory (MAI), whilst their mathematics performance was evaluated using the Mathematics Performance Test (MPT). Students in grade X were found to have high level of metacognitive skills ($M= 3.54$, $SD=.42$). While the correlational analysis showed a weak but significant positive correlation ($r =.133$, $p \leq .05$) between students' metacognitive skills and mathematics performance. The outcome also showed that students' metacognitive skills are a statistically significant predictor of their mathematics performance. The findings of the study indicated that metacognition be taken into account to aid students' learning of mathematics.

Key Words: Metacognitive Skills, Metacognitive Awareness Inventory (MAI), Mathematics Performance Test (MPT), Metacognitive Knowledge, Metacognitive Regulation

Introduction

Mathematics has always been featured as a core and compulsory subject in the schools of Bhutan. However, research studies such as the National Education Assessment (MoE, 2003); Education without Compromise (2008); Bhutan's Annual Status of Student Learning (REC, 2008, 2010 & 2011); and The Quality of School Education in Bhutan (REC, 2009) conducted by the Ministry of Education (MoE) and Royal Education Council (REC) among others, have demonstrated that the compulsory status of the subject has done very little to stimulate and motivate Bhutanese students to continue the path of education in mathematics by consistently revealing the underachievement in mathematics. International studies such as the Program for International Student Assessment (PISA) and Trends in Mathematics and Science Study (TIMSS) have also revealed mathematics learning and achievement in students to be a global concern (Mohamed & Waheed, 2011).

According to BCSEA (2020), it was reported that the performance in mathematics by Bhutan Certificate of Secondary Education (BCSE) is comparatively lower in other subjects. BCSEA (2019) reported that the mean score of BCSE (Grade X) students in mathematics was 50.75% with a similar pattern in 2020 (BCSEA, 2020) with 52.02%. BCSEA (2019) also revealed that Bhutanese students only scored 38.84% in PISA-D Mathematical literacy, which is significantly below reading literacy (45.3%) and scientific literacy (45.1%). A similar situation was observed in Sarpang Dzongkhag where this study was carried out. According to BCSEA (2020), the mean score of Sarpang Dzongkhag in mathematics was 46.44%, and the school where this study had taken place, in particular, scored only 43.09%, which was lower than the national mean score (52.02%)

However, a significant number of studies have proved that metacognition is an essential component to successful learning (Caviola et al., 2009; Ozsoy & Ataman, 2009; Pugalee, 2001; Teong, 2002; Victor, 2004). Some researchers have also concluded that there is a reasonable relation between students' academic success level and metacognitive skills (Case et al., 1992; Desoete & Roeyers, 2002; Rezvan et al., 2006). Metacognition skills can be termed as an individual's skills of his thinking processes and his ability to control these processes (Cakiroglu, 2007; Desoete & Ozsoy, 2009; Flavell, 1979; Hacker & Dunlosky, 2003; Ozsoy et al., 2009).

Though there are some research conducted in Bhutan to understand the cause of underachievement in mathematics performance, no research has been conducted to understand the relationship between students' metacognitive skills and their performance in mathematics. Therefore, this study aimed to investigate the relationship between grade X students' metacognitive skills and mathematics performance.

Purpose of the study

There were two main purposes of this study, the first purpose was to determine the level of the grade X students' metacognitive skills and then investigate whether there existed a significant relationship between students' metacognitive skills and their mathematics performance.

Research Questions

This study was guided by the following research questions:

1. What is the level of metacognitive skills of grade X students?
2. Is there a significant relationship between metacognitive skills and mathematics performance of grade X students?

Significance of the study

The study sought to understand the level of grade X students' metacognitive skills and check whether there was a significant relationship between mathematics performance and metacognitive skills. The finding of the study might be useful in informing the readers of the importance of meta-cognitive skills in learning mathematics. In addition, it is hoped that the study may be the beginning of an ongoing body of research into the study of metacognition and its importance in education. Moreover, chools and parents may choose to apply the recommendation derived from the results which may help the students perform better. Similarly, the study may serve as a guide to administrator on what may be emphasized by teachers in the school curriculum to improve students' performance in mathematics. Finally, for the researchers, the study may help them understand critical areas in the educational process that many researchers were not able to explore.

Literature Review

Metacognition has been characterized as ‘‘knowing about knowing’’; it is the knowledge that people have about their thought processes (Bruning et al., 1995). Flavell (1979) first coined this term metacognition and defined it as “cognition about cognition” or “thinking about thinking”. Metacognition involves the study of ‘‘how we think about our thinking to develop strategies for learning’’ (Hamachek, 1995, p. 208). Metacognition is a regulatory system that helps a person understand and control his or her cognitive performance. This has led to the understanding that metacognition skills can be termed as an individual’s skills of his thinking processes and his ability to control these processes (Cakiroglu, 2007; Desoete & Ozsoy, 2009; Flavell, 1979; Hacker & Dunlosky, 2003; Ozsoy et al., 2009). Therefore, metacognition can be termed as being aware of one’s own thought process and directing it toward learning. According to Flavell (1979), metacognition consists of two components; metacognitive knowledge (What one knows about cognition) and metacognitive experiences or regulation (How one controls cognition).

A study was conducted by Young and Fry (2008) to analyze the relationship between metacognitive skills and the academic results of 178 higher education students. A correlational analysis found that there exists a significant positive correlation between metacognitive skills and the academic achievement of the students. In addition, various past studies concluded metacognitive skills as an essential component to successful learning (Caviola et al., 2009; Ozsoy & Ataman, 2009; Pugalee, 2001; Teong, 2002; Victor, 2004). Further, some researchers have also claimed that there was a reasonable relation between students’ academic success level and metacognitive skills (Case et al., 1992; Desoete & Roeyers, 2002; Rezvan et al., 2006).

Similarly, several literatures showed the relationship between metacognition and mathematics performance. Ozsoy (2010) conducted a study aimed at investigating the relationship between metacognitive skills and mathematics achievement of fifth-grader students. The participating population comprised 242 students. The results demonstrated a significant and positive relationship between metacognition and mathematics achievement. Furthermore, the study showed that 42% of the total variance of mathematics achievement could be explained by metacognitive knowledge and skills. This concludes that to gain a better understanding of successful mathematical performance, metacognition seems to be important (Lucangeli & Cornoldi, 1997).

Many researchers argued that metacognition has an important role in being successful in mathematics (Borkowski & Thorpe, 1994; De Clercq et al., 2000; Desoete et al., 2001a, b; Schoenfeld, 1992). Artz and Armour-Thomas (1992) point out that the main reason underlying the failure of students in problem-solving is that they cannot monitor their mental processes during problem-solving. Therefore, metacognition may affect how children learn mathematics or perform better in mathematics. It may be essential that students learn how to monitor and regulate the steps and procedures used to meet the goal of solving problems. It was reported that academically successful students acquire the self-understanding that supports effective strategies to solve problems (Garrett et al., 2006). In addition, the study conducted by Desoete (2009) indicated that metacognitive knowledge and skills account for 37% of the achievement in mathematical problem-solving. This gives evidence that metacognition is an important component of intelligence and cognition as well as a major influence on academic success.

Some studies indicated that there exist positive and significant increases in the academic achievement of children using instruction activities toward developing metacognitive skills (McDougall & Brady, 1998; Naglieri & Johnson, 2000; Ozsoy & Ataman, 2009; Ozsoy et al., 2009; Teong, 2002; Victor, 2004). Therefore, metacognition can be used as a strong predictor of academic level. However, this is not true all the time. Some studies have also shown that there is a negative or no relationship between metacognitive skills and academic achievement (Sperling et al., 2004).

Schoenfeld (1985) has emphasized that metacognition is generally ignored in education processes. He argued that metacognitive skills and mathematical knowledge are inseparable entities. One of the leading problems observed in students at all educational levels is the lack of the development of metacognitive skills and mathematical knowledge. Because mathematics education predominantly focuses on situations and processes but it does not attach sufficient importance to the studies that develop understanding. This explains the failure of students in mathematics courses (Schoenfeld, 1985).

Many studies have explored the importance of metacognitive skills and their importance in enhancing students' academic performance. However, almost all of the studies are conducted in Western countries who have different cultures, environments, and mindset. What would Bhutanese students think about metacognitive skills, and how is it important for Bhutanese students in enhancing mathematics performance?

Methodology

Research design demands planning and systematics inquiry. Diverse research designs let us choose the tools that are most suitable for the study (Creswell, 2014). This study employed a quantitative correlational survey design. Quantitative correlation survey design helps to examine the relationships between and among variables which is central to research questions and hypotheses through surveys and experiments (Creswell, 2014). This study used an adapted version of the Metacognitive Awareness Inventory (MAI) survey questionnaire to measure the level of students' metacognitive Skills. Whereas, Mathematics Performance Test (MPT) was used to examine students' performance in mathematics.

Participants

The research was conducted in one of the secondary schools in Sarpang Dzongkhag, southern part of Bhutan, as per the convenience of the researcher. The population of the study comprised all the students of grade X of the school. There were 9 sections of grade X students with a total population of 352 students, including 166 boys and 186 girls. Purposive sampling was used, where all the grade X students were selected for the survey questionnaires. According to Descombe (2010), purposive sampling works well when the researcher already knows something about the specific people or events and deliberately selects ones because they are seen as instances that may produce the most valuable data. The purposive sampling strategy can also be employed to elicit rich and in-depth information from a typical sample (Creswell, 2014). Considering all these advantages, this sampling procedure was deemed appropriate for the study as well.

Instruments

In order to measure the metacognitive skills of students, an adapted version of MAI (Schraw & Dennison, 1994), a pre-established survey questionnaire was used. After a wide range of literature reviews and expert opinions, 52 items of the survey questionnaire were contextualized and modified by adding learning aspects to the items. For example, the item "I ask myself periodically if I am meeting my goals" was changed into "I ask myself periodically if I meet my learning goals" and "I organize my time to best accomplish my goals" to "I organize my time to best accomplish my learning goal". Similar changes were made to some of the items to make them more suitable and readable for students. Further, items were rated on a five-point Likert scale to measure students' agreement on the items, which ranges from "1-Strongly Disagree" to "5-Strongly Agree". However, the mean of the five-point Likert Scale was interpreted using Table 1 adapted from Brown (2010). The interpretation was used to describe the level of students' Metacognitive skills.

All the data collected from the MAI survey questionnaire and MPT was analyzed using the Statistical Package for the Social Science (SPSS, version 25) software.

Table 1

Interpretation of Likert-Scale

Mean Score	Metacognitive Level
4.21 - 5.00	Very High
3.41 - 4.20	High
2.61 - 3.40	Moderate
1.81 - 2.60	Low
1.00 - 1.80	Very Low

Brown (2010)

The MPT was developed by the researcher to measure students' performance in mathematics. The test consists of ten questions. Standardized test questions were prepared from grade X mathematics textbook "Understanding Mathematics" published by the Department of Curriculum Research and Development, Ministry of Education (MoE). MPT consists of ten problem-solving questions prepared from Unit I: Matrices and Networks, and Unit II: Commercial Mathematics based on the guidelines of the curriculum for grade X. The questions were set for 30 marks. Later the score from the MPT was administered to examine the relationship between students' performance in mathematics and students' metacognitive skills.

Reliability of the Instrument

The MAI was selected to study the level of metacognitive skills. The survey questionnaire was trialed out with one of the schools in the Dzongkhag. The overall Cronbach's alpha (α) coefficient of the MAI was .92. A score of .70 or greater is generally considered to be acceptable in Cronbach's Alpha scale as shown in Table 3. Similarly, the reliability of the MPT was done using test re-test reliability test. The Cronbach's alpha (α) coefficient of the test items was .86, which indicated that the instrument was reliable for the study.

Table 2: Description of Internal Consistency using Cronbach's Alpha

Cronbach's Alpha	Internal Consistency
α ≥ 0.9	Excellent
0.9 > α ≥ 0.8	Good
0.8 > α ≥ 0.7	Acceptable
0.7 > α ≥ 0.6	Questionable
0.6 > α ≥ 0.5	Poor
0.5 > α	Unacceptable

Note: Adapted from Andale (2014, p.1)

Data Analysis

As the study involved a quantitative correlational survey design, the data from the quantitative survey (MAI) and mathematics performance test (MPT) were analyzed simultaneously. Firstly, a descriptive analysis was performed on MAI to understand the level of metacognitive skills. Then, inferential statistics like Pearson correlation and linear regression analysis test were run to investigate the relationships between students' metacognitive skills and mathematics performance. Further, the correlation between the students' metacognitive skills and students' mathematics performance was interpreted using the modified rating scale of Sugiyono (2013) as shown in Table 3. Moreover, tables and figures were used for easy interpretation, readability, and understanding.

Table 3: Interpretation of Correlation

Correlation Coefficient Value (*r*)	**Interpretation**
0.00 – 0.25	Weak
0.26 – 0.50	Moderate
0.51 – 0.75	Strong
0.76 – 1.00	Very Strong

Results and Discussion

For this study, survey questionnaires were administered to 352 grade X students, however, 347 questionnaires were returned giving a response rate of 98.57%. On the other hand, 1.43% of the students could not participate in the study, which comprised three students who could not respond to the survey as they were absent during the survey, and two other students' responses were considered invalid as there were many items not attempted. It was found that there were more female participants (N=185) which comprised 53.3% than males (N=162) which comprised 46.7%.

Level of Students' Metacognitive Skills

The results (Table 4) from the descriptive analysis of the survey questionnaires (MAI) showed that the grade X students possessed a high level of metacognitive skills (M = 3.54, S.D = .42). The findings from this study corroborated the findings of the study done by Garzon et al., (2020). It was indicated that students from grades 6 to 11 possess a high level of metacognitive skills in one of the private schools in the city of Bogotá, Colombia. Further, the result is echoed by Amin and Sukestinyarna (2015), and Abdelrahman (2020) who performed the study with grade XII students from Kersana Brebes Public senior High School, and college students of Ajam University, UAE, respectively. On the other hand, the study by Ozsoy (2010), carried out in six public primary schools in Zonguldak-Eregli, Turkey, found that fifth-grade primary school students possess a below-average level of metacognitive skills. This result contradicts the current findings. These findings clearly show that the level of metacognitive skills of individual students can be related to the development in age and grade. This assumption is supported by the study of Flavell (1988), and Schneider and Lockl (2002) that stated that age-specific development is a key factor as well as education, in metacognitive development. This statement is further consistent with several studies that supported that higher level of schooling have better metacognitive skills (Roeschl-Heils, et al., 2003; Van-Kraayenoord, et al., 2012; Van Kraayenoord & Schneider, 1999).

Table 4: The overall level of Metacognitive Skills

	N	Mean	Std. Deviation	Level
Metacognitive Knowledge	347	3.58	.43	High
Metacognitive Regulation	347	3.49	.50	High
Metacognitive Skills	***347***	***3.54***	***.42***	***High***

Note: 4.21 - *5.00 Very High, 3.41 - 4.20 High, 2.61 - 3.40 Moderate, 1.81 - 2.60 Low, 1.00 - 1.80 Very Low*.

Relationship between students' Metacognitive skills and mathematics performance

Linear regression analysis was conducted to determine the degree of relationship between students' metacognitive skills and mathematics performance. The result from Table 4 indicated that there exists a significant weak positive correlation between students' metacognitive skills and mathematics performance ($r = .133$, $p < .05$) at a 95% confidence interval. Further, this model revealed that 1.5% (adjusted R square) of the variability in students' mathematics performance was explained by students' metacognitive skills. The model produced a beta value of 1.192, which indicated that for every one-point gain in the metacognitive skills item, 1.192 significant increase should be observed in mathematics performance. Therefore, the finding shows that students' metacognitive skills and students' mathematics performance are significantly related ($p = 0.00$) at a 95% confidence interval.

The Pearson correlation demonstrates that there is a weak positive correlation between students' metacognitive skills and mathematics performance ($r = .133$). Further, a simple linear regression result of the current study shows that 1.5% of the variation in mathematics performance could be explained by students' metacognitive skills. The result is consistent with the findings from the previous studies (Arrepattamannil & Caleon, 2013; Hong-Nam, 2014; Sperling et al., 2012; Tavakoli, 2014; Young & Fry, 2008) which reported a significant positive relationship between metacognitive skills and mathematics performance. Therefore, it could be assumed that metacognitive skills play a significant role in developing students' mathematical learning and enhancing mathematical performance. In this regard, Young and Fry (2008) claimed that students who apply metacognitive aspects are believed to have outstanding academic achievement.

However, the current study presented that only 1.5% of the variation in mathematics performance could be explained by metacognitive skills, which is very less compared to the findings of the studies conducted by Doesoete et al., (2001a), and Lucangeli and Cornoldi (1997). Doesoete (2001a) reported that 42% of the variation in mathematics achievement could be explained by metacognitive skill, whereas Lucangeli and Cornoldi (1997) reported 37% of the total variance of mathematics achievement could be explained by students' metacognitive knowledge and skills. These major differences in the effect size of the metacognition could be due to ignorance of metacognition practices in the school system. This assumption is supported by Schoenfeld (1985), who emphasized that metacognition is generally ignored in education processes and stated that metacognition skills and mathematics is inseparable entities.

Accordingly, it can be concluded that teaching and learning processes in the school could include the instruction of metacognitive skills. This is in line with many studies that confirmed that teaching metacognitive skills to students may lead to some improvement in their academic achievement (Cardelle-Elawar, 1992; Ozsoy & Ataman, 2009). Further, the different approaches to improving metacognitive abilities, such as 'improve through metacognition' (Mevarech & Fridkin, 2006; Mevarech & Kramarski, 1997), 'metacognitive problem-solving activities' (Ozsoy & Ataman, 2009), and 'reciprocal teaching' (Palincsar & Brown, 1984) should be introduced and trained to teachers in teacher training colleges and by Teacher Professional Support Division (TPSD).

Table 5

Linear regression between Metacognitive skills and Mathematics Performance

Dependent Variable	Independent Variable (Predictor)	R	R Square	Adjusted R Square	F-value	P-value	Beta Score	Sig
Mathematics Performance	Metacognitive Skills	.133*	.018	***.015***	6.195	.013b	***1.192***	.000

Conclusion and Recommendation

Mathematics has always been featured as a core and compulsory subject in the Bhutan education system however, the compulsory status has very little effect on learners by consistently revealing the underachievement in mathematics. According to BCSEA (2020), the performance in mathematics by grade X students was comparatively lower than in other subjects. Similarly, in Sarpang Dzongkhag the mean score of the dzongkhag in mathematics performance was lower than the national mean. Therefore, considering students' low performance in mathematics in Bhutan, a quantitative correlation survey study was carried out in one of the schools in Sarpang Dzongkhag to investigate students' level of metacognitive skills and their relationship with mathematics performance. The study used the MAI survey questionnaire and the MPT questions. A total of 347 students were involved in the studies.

The findings of the study revealed that grade X students have a high level of metacognitive skills. The study indicated that there is a significant relationship between students' metacognitive skills and mathematics performance. Additionally, the study revealed that the student's metacognitive skills are a significant predictor of students' mathematics performance.

Therefore, the following recommendations are made based on the findings.

1. Metacognition is one of the factors often associated with the academic performance of students. The present study revealed that there is a significant positive relationship between metacognitive skills and mathematics performance. Therefore, teachers, school leaders, and the school system may explore on adopting metacognition strategies to enhance students' performance.

2. The results of the study are solely based on self-report metacognition questionnaires. Future researchers and teachers can explore different assessment techniques, such as think-aloud procedures and systematic behavior observation to authenticate the relationship between metacognition and students' performance.

3. To fully comprehend the relationship between students' metacognition and mathematical performance, additional research can be conducted using a mixed-method approach, quasi-experiment, or action research.

References

Abdelrahman, R. M. (2020). Metacognitive awareness and academic motivation and their impact on academic achievement of Ajman University students. *Heliyon*, *6*(9): 25-37. https://doi.org/10.1016/j.heliyon.2020.e04192

Artz, A. F., & Armour-Thomas, E. (1992). Development of a cognitive-metacognitive framework for protocol analysis of mathematical problem solving in small groups. *Cognition and Instruction*, 9, 137–175. https://doi.org/10.1207/s1532690xci0902_3

Bhutan Council for School Examinations and Assessment (BCSEA). (2019). *Findings from Bhutan's experience in PISA for Development.* National Project Centre.

Bhutan Council for School Examinations and Assessment (BCSEA). (2019). *Pupil performance report 2019,* (12). http://www.bcsea.bt/publications/PPR-2019.pdf

Bhutan Council for School Examinations and Assessment (BCSEA). (2020). *Pupil performance report 2020,* (13). http://www.bcsea.bt/publications/PPR-2020.pdf

Borkowski, J. G., & Thorpe, P. K. (1994). Self-regulation and motivation: A life-span perspective on underachievement. In D. H. Schunk & B. J. Zimmerman (Eds.*), Self-regulation of learning and performance. Issues Educational Applications* (pp. 45–100). Hillsdale, NJ: Erlbaum.

Brown, T. (2010). Construct validity: A unitary concept for occupational therapy assessment, evaluation, and measurement. *Hong Kong Journal of Occupational Therapy*, *20*(1), 30-42.

Bruning, R., Schraw, G., & Ronning, R. (1995). *Cognitive psychology and instruction.* Englewood Cliffs, Prentice-Hall.

Cardelle-Elawar, M. (1992). Effects of teaching metacognitive skills to students with low mathematics ability. *Teaching & Teacher Education*, 8, 109–121.

Case, L. P., Harris, K. R., & Graham, S. (1992). Improving the mathematical problem solving of students with learning disabilities: Self-regulated strategy development. *The Journal of Special Education, 28*, 1–19.

Caviola, S., Mammarella, I. C., Cornoldi, C., & Lucangeli, D. (2009). A metacognitive visuospatial working memory training for children. *International Electronic Journal of Elementary Education*, *2*(1), 123–136.

Creswell, J. W. (2014). Research design: Qualitative, quantitative and mixed methods approach (4th Ed.). Sage Publications.

Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. SAGE.

De Clercq, A., Desoete, A., & Roeyers, H. (2000). EPA 2000: A multilingual, programmable computer assessment of off-line metacognition in children with mathematical learning disabilities. *Behavior Research Methods, Instruments, & Computers,* 32, 304–311.

Desoete, A., & Ozsoy, G. (2009). Introduction: Metacognition, more than the lognes monster? *International Electronic Journal of Elementary Education*, *2*(1), 1–6.

Desoete, A., & Roeyers, H. (2002). Off-line metacognition—a domain-specific retardation in young children with learning disabilities. *Learning Disability Quarterly*, 25, 123–139.

Desoete, A., Roeyers, H., & Buysse, A. (2001a). Metacognition and mathematical problem-solving in grade 3. *Journal of Learning Disabilities*, 34, 435–449.

Education without Compromise. (2008). *Education without compromise*. Royal Government of Bhutan, Council of Ministers

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive-developmental inquiry. *American Psychologist, 34* (10), 906-911.

Garrett, A. J., Mazzocco, M. M., & Baker, L. (2006). Development of the metacognitive Skills of prediction and evaluation in children with or without math disability. *Learning Disabilities Research & Practice*, 21(2), 77–88.

Garzon, M. D. F., Bustos, H. A. P., & Lizarazo, U. J. O. (2020). Relationship between metacognitive skills, gender, and level of schooling in high school students. *Suma Psicológica,* 27(1). https://doi.org/10.14349/sumapsi.2020.v27.n1.2

Hacker, D. J., & Dunlosky, J. (2003). Not all metacognition is created equal. *New Directions For Teaching And Learning*, 95, 73–79. https ://doi.org/10.1007/s11409-008-9026-0

Hamachek, D. (1995). Self-concept and school achievement: Interaction dynamics and a tool for assessing the self-concept component. *Journal of Counselling and Development*, 73(4), 419-425.

Hong- Nam, K. (2014). ELL high school students' metacognitive awareness of reading strategy use and reading proficiency. *The Electronic Journal for English as a Second Language,* 18(1): 1–16.

Lucangeli, D., & Cornoldi, C. (1997). Mathematics and metacognition: What is the nature of the relationship? *Mathematical Cognition, 3* (2), 121-139.

McDougall, D., & Brady, M. P. (1998). Initiating and fading self-management interventions to increase math fluency in general education classes. *Exceptional Children*, *64*(2), 151–166. https://doi.org/10.1177/001440299806400201

Mevarech, Z. R., & Fridkin, S. (2006). The effects of IMPROVE on mathematical knowledge, mathematical reasoning and metacognition. *Metacognition and Learning*, 1(1), 85–97.

Mevarech, Z. R., & Kramarski, B. (1997). IMPROVE: A multidimensional method for teaching mathematics in heterogeneous classrooms. *American Educational Research Journal*, 34(2), 365–395.

Ministry of Education (MoE). (2003). *National education assessment in Bhutan: A benchmark study of student achievement in Literacy and numeracy at Class VI*. BCSEA.

Mohamed, L., & Waheed, H. (2011). Secondary students' attitude towards mathematics in a selected school of Maldives. *International Journal of Humanities and Social Science*, *1*(15), 277-281.

Naglieri, J. A., & Johnson, D. (2000). Effectiveness of a cognitive strategy intervention in improving arithmetic computation based on the PASS theory. *Journal of Learning Disabilities, 33*(6), 591–597. https://doi.org/10.1177/002221940003300607

Ozsoy, G., & Ataman, A. (2009). The effect of metacognitive strategy training on problem-solving achievement. *International Electronic Journal of Elementary Education,* 1(2), 67–82.

Ozsoy, G. (2010). An investigation of the relationship between metacognition and mathematics achievement. *Asia Pacific Education Review*, *12*(2), 227-235. https://10.1007/s12564-010-9129-6

Ozsoy, G., Memis, A., & Temur, T. (2009). Metacognition, study habits and attitudes. *International Electronic Journal of Elementary Education*, *2*(1), 154–166.

Palincsar, A. S., & Brown, A. L. (1984). Reciprocal teaching of comprehension fostering and comprehension monitoring activities. *Cognition and Instruction*, *2*, 117–175.

Pugalee, D. K. (2001). Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving. *School Science and Mathematics*, *101*, 236–245.

Rezvan, S., Ahmadi, S. A., & Abedi, M.R., (2006). The effects of metacognitive training on the academic achievement and happiness of Esfahan University conditional students. Counsell. *Psychol. Q*, *19*(4), 415–428.

Roeschl-Heils, A., Schneider, W., & Van Kraayenoord, C. E. (2003). Reading, metacognition and motivation: A follow-up study of German students in grades 7 and 8. *European Journal of Psychology of Education, 18*(1), 75-86.

Royal Education Council (REC). (2008). *Bhutan's Annual Status of Student Learning* (ASSL). REC.

Royal Education Council (REC). (2010). *Bhutan's annual status of student learning* (ASSL). REC.

Royal Education Council (REC). (2011). *Bhutan's Annual Status of Student Learning* (ASSL). REC.

Royal Education Council & iDiscoveri Education (REC). (2009). *The quality of school education in Bhutan – Reality and opportunities*. REC.

Schneider, W., & Lockl, K. (2002). *The development of metacognitive knowledge in children and adolescents.* Cambridge University Press. https://doi.org/10.1017/CBO9780511489976.011

Schoenfeld, A. (1985). *Mathematical problem-solving*. Academic Press.

Schoenfeld, A. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 165–197). MacMilla.

Schraw, G., & Dennison, R. S. (1994). Assessing metacognitive skills. *Contemporary Educational Psychology, 19*, 460–475.

Sperling, R. A., Howard, B. C., Staley, R., & DuBois, N. (2004). Metacognition and self-regulated learning constructs. *Educational Research and Evaluation, 10*(2), 117–139.

Sugiyono. (2013). *Metode Penelitian Kuantitatif Kualitatif dan R&D*. Alfabeta

Tavakoli, H. (2014). The effectiveness of metacognitive strategy awareness in reading comprehension: The case of Iranian university EFL students. *The Reading Matrix, 14*(2): 314–336.

Teong, S. K. (2002). The effect of metacognitive training on mathematical word-problem solving. *Journal of Computer Assisted Learning*, *19*, 45–46.

Van-Kraayenoord, C., Beinicke, A., Schlagmuller, M., & Schneider, W. (2012). Word identification, metacognitive knowledge, motivation and reading comprehension: An Australian study of Grade 3 and 4 pupils. *Australian Journal of Language and Literacy*, *35*(1), 51-68.

Van Kraayenoord, C. E., & Schneider, W. E. (1999). Reading achievement, metacognition, reading self-concept and interest: A study of German students in grades 3 and 4. *European Journal of Psychology of Education*, *14*(3), 305-324. https://doi.org/10.1007/BF03173117

Victor, A. M. (2004). *The effects of metacognitive instruction on the planning and academic achievement of first and second-grade children.* Ph.D. thesis, Graduate College of the Illinois Institute of Technology.

Young, A., & Fry, J. D. (2008). Metacognitive Awareness and Academic Achievement in College Students. *Journal of the Scholarship of Teaching and Learning*, *8*, 1-10

About the Authors

Nima Dorji, M.Ed**.** is a teacher at Norbuling Higher Secondary School in Sarpang Dzongkhag under the Ministry of Education and Skills Development. His research interest includes education teaching learning and assessment practices, and action research.

Purna Bahadur Subba, MSc. is a Mathematics Lecturer at Samtse College of Education under the Royal University of Bhutan. His research interest includes mathematics curriculum, Teaching-Learning Process, Pedagogy, and GNH.