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A Comparative Analysis of Students' Mathematics Metacognitive Awareness in the Medium of Instruction

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Abstract

Metacognitive awareness has a decisive role in learning mathematics. This research has investigated the amount of metacognitive awareness in mathematics among secondary level students and examined variations in the language of instruction (English vs. Nepali). We were used a cross-sectional quantitative survey method for 402 students of grade IX and six schools from the Kathmandu district. The Junior Metacognitive Awareness Inventory (Jr MAI) tool by Sperling et al. (2002) was used by translating and modifying in the Nepalese context to evaluate metacognitive awareness. The quantitative data were analyzed by using SPSS 20 version with descriptive statistics and use independent samples t-test. The results revealed that students showed a relatively higher average metacognitive awareness, which is significantly higher. Students from Nepali medium schools achieved slightly higher scores ($p = 0.237$) than English medium schools, which is not significant at 0.05 level of significance. These results designated that the medium of instruction might not be an influential factor in the metacognitive development of students.

Keywords: Achievement, Bilingual Education, Mathematics Learning, Medium of Instruction, Metacognitive Awareness

Introduction

In educational settings, metacognition benefits students. Metcalfe and Shimamura (1994) connected the metacognition to understanding 'when and how' to apply specific learning or problem-solving techniques. Metacognition involves reflecting on the thought process, which includes three key components: awareness of our thinking, regulation or control, and beliefs and intuition (Schoenfeld, 1992). Likewise, Jausovec (1994) claimed that metacognition includes awareness of general cognitive strategies, knowledge about monitoring, evaluation, and regularity strategies. Therefore, metacognition signifies "the capacity to consider and regulate one's own learning" (Schraw & Dennison, 1994).

Metacognitive knowledge includes the complete understanding and awareness held about previous knowledge concerning cognitions (Schraw & Moshman, 1995). This area concerns to a recognition of personal thoughts or cognitions. It includes three subdomains such as declarative, procedural, and conditional knowledge. Moreover, the declarative knowledge consists of the specific elements that affect learning and performance (Schraw & Moshman, 1995). The procedural knowledge incorporates way of doing the task, use of the ability spontaneously, and applying approaches effectively. The formation of figures in procedural learning abilities and approaches used for effective motivation leds to instinctive and more proficient with better used the approaches and select alternatives. Conditional awareness often influences how individuals perform a mathematics task when facing time restrictions.

The second area proposed by Schraw and Moshman (1995) is cognition regulation linked to the management of thought processes. It includes planning, oversight, and assessment. In this context, planning involves choosing appropriate strategies to identify solutions and issues that allocating resources suitable for efficient and effective resolution of problems. Monitoring, alternatively, is the current consciousness of comprehension and implementation. It governs monitoring actions while performing a task and self-assessment. Ultimately, assessment takes place once a task is finished, involving the assessment of performance and the regulatory aspects of one's thoughts, as well as reassessing objectives and findings. Metacognition is vital to mathematics learning and teaching, influencing all cognitive subdomains (Schraw & Moshman, 1995). Consequently, the aspects of metacognition are fundamental to every problem-solving endeavor in mathematics and better outcomes in mathematics learning.

Many schools apply the second language as the medium of instruction in the classroom. The medium of instruction for mathematics teaching is English, which is relatively a problem for some teachers and students (Jourdain & Sharma, 2016). The mathematics teachers said that students have insufficient level of understanding in english as a medium of instruction. This may be one of the causes for the underperformance of students in mathematics in non-native English speaking countries (Launio, 2015). Similarly, Skaalvic and Rankin (1995) explored that both mathematics and word problems with self-perception were highly related to corresponding achievement. Yip et al. (2003) focused the achievement test incorporating multiple-choice items and free-response questions found that the students with English-medium instruction, regardless of their higher initial ability, performed less than their native students. They were weak in comprehension and abstract concepts, the aptitude to differentiate between scientific terms, and the capability to apply scientific knowledge in innovative or realistic situations.

Although medium of instruction and metacognitive awareness of students have greater effect on mathematics achievement, there is no research has explored the relation of those two factors: the medium of mathematics instruction and metacognitive awareness of the secondary level students. In this context, this study aim to investigate the degree of mathematics metacognitive awareness in secondary-level students and to determine if there is a significant difference in their metacognitive awareness influenced by the language of instruction (Nepali or English). To fufill the stated aim of the research, the following research questions have been designed:

1. What is the level of metacognitive awareness in mathematics among students at the secondary level?
2. Is there a significant difference in mathematics metacognitive awareness between students studying in Nepali medium and those in English medium?

Theoretical Framework

This research has been grounded in Cummins' Theory concerning language proficiency and Ausubel's Theory of Meaningful Verbal Learning. Cummins' Theory stated that using the first language as the medium of instruction allows bilingual individuals support in learning and develop academic skills (Cummins, 1979). It also highlighted the role of language proficiency assessment in bilingual education, which is to place students in classes taught in the language that will most enrich their learning. This theory endorsed the notion that by utilizing instructional mediums, students could learn more easily, turns to a higher possibility of understanding, led to improve student achievement. Cummins theory (1979) argued language proficiency as a multidimensional construct, which includes cognitive as well as linguistic component.

Ausubel's Theory of Meaningful Verbal Learning suggested that successful teaching would happen when linking new knowledge to previous understanding at each stage of the process (Blanton & Tuinman, 1973). The success of communication relies on specific factors within the person. The emphasis will become clearer concerning various aspects of the relationship between personal processes and the essence of communication. In this context, the Ausubel's Theory of Meaningful Verbal Learning and Cummins' Theory of language proficiency equally could provide insightful observation to see the impact of medium of instructions on metacognitive awareness of the students in learning mathematics.

Methods and Procedures

In this research, we employed a cross-sectional quantitative survey design as suggested by Creswell and Creswell (2017). The major objective of quantitative research is to evaluate causal relationships in a value-neutral context, as noted by Johnson and Onwuegbuzie (2004). A total of three Nepali medium schools and three English medium schools in the Kathmandu Valley were randomly chosen as sample schools for the research, and all grade 9 students at those schools were included as sample students. A sample of 402 students contained 185 from Nepali medium and 217 from English medium. This research adopted the Junior Metacognitive Awareness Inventory (Jr MAI) from Sperling *et al.* (2002) which included eighteen items in five-point Likert scale from 1 (never) to 5 (always). The possible score of the awareness scale is range from 18 to 90. The scale has the associations of both knowledge of cognition and regulation of cognition. Sample items include "*I can make myself learn when I need to*" and "*I draw pictures and diagrams to help me understand while learning*."

To make the questionnaire items more respondent-friendly in the Nepalese context, they were translated into Nepali, and essential adjustments were made to the language while preserving the essence. Using the translators' assistance, the Nepali version was retranslated into English to verify the translation's accuracy. Although the scale demonstrated a high degree of reliability worldwide (Aydin and Ubuz, 2010; Kirbulut, 2014), it was revalidated in the context of Nepalese secondary classrooms. The scales were set up for a pilot study. By testing the tool with 50 students of grade nine who were not part of the study's sample, the internal consistency and reliability was found to be 0.87. This indicated that the scale demonstrated a high level of reliability in the test set. The average value of items was 3.58, and the variance for the item was 1.15. The correlations for each value exceeded by 0.3. All the values for Cronbach's alpha is decreases, if the item was deleted and gives a lower than the test reliability. Consequently, every question in the survey was appropriate for this research. The extension range obtained from the principal component analysis was .63 to .90, meaning that all values were above 0.3. Consequently, each item was acceptable. In the component matrix, all exhibit factor loadings exceeded 0.4. These findings enabled the use of the instrument in this investigation's context was further modification of the scale. Surveys were conducted during regular classroom periods.

Analysis and Interpretation Procedure

The researchers used SPSS 20, a quantitative data analysis software to analyzed the data. Descriptive statistics as well as inferential statistics with independent samples t-test were computed for data analysis. The obtained results were interpreted by using insights from empirical studies and theoretical contributions.

Result and Discussion

The results with necessary discussion based on the objectives of the research, have been explained below

Level of Mathematics Metacognitive Awareness

In the mathematics, metacognitive awareness scale is the scores of all questions were to determine the overall metacognitive awareness. The potential range for the scale score scale is from 18 to 90. A greater value indicates higher metacognitive awareness, while a lesser value indicates the lower metacognitive awareness. Table 1 represents the mean metacognitive awareness score, the maximum and minimum values and corresponding standard deviation. The mean metacognitive score was computed by dividing the cumulative scores by the number of students.

Table 1:

Descriptive Statistics of the Metacognitive Awareness

Content	N	Minimum	Maximum	Mean	SD
Metacognitive Awareness	402	24.00	86.00	66.254	11.334

Table 1 gives the mathematics metacognitive awareness of the sample students was 66.254, indicating a good level of metacognitive awareness in mathematics. The standard deviation was 11.334, with scores ranged between 24 and 86, and exhibited the wide range of variation in math metacognitive awareness. Certain students exhibited very low levels of math metacognition, while others displayed medium and exceptionally high levels.

Levels of Mathematics Metacognitive Awareness Based on Medium of Instruction

The descriptive statistics such as mean, standard deviation, and coefficient of variation for mathematics metacognitive awareness among Nepali and English medium instruction students were calculated and presented in Table 2. The mean score were computed based on Five- point Likert scale score.

Table 2:

Metacognitive Awareness of Nepali and English Medium of Instruction

Content	Medium of Instruction	N	Mean	SD	CV(%)
Mean Metacognitive Awareness	Nepali	185	3.721	.651	17.495
	English	217	3.646	.611	16.758

Note. *Analyzed by SPSS 20*

In the above Table 2, it shows that the average metacognitive awareness of students in Nepali medium instruction was 3.721, while for English medium instruction, it was 3.646. This shows that the metacognitive awareness varied concerning the medium of instruction. The average metacognitive awareness score of the students in Nepali medium of instruction was greater than of the students in the English medium of instruction. The higher C.V. of Nepali medium students' compared to English medium students' indicated that the Nepali medium students showed less consistent math metacognition than the English medium students. At this stage, the significant differences in the metacognitive awareness of the students in Nepali and English medium instruction is found by using independent sample t-test.

Table 3:

Independent samples t-test between Nepali and English Mediums of Instruction

Content	**t**	**df**	**ρ**	**MD**	**SD error difference**	**95% confidence interval of the Difference**	
						Lower	Upper
Mean Metacognitive Awareness	1.184	400	0.237	0.0746	.06298	-.04923	.19839

Note. *Analyzed by SPSS 20*

In the table above, the t-statistic was determined to be 1.184 with 400 degrees of freedom. As p = 0.237 (> 0.05), it indicates that the average mathematics metacognitive awareness was not statistically significant. Therefore, it could be inferred that there were differences in mathematics metacognitive awareness scores between the two mediums of instruction, although these differences were not statistically significant. Although students from the Nepali medium of instruction revealed rather higher average metacognitive awareness than those from the English medium, the difference was not statistically significant demonstrating that medium of instruction alone may not be a influential factor in decisive students' metacognitive ability in mathematics.

Discussion

The results of this research correspond with theoretical perspectives on metacognition, mostly the framework proposed by Schraw and Moshman (1995) that highlighted the knowledge and the regulation of cognition. The comparatively elevated mean score for metacognitive awareness (66.254) signposted that secondary-level students had a better comprehension of when and how to apply problem-solving strategies in mathematics, reflecting the declarative, procedural, and conditional knowledge accentuated in existing literature. However, the substantial variation in scores suggested that metacognitive awareness fluctuates across students. This distinction might be associated with varying personal experiences, domestic learning environment, or degrees of self-regulation elements that Ausubel (1978) observed as indispensable for meaningful learning. In the context of performance acceleration, Lamichhane (2022) highlighted the engaged reading is one of the most significant contributors which liberates mathematics performance. It further reinforced Schoenfeld’s (1992) affirmation that awareness, management, and confidence in one’s cognitive processes differ and influence the way the learners interact with mathematics. In this context, Ghimire (2025) suggest a potential experience-related pattern in teachers' commitment that may have consequences for professional development and educational policies for better learning mathematics

Although it was expected that the medium of instruction could largely influence metacognitive awareness considering Cummins’ (1979) theory on the significance of the first-language teaching, the statistical evaluation exhibited mundane difference between students instructed in Nepali and those in English. While the group using Nepali as the medium scored slightly higher on average, the difference was not significant (p =

0.237). This result points out that the metacognitive growth of the learnersin mathematics might depend more on instruction methods, classroom activities, and personal cognitive aspects than on the language employed. Nonetheless, aligning with Yip et al. (2003) and Launio (2015), linguistic challenges persist to draw attention, specifically for the students who might find it challenging to grasp abstract concepts or scientific terminology in a second language. Consequently, future pedagogical strategies must incorporate metacognitive skills development in both of the language environs, ensuring equitable prospects for mastering mathematical concepts and problem-solving proficiency.

Conclusion and Implications

While there existed individual variation among secondary school students, they exhibited a good amount of metacognitive awareness in mathematics with no significant statistical difference in metacognitive awareness among students from Nepali and English medium of instruction.

These results suggested that despite metacognitive awareness in mathematics being essential among secondary-level students, it is indeed inconsistently acquired skill. Teachers, irrespective of the instructional medium, should consider integrating clear metacognitive strategies into their teaching methods to assist all students, particularly in those whose metacognitive awareness minimal. Furthermore, school policies and curriculum developers, above all, should focus on metacognitive skills using effective pedagogical methods instead of attributing variations on the language of instruction alone since no significant difference was identified among instructional mediums.

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