**Classroom Climate, Students' Mathematics Achievement, Students' Knowledge of Cognition and Regulation Cognition: A Mediation Analysis**

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**ABSTRACT**

The role of mathematics in development of the branches of science and technology is enormous. The literature reviews revealed among the factors that affect the achievement of students in mathematics subject are classroom climate, students’ knowledge of cognition and regulation cognition. Therefore, this study aims to determine the mediation effect of knowledge of cognition and regulation of cognition on relationship between classroom climate (student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity) and students' mathematics achievement. This study employed survey method involving a total of 326 form four students from five rural secondary schools located in five Divisions in Sabah via multi-stage cluster sampling. Data were collected using two questionnaires: 1) What is Happening in This Class? (WIHIC) and 2) Metacognitive Awareness Inventory (MAI) as well as mathematics form four achievement test. The data was analysed by using Partial Least Squares-Structural Equation Modelling (PLS-SEM) through Smart PLS version 3.2.8 software. The findings indicated that knowledge of cognition mediates the relationships between classroom climate (investigation, task orientation and equity) and students' mathematics achievement, while regulation cognition mediates the relationships between classroom climate (student cohesiveness, investigation and equity) and students' mathematics achievement. Based on these findings, this study recommends that schools should endeavour to create a positive classroom climate focusing to improve student cohesiveness, task orientation, investigation and equity, as well as students' knowledge of cognition and regulation cognition to increase students' mathematics achievement. Pedagogical implications and suggestions for further research are discussed.

**Contribution/Originality:** This study is one of very few studies in Malaysia which have investigated the mediation effect of knowledge of cognition and regulation
cognition on relationships among classroom climate and students’ mathematics achievement within the rural area school context.

1. Introduction

The role of mathematics in development of the branches of science and technology is enormous. So, it is not surprising that mathematics is a core subject and becomes a basic requirement for admission into all levels of education around the world, including Malaysia. The revised Standard Curriculum for Secondary Schools (KSSM) mathematics which was implemented in 2017 to replace the Integrated Secondary School Curriculum (KBSM) aims to produce individuals who are mathematically minded, which means individuals who can think mathematically, creatively and innovatively as well as competent in applying mathematical knowledge and skills effectively and responsible in problem solving and decision making, based on attitudes and values to be able to deal with challenges in daily life, in line with the development of science and technology as well as the challenges of the 21st century (Curriculum Development Division, Ministry of Education (MOE) Malaysia, 2018). In other words, KSSM Mathematics aims to produce students who are effective in solving problems in accordance with 21st Century Learning skills. This is in line with one of the seven standards in the National Council of Teachers of Mathematics (NCTM) which states problem solving should be the main focus of the mathematics curriculum (National Council of Teachers of Mathematics, 2010).

Nevertheless, students’ knowledge in mathematics and the ability to apply that knowledge in problem solving becomes a challenge to students and is always associated with poor achievement in mathematics (Laistner, 2016). Hence, improving students’ mathematics achievement has been, and continues to become a major educational goal (Wang & Eccles, 2016). Student achievement in mathematics globally and locally has been a major concern in education such as Malaysia (MOE Malaysia, 2020), United States of America (You et al., 2021), Brunei (Mundia & Metussin, 2019), Chile (Gazmuri et al., 2016), India (Kushwaha, 2014), Indonesia (Pratiwi & Primana, 2018) and Turkey (Özcan & Erktin, 2015). The factors that influence students’ mathematic achievement should be taken into consideration by all parties in order to shape a quality mathematics curriculum that is comparable to international standards such as Programme for International Student Assessment (PISA) dan Trends in Mathematics and Science Study (TIMSS). Although the association between students’ academic achievement and intelligence is well established, intelligence is not the only factor that explains students’ achievement (Kaur et al., 2018). Other factors that have been found to have a significant influence on students’ mathematics achievement are metacognition awareness (Riyan Hidayat et al., 2018; Al-Shabibi & Alkharusi, 2018; Bishara & Kaplan, 2018; Ellah et al., 2018; Langdon et al., 2019; Mamon et al., 2020; Salam et al., 2020) and classroom climate (Cayubit, 2021; Reynolds et al., 2017; Riaz & Asad, 2018). This statement is also consistent with Lee and Stankov’s study (2018) on 2003, 2007 and 2011 TIMSS report as well as 2003 and 2012 PISA report which indicated that non-cognitive predictors on students’ mathematics achievement are school climate and students’ metacognition. In other words, a conducive classroom climate increases students’ metacognitive skills in mathematics learning which in turn affects the students’ achievement.

The concept of metacognition refers to thinking about thinking (Flavell, 1979) is often defined as the skills that are accompanied by monitoring, evaluating and strategy use (Scott & Levy, 2013). Meanwhile, Schraw and Dennison’s definition of metacognition
awareness has been well accepted by most researchers from the field of education and psychology (Schraw & Dennison, 1994). Metacognition awareness consists of two domains: Knowledge of cognition and regulation cognition. Knowledge of cognition has three subcomponents namely declarative knowledge, procedural knowledge and conditional knowledge. In general, knowledge of cognition refers to the ability to know what we know about how we learn, the most effective procedures and strategies work best for us and situations are most effective for us. On the other hand, cognition regulation, is a set of activities in which we engage to facilitate learning and memory. The main subcomponents of cognition regulation are planning, monitoring and evaluating. Thus, knowledge of cognition and regulation cognition are fundamental skills in mathematics learning.

There have been numerous studies reported the role of classroom climate quality such as students’ cohesiveness (Lay, 2017; Ouyang & Chang, 2019; Siti Nazleen & Nor Shahida, 2020), teacher support (Zepeda et al., 2018), involvement (McCleary et al., 2019), investigation (Muhammad Asy’ari et al., 2019), task orientation (Manwaring et al., 2017), cooperation (Erdogan, 2019; Fischer et al., 2018) and equity (Luria et al., 2017; Tang et al., 2017) in selecting learning strategies especially knowledge of cognition and regulation cognition. These studies highlighted the importance of leveraging student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity in a classroom to develop students’ knowledge of cognition and regulation cognition and further leading to mathematics achievement.

According to Bae and Kwon (2021), there is a growing body of evidence which illustrates the effect of metacognition awareness on mathematics learning. To date, only few studies have reported the interaction effects of the three variables: classroom climate, metacognition awareness (knowledge of cognition and regulation cognition) as well as students’ mathematics achievement especially in Malaysia education but none investigated those variables’ effect simultaneously in the context of rural schools. Therefore, to complement existing gaps and emerging issues, a study needs to be conducted to investigate the influence of classroom climate on students’ knowledge of cognition and regulation cognition as well as students’ mathematics achievement.

The objective of the study is to determine the mediation effects of knowledge of cognition and regulation cognition on the relationships between classroom climate (students’ cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity) and students’ mathematics achievement. Thus, this leads to the following hypotheses:

- **H₀₁ (a)** Knowledge of cognition is not a mediator for the relationship between student cohesiveness and the students’ mathematics achievement.
- **H₀₁ (b)** Knowledge of cognition is not a mediator for the relationship between teacher support and the students’ mathematics achievement.
- **H₀₁ (c)** Knowledge of cognition is not a mediator for the relationship between involvement and the students’ mathematics achievement.
- **H₀₁ (d)** Knowledge of cognition is not a mediator for the relationship between investigation and the students’ mathematics achievement.
- **H₀₁ (e)** Knowledge of cognition is not a mediator for the relationship between task orientation and the students’ mathematics achievement.
- **H₀₁ (f)** Knowledge of cognition is not a mediator for the relationship between cooperation and the students’ mathematics achievement.
H₀₁ (a) Knowledge of cognition is not a mediator for the relationship between equity and the students’ mathematics achievement.
H₀₂ (a) Regulation cognition is not a mediator for the relationship between student cohesiveness and the students’ mathematics achievement.
H₀₂ (b) Regulation cognition is not a mediator for the relationship between teacher support and the students’ mathematics achievement.
H₀₂ (c) Regulation cognition is not a mediator for the relationship between involvement and the students’ mathematics achievement.
H₀₂ (d) Regulation cognition is not a mediator for the relationship between investigation and the students’ mathematics achievement.
H₀₂ (e) Regulation cognition is not a mediator for the relationship between task orientation and the students’ mathematics achievement.
H₀₂ (f) Regulation cognition is not a mediator for the relationship between cooperation and the students’ mathematics achievement.
H₀₂ (g) Regulation cognition is not a mediator for the relationship between equity and the students’ mathematics achievement.

Figure 1 shows the conceptual framework of the current study. This framework comprises of independent, mediating and dependent variables under secondary schools setting in rural area of Sabah, Malaysia. The independent variables include students’ cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity which are adapted from psychosocial aspects of a classroom climate proposed by Fraser et al. (1996). The mediating variables include knowledge of cognition and regulation cognition which are adapted from the concept of metacognition awareness by Schraw dan Dennison (1994).

Figure 1: Conceptual framework of the current study

2. Review

2.1. Classroom Climate

Zedan and Bitar (2014) defined classroom as an educational, learning and social environment, whereas students stay long in a learning environment for a long time during long periods. Escabias and Ortega-Martin (2006) argued that organizing the students into a classroom aims to promote learning by allowing teachers and students to spend a significant amount of time with activities that result in learning. Classroom
environment has two aspects: physical environment referring the material setting of the classroom such as furniture, desks and chairs and psychological environment referring to the social quality of the school and classroom. However, classroom climate in this study is merely focusing on psychological environment aspects.

The seminal work of Moos (1974) classified three dimensions of the association between individual relationship and the surrounding environment: relationship (identify the nature and intensity of personal relationships within the classroom climate), personal growth (assess the extent to which the environment promotes personal growth and self enhancement) as well as systems maintenance and change (involve the extent to which the environment is orderly, clear in expectations, maintains control and is responsive to change) that strongly influenced research in classroom learning environment nowadays. Hence, in this study, subscales of students' cohesiveness, teacher support and involvement can be categorized in the dimension of relationship, investigation, task orientation, cooperation can be categorized in personal growth dimension meanwhile subscale of equity in the category of systems maintenance and change dimension, in accordance to the allocation proposed by WIHIC's developers Fraser et al. (1996).

Based on Vygotsky's sociocultural theory (Vygotsky, 1978), most of the children's learning is developed through interactions with others in their social world. Vygotsky (1978) believed that human learning is originated in two levels: first, through individual social interaction with others such as their parents or siblings in terms of students' home environment meanwhile teachers and students in a classroom setting. Second, the students' ability to convert the acquisition knowledge from social interaction into their personal understanding. The second level of Vygotsky's sociocultural theory (Vygotsky, 1978) is the idea that the potential of students' cognition is limited to a zone of proximal development (ZPD). This zone is used to describe skills that are difficult to achieve by students can be fully developed with the assistance and social interaction with adults or more capable peers.

Therefore, it is vital to examine the psychosocial features of the classroom climate (students' cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity) and their relation to students' knowledge of cognition and regulation cognition toward learning and achievement especially the mediation analysis.

2.2. Mediation Effect of Knowledge of Cognition in Classroom Climate and Students' Achievement

There is a vast literature documenting the relationship between classroom climate and knowledge of student cognition at the primary school level (Fischer et al., 2018), secondary school level (Erdogan, 2019; Liu & Su, 2018; Zepeda et al., 2018) as well as the higher institutional level (Mcleray et al., 2019; Salam et al., 2020; Sugiharto et al., 2018). Further, recent empirical studies have confirmed there is a positive relationship between metacognition and achievement in many subject areas, such as science subject (Ellah et al., 2018; Langdon et al., 2019), mathematics subject (Bishara & Kaplan, 2018; Nurulhuda & Saemah Rahman, 2017; Rryan Hidayat et al., 2018; Al-Shabibi & Alkharusi, 2018) and language subject (Ghaith & El-Sanyoura, 2019). Taken together, these findings suggest the need to investigate the components in the concept of metacognition in terms of knowledge of cognition and regulation of cognition.
As knowledge of cognition has a crucial role for mediating success in different classroom climate (Dökmeciögu et al., 2020), it has become one of the most important areas of research within educational studies. Literature has shown that knowledge of cognition serves as a mediator in many different contexts related to learning outcomes, including students’ academic achievement. Sadipour et al. (2017) study on the mediation effect of metacognitive learning strategies found that metacognitive learning strategies mediate the relationship between emotional intelligence which is connected to the students’ positive emotion and students’ academic performance. Based on structural equation modelling (SEM) results, it was concluded that the psychological aspects have affected students’ approach to learning strategies such as metacognitive and this leads to effective learning and thus improve students’ academic performance.

Studies on benefits of student engagement especially in knowledge of cognition and school climate on academic achievement largely situated within Western contexts (Lee & Stankov, 2018). However, a study by Chong et al. (2018) has proven that cognitive engagement mediated the effects of teacher support and students’ competencies with a Singapore junior high school population. The study demonstrated that cognitive engagement construct has empirical utility and relevance in the context of Asia though theorized in a western context. Similarly, this was also empirically supported by Riyan Hidayat et al. (2018), who showed that dimensions in metacognition mediated students’ achievement goals and mathematical modeling competency in the Indonesian context. Thus, the findings of the current study might contribute to the development of knowledge of cognition and regulation cognition in mathematics among students especially in Malaysian context.

2.3. Mediation Effect of Regulation Cognition in Classroom Climate and Students’ Achievement

Extensive of studies revealed important findings related to classroom climate and regulation cognition (Alzahrani, 2017; Cayubit, 2021; Fathi & Shabani, 2020; Fischer et al., 2018; Hafizoglu & Yerdelen, 2019; Liu & Su, 2018) which have received adequate attention from the researchers and practitioners. Moreover, it should be noted that regulation cognition has been widely recognised as a potential predictor of the students’ achievement (Izzati & Mahmudi, 2018; Mirhosseini et al., 2018; Mohamad Ariffin & Norulhuda, 2020). In spite of that, the literature reveals limited studies on the mediating role of regulation cognition on classroom climate and students’ achievement especially in Malaysian context. This is due to lack of higher order thinking skills (HOTS) elements applied to students in the classroom (Abdul Halim et al., 2017) as teachers spent most of the time for drilling and syllabus completion. Many strategies for teaching HOTS embrace knowledge of cognition and regulation cognition as the crucial component of instruction. It has been argued that students with a high level of regulation cognition are able to solve mathematics HOTS type problems as it demands students’ abilities to analyze, evaluate and create so that they have critical power and creativity to solve problems in daily life (Susilo & Retnawati, 2018). In general, a positive classroom climate is essential in ensuring students’ success. A study involving college students (Cayubit, 2021) revealed that classroom climate factors: involvement, student cohesiveness, satisfaction, task orientation, innovation, and individualization influence the adoption of learning strategies and students’ engagement. In other words, when the classroom climate is conducive, its different facets aid students in choosing appropriate and effective learning strategies such as regulation cognition and encourage students to participate in learning activities.
It is noteworthy that students’ regulation cognition also serves as a mediator in different contexts related to learning outcomes, including students’ academic achievement. A large scale study involving a total number of 1800 students from junior high schools, senior high schools and college (Zhou et al., 2021) revealed that students’ perception of the learning environment predicted study engagement and this association was mediated by intentional self-regulation. Therefore, establishing a caring, trusting and cohesive student–teacher relationship and emphasizing student’s practical skills would be helpful for study engagement which is regarded as one of the crucial factors for students’ performance. Similarly, Law et al. (2019) demonstrated that the cognitive presence has an indirect effect on student enrolment in blended learning setting and learning performance. This finding shows that the characteristics of freestyled and open dialogue found in blended learning setting provides flexibility in students’ interaction and group discussion in deciding when, how and with what content and activities they engage in which in turn enhances student innovativeness compared to traditional learning. However, the extent to which students’ perceptions of classroom climate in terms of students’ cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity influence students’ mathematics achievement with their level of regulation cognition is rarely investigated. More specifically, to our knowledge, there is no attempt from other studies to measure the effect of metacognition awareness as two variables (knowledge of cognition and regulation cognition) and mathematics classroom climate on students’ achievement in Malaysian rural school context. Thus, a mediation analysis is proposed.

3. Methodology

3.1. Research Design and Sampling Procedures

This study employed a survey design to investigate the mediation effects of knowledge of cognition and regulation cognition on relationship between classroom climate and students’ mathematics achievement in the context of rural secondary schools in Sabah, Malaysia. The population of this study is comprised 1319 Form Four students from five Divisions in Sabah: Interior Division, Kudat Division, Sandakan Division, Tawau Division and West Coast Division. By using multi-stage cluster sampling, one district was selected representing each Division with the district functioning as the first cluster at the first stage. Then, one school was selected from the selected district (first cluster) as the second cluster at the second stage. All Form Four students from each cluster were selected to finally determine the final sample. The total number of 338 Form four students from five selected rural secondary schools in Sabah, Malaysia, were selected for the final sample. The sample consisted of 149 (44.1%) boys and 189 (55.9%) girls.

3.2. Instrument

The data for the current study were collected using two psychometric scales, namely: What is Happening in This Class (WIHIC) (Fraser et al., 1996) and Metacognition Awareness Inventory (MAI) (Schraw & Dennison, 1994) as well as a mathematics achievement test developed by the researcher. The English version of WIHIC and MAI questionnaires were translated into Malay language by the researcher and back translated to English by an English teacher to ensure the validity of the translation. Then, the back translations were checked by a language expert.
3.3. What is Happening in This Class (WIHIC)

Students’ perceptions of their mathematics learning experiences in classroom were measured using WIHIC, a multidimensional scale which consisted of seven sub scales: student cohesiveness (KP), teacher support (SG), involvement (PL), investigation (PS), task orientation (OT), cooperation (KJ) and equity (KS), each with eight items. Each item is rated on a Likert-type scale where students answer the items according to five statements which are ‘Never’ (1), ‘Seldom’ (2), ‘Sometimes’ (3), ‘Often’ (4) and ‘Always’ (5). The questions in WIHIC have been modified specifically on mathematics learning experiences due to the original questions in WIHIC encompassing a more general view on classroom climate. For example, the item “I discuss ideas in the class” is changed to “I discuss ideas in mathematics class”. To determine the reliability of items in WIHIC in the context of the current study, a pilot study was conducted. By using the Rasch Measurement Model Approach, the reliability value based on Cronbach’s Alpha was 0.92. Moreover, after the pilot study, the total number of items in the WIHIC decreased from 56 to 54.

3.4. Metacognition Awareness Inventory (MAI)

Students’ knowledge of cognition and regulation of cognition were measured using the MAI. The MAI consists of 52 items: 17 items addressing knowledge of cognition and 35 items addressing the regulation cognition. The knowledge of cognition includes eight items on declarative knowledge, four items on procedural knowledge and five items on conditional knowledge. The regulation cognition includes seven items on planning, 10 items on information management strategies, seven items relating to comprehension monitoring, five items on debugging strategies and six items on evaluation. Items included in MAI were rated on a five-point Likert-type scale ranging from ‘strongly disagree’ (1) to ‘strongly agree’ (5). Pilot study carried out to verify reliability items in MAI showed that the Cronbach’s Alpha value was 0.88. After the pilot study, the total number of items in the MAI decreased from 52 to 51.

3.5. Mathematics Achievement Test

With the purpose to measure students’ mathematics achievement, a 19-item mathematics test based on Malaysian mathematics curriculum was developed by the researcher. The total periods of mathematics classes and number of instructional objectives in mathematics Form Four curriculum were taken into account when it was developed. For validity and reliability of the test, the items were constructed based on five years trends of Malaysian Certificate of Education (SPM). To validate the test, a pilot study was conducted. After the pilot study, the total number of items in the mathematics achievement test decreased from 22 to 19. The reliability value by using Cronbach’s Alpha was 0.90 based on Rasch Measurement Model Approach. Thus, the total scores for the 19-item mathematics test obtained by the students were used to gather information about the students’ mathematics achievement in the context of the current study.

3.6. Data Analysis

The Smart PLS program version 3.2.8 was utilized to run the data analysis. As mentioned earlier, the current study hypothesizes two mediators in a model study, the researcher estimated specific indirect effect instead of total indirect effects as suggested by Memon et al. (2018). A statistically significant indirect effect (t-value > 1.96, two-tailed, p <0.05)
are evidence for mediation (Preacher & Hayes, 2004; Zhao et al., 2010). In addition, an assessment of the confidence interval is also an important criterion to confirm the mediation effect. If a confidence interval for the specific indirect effect does not straddle a zero in between, this supports the presence of mediation effect and vice versa (Memon et al., 2018). Bootstrapping is a nonparametric procedure that can be used to test the statistical significance of various PLS-SEM results. However, the bias-corrected and accelerated (BCa) bootstrap confidence intervals method is the most consistent effective technique (Puth et al., 2015) and it adjusts the confidence intervals for skewness (Sarstedt et al., 2019).

4. Result

The mediation analysis was conducted using 5000 bootstrapping samples. To test the mediating role of knowledge of cognition (H⁰₁a, H⁰₁b, H⁰₁c, H⁰₁d, H⁰₁e, H⁰₁f, H⁰₁g) and regulation cognition (H⁰₂a, H⁰₂b, H⁰₂c, H⁰₂d, H⁰₂e, H⁰₂f, H⁰₂g) researcher applied bootstrapping technique using Bca to test the specific indirect effects.

Table 1: The result of mediation tests

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Hypotheses</th>
<th>Path Coefficient</th>
<th>T value</th>
<th>P value</th>
<th>BCA CI [LB, UB]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of Cognition (PK) as Mediator</td>
<td></td>
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<tr>
<td>KP</td>
<td>Students’ Mathematics Achievement</td>
<td>H⁰₁a</td>
<td>0.048</td>
<td>1.003</td>
<td>0.316</td>
<td>[-0.029, 0.149]</td>
</tr>
<tr>
<td>SG</td>
<td>H⁰₁b</td>
<td>-0.051</td>
<td>0.974</td>
<td>0.330</td>
<td>[-0.156, 0.044]</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>H⁰₁c</td>
<td>0.048</td>
<td>1.333</td>
<td>0.182</td>
<td>[-0.013, 0.130]</td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>H⁰₁d</td>
<td>0.058</td>
<td>2.230</td>
<td>0.026</td>
<td>[0.013, 0.114]</td>
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<tr>
<td>OT</td>
<td>H⁰₁e</td>
<td>0.059</td>
<td>1.820</td>
<td>0.069</td>
<td>[0.002, 0.131]</td>
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<tr>
<td>KJ</td>
<td>H⁰₁f</td>
<td>0.036</td>
<td>0.969</td>
<td>0.332</td>
<td>[-0.028, 0.119]</td>
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<tr>
<td>KS</td>
<td>H⁰₁g</td>
<td>0.073</td>
<td>2.283</td>
<td>0.022</td>
<td>[0.013, 0.136]</td>
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<table>
<thead>
<tr>
<th>Regulation Cognition (RK) as Mediator</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>KP</td>
<td>Students’ Mathematics Achievement</td>
<td>H⁰₂a</td>
<td>0.174</td>
<td>2.546</td>
<td>0.011</td>
<td>[0.070, 0.338]</td>
</tr>
<tr>
<td>SG</td>
<td>H⁰₂b</td>
<td>-0.123</td>
<td>1.673</td>
<td>0.094</td>
<td>[-0.290, 0.001]</td>
<td></td>
</tr>
<tr>
<td>PL</td>
<td>H⁰₂c</td>
<td>0.019</td>
<td>0.385</td>
<td>0.700</td>
<td>[-0.079, 0.116]</td>
<td></td>
</tr>
<tr>
<td>PS</td>
<td>H⁰₂d</td>
<td>0.099</td>
<td>2.699</td>
<td>0.007</td>
<td>[0.033, 0.177]</td>
<td></td>
</tr>
<tr>
<td>OT</td>
<td>H⁰₂e</td>
<td>0.037</td>
<td>0.834</td>
<td>0.404</td>
<td>[-0.052, 0.126]</td>
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</tr>
<tr>
<td>KJ</td>
<td>H⁰₂f</td>
<td>0.061</td>
<td>1.188</td>
<td>0.235</td>
<td>[-0.029, 0.174]</td>
<td></td>
</tr>
<tr>
<td>KS</td>
<td>H⁰₂g</td>
<td>0.114</td>
<td>2.515</td>
<td>0.012</td>
<td>[0.024, 0.205]</td>
<td></td>
</tr>
</tbody>
</table>


The indirect effect of investigation (β = 0.058, p = 0.026, 95% CI; LB:0.013, UB: 0.114), task orientation (β = 0.059, p = 0.069, 95% CI; LB:0.002, UB: 0.131) and equity (β = 0.073, p = 0.022, 95% CI; LB:0.013, UB: 0.136) on students’ mathematics achievement through knowledge of cognition were significant. There is no mediation effect for knowledge of cognition on student cohesiveness (β = 0.048, p = 0.316, 95% CI; LB:-0.029, UB: 0.149), teacher support (β = -0.051, p = 0.330, 95% CI; LB:-0.156, UB: 0.044), involvement (β = 0.048, p = 0.182, 95% CI; LB:-0.013, UB: 0.130) and cooperation (β = 0.036, p = 0.332, 95% CI; LB:-0.028, UB: 0.119).
The indirect effect of student cohesiveness ($\beta = 0.174$, $p = 0.011$, 95% CI; LB:0.0070, UB: 0.338), investigation ($\beta = 0.099$, $p = 0.007$, 95% CI; LB:0.033, UB: 0.177) and equity ($\beta = 0.114$, $p = 0.012$, 95% CI; LB:0.024, UB: 0.205) on students' mathematics achievement through regulation cognition were significant. There is no mediation effect for regulation cognition on teacher support ($\beta = -0.123$, $p = 0.094$, 95% CI; LB:-0.290, UB: 0.001), involvement ($\beta = 0.019$, $p = 0.700$, 95% CI; LB:-0.079, UB: 0.116), task orientation ($\beta = 0.037$, $p = 0.404$, 95% CI; LB:-0.052, UB: 0.126) and cooperation ($\beta = 0.061$, $p = 0.235$, 95% CI; LB:-0.029, UB: 0.174).

To sum up, the bootstrapping results presented in Table 1 indicated that the mediation effect of classroom climate (Investigation, Task orientation and Equity) on students' mathematics achievement through knowledge of cognition and the mediation effect of classroom climate (Student Cohesiveness, Investigation and Equity) on students' mathematics achievement through regulation cognition were significant.

5. Discussion

By rooting Vygotsky’s sociocultural theory (Vygotsky, 1978), students’ social interactions are vital to their cognition development which imply the classroom climate is the “culture” that determines students’ learning development such as the knowledge of cognition and regulation cognition, and these in turn affect the students’ academic achievement. From the literature review, it could be surmised that classroom climate, which consists of interactions between teachers and students, students with students and the type of classroom activities has a profound influence on students’ academic achievement. Thus, developing students’ knowledge of cognition and regulation cognition in the students’ ZPD takes into account that every student is able to achieve better with the help of a positive classroom climate. The current study conceptualizes psychosocial features of the classroom climate based on seven scales proposed by Fraser et al. (1996): Student Cohesiveness, Teacher Support, Involvement, Investigation, Task Orientation, Cooperation and Equity.

This study explored the associations between students’ perceptions of the classroom climate, their knowledge of cognition and regulation cognition and their mathematics achievement. Our results strongly supported predictive links among classroom climate, knowledge of cognition, regulation cognition and students’ academic achievement.

To step beyond the investigation of the direct relationships between classroom climate and learning outcomes, there have been studies focusing on the mediation effect of metacognition awareness (Fariba Mirzaei et al., 2012; Nurulhuda & Saemah, 2017; Kwan & Wong, 2015; Trigueros et al., 2020). However, to the best of our knowledge, this study is the only one to measure metacognition awareness as two constructs: knowledge of cognition and regulation cognition as mediators simultaneously.

In line with previous findings, through knowledge of cognition, classroom climate that encourages investigation (Cheng & Wan, 2017; Nurulhuda & Saemah, 2017), task orientation (Neuenhaus et al., 2018; Hayat et al., 2020) and equity enhanced students’ mathematics achievement significantly (see Table 1). The other four factors (Student Cohesiveness, Teacher Support, Involvement, and Cooperation) of classroom climate did not show significant mediation level by knowledge of cognition. This shows that only certain components in classroom climate are influenced by knowledge of cognition. Thus, the findings of the current study regarding student cohesiveness contradict the result of
Sadipour et al. (2017) and Wentzel et al. (2018). More specifically, student with positive emotion tends to participate and interact with other students in the classroom, affect the use of learning strategies such as metacognitive strategies and lead to the improvement of students’ academic performance. Moreover, the inconsistent findings of teacher support as reported in Chong et al. (2018) show that more future studies are needed to investigate types of teacher support other than emotional support as measured in the current study to explain teacher support on knowledge of cognition and students’ achievement. Furthermore, these findings contradict the work by Law et al. (2019), when students are self-initiated to participate in learning and thinking activities, interact with others will positively and directly affect their learning performance. These apparently contradictory results can be explained by the passive interaction of teacher-student classroom climates in the current study due to the fact that lecture-based teaching is still common in Asian education context (Tran et al., 2019).

Regulation cognition mediated the effects of classroom climate component: student cohesiveness, investigation and equity on students’ mathematics achievement. This suggests that students with high perception of close relationships with classmates, do more inquiry, have equal learning opportunities with other students in the classroom, are likely to plan, manage information, monitor their comprehension, use debugging strategies and evaluate their understandings which in turn leads to improved mathematics achievement. These results echo our expectations as well as previous findings from Zhou et al. (2021), Fariba Mirzaei et al. (2012) and Nurulhuda and Saemah (2017) which indicated that students’ regulation cognition, is positively linked to their reports of closeness with their classmates and the emphasis of inquiry activities in the classroom. This finding can be justified by taking into account the quality of student-student relationships and the role of inquiry skill in improving the students’ academic performance. According to Zhou et al. (2021), a cohesive relationship can foster more supportive environment which in turn promotes interaction between students and other elements in the environment and form positive study engagement behaviors. In other words, the bond of friendship among classmates promotes a sense of togetherness to succeed in learning and encourages them to use the most effective learning strategies such as regulation cognition. Furthermore, the finding of Nurulhuda and Saemah (2017) suggested that the inclusion of learner-centered, knowledge-centered, assessment centered and community-centered to the students’ learning environment which allow them to become more aware of their thinking processes and help them to develop regulation cognition. This result implied metacognitive aspects (knowledge of cognition and regulation cognition) to be a prerequisite for effective learning and is believed to directly contribute to an increase in student achievement.

However, this study failed to provide sufficient evidence to conclude the mediation effect of regulation cognition between teacher support, involvement, task orientation and cooperation on students’ mathematics achievement. One reason for the absence of indirect relationship is that the mathematics achievement test used in this study may be less affected by instructional processes in the class. When students grow older, their mathematics acquisition and problem-solving skills may become more automatized and therefore, more independent from teacher support and warmth. This view is supported by the work of Brown (1987), regulatory processes including planning, monitoring, and evaluation may not be conscious or statable in many learning situations.

This study contributes significantly to the body knowledge by empirically testing mediation effects of knowledge of cognition and regulation cognition connecting to
evidence and students’ mathematics achievement within the Malaysian rural school context. Moreover, no study to date has examined both the mediating effect of knowledge of cognition and regulation cognition though extensive studies have assessed the direct relationships related to equity such as Luria et al. (2017), Ahmed and Indurkhya (2020), Schnell dan Prediger (2017), and Tang et al. (2017). From a practical point of view, the findings of this study suggest the existence of direct and indirect relationships between equity and students’ achievement via knowledge of cognition and regulation cognition.

The output of this study highlighted the crucial roles of a positive classroom climate, specifically student cohesiveness, task orientation, investigation and equity as well as students’ knowledge of cognition and regulation cognition in influencing students’ learning and achievement. This finding is coherent with Kaur et al. (2018), if knowledge of cognition skillfulness and regulation cognition approaches are promoted in students, they begin to think about their own learning more explicitly. Knowledge of cognition and regulation cognition mediate the relationship between classroom climate and students’ mathematics achievement. This finding explains that knowledge of cognition and regulation cognition serve as a key leverage point in students’ learning as it enables student to know about their own thinking processes and help them to control their thinking which in turn influences their mathematics learning behavior that directly contributes to students’ mathematics performance. The current study provides support for the use of knowledge of cognition as a mediator in the relationship between classroom climate and students’ performance in the context of secondary schools especially rural schools in Malaysia. Knowledge of cognition and regulation cognition are indirectly important to create a positive classroom climate and to achieve learning success. Classroom climate perceived as having more student cohesiveness, investigation, task orientation and equity indirectly encourage student to use effective learning strategies such as metacognition awareness, and this in turn would benefit the students as they become responsible to their own learning.

6. Limitations and Future Directions

This study has several limitations that should be acknowledged. First, the review of the students’ perception on classroom climate, their knowledge of cognition and regulation cognition level were based on students' own confession or report through their response to MAI and WIHIC questionnaires. Thus, the results of the current study are constrained by the respondents’ honesty and sincerity when answering the questionnaires submitted. In general, the nature of the self-report instrument in this current study cannot guarantee the truthfulness of the respondents. Thus, the potential that true associations between variables may be inflated.

Second, the students selected as sample study consisted of students who came from different backgrounds and cultures in the same classroom. The student’s perception of his/her individual role within the classroom through the WIHIC questionnaire in order to assess the quality of classroom climate are constrained by students’ own experiences in their respective classrooms. Thus, students’ perceptions may change with different contexts.

Third, the findings cannot be generalized in larger context across the cultures of other states in Malaysia since the data collected are limited to rural schools in Sabah. Thus, future study is needed to see if WIHIC and MAI fits other samples in urban schools in this context. It is also suggested that future studies include measures of knowledge of
cognition and regulation cognition and academic achievement to permit investigation of associations between the classroom climate and student outcomes in Malaysia.

Fourth, the current study employed quantitative techniques that only collected students’ perceptions, rather than their actual learning behaviors and outcomes. The correlational nature of the current study precludes interpretations about possible causal relationships of classroom climate and knowledge of cognition and regulation cognition on mathematics achievement. In order to overcome the limitations of this study, future study should employ experimental approach to elucidate the effectiveness of classroom climate and knowledge of cognition and regulation cognition on students’ math achievement. Moreover, the future study should include moderating variables to provide better understanding on the relationship between these variables.

Finally, the current study employed a cross-sectional study (survey method) design, over a longitudinal design. Since knowledge of cognition and regulation may take time to be embedded in a learning behavior as well as student perceived classroom climate, hence, longitudinal design should be considered for the future study to capture the link between these variables.

7. Conclusion

This study investigated the mediation effects of knowledge of cognition and regulation cognition on the relationships between classroom climate and students’ mathematics achievement. The findings indicated a significant indirect effect between component of classroom climate (i.e. student cohesiveness, task orientation, investigation and equity) and students’ mathematics achievement through knowledge of cognition and regulation cognition. Based on the findings, when students make good friendship with other students, help each other, do more investigation, task oriented and their mathematics teacher behaves equally towards all students significantly influence students’ knowledge of cognition and regulation cognition and mathematics achievement. The result of this study will add value to existing literature on the relationship between perceived classroom climate on students’ achievement particularly on issue related to learning outcomes such as knowledge of cognition and regulation cognition. The significant mediating role played by knowledge of cognition and regulation cognition have drawn attention to the need for a well-organized workshops for teachers to provide the support and learning tools necessary to further develop metacognitive strategies. It is also suggested that schools should endeavour to create a positive classroom climate which emphasize student cohesiveness, task orientation, investigation and equity to support students’ knowledge of cognition and regulation cognition in order to improve academic performance.

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Conflict of Interests

The authors declare no conflict of interest in this study.

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