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Affective Determinants of Additional Mathematics Achievement in Malaysian Technical Secondary Schools

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Abstract

The purpose of this study was to identify the affective determinants of additional mathematics achievement in technical secondary schools. In addition, this study also aimed to identify the best predictor of affective variables toward additional mathematics achievement. The respondents of the study were 250 students from three public technical secondary schools in Kedah, Malaysia that were selected using random sampling. 40 multiple-choice items were selected to measure and determine their level of additional mathematics achievement. The affective variables were based on attitude, anxiety and habit. Multiple regression were used for tests of significance. The findings of the study showed that attitude has a positive relationship whereas anxiety in learning Additional Mathematics has a negative relationship with additional mathematics achievement. Additionally, the findings showed that attitude was the best predictor of additional mathematics achievement. This finding proposed the importance of assessing students’ affective attributes before assessing their cognitive ability in additional mathematics achievement. Therefore, this study suggests that teachers, counsellors and principals could assess students’ affective attributes in identifying students’ cognitive ability in learning additional mathematics.

Keywords: Attitude, Anxiety, Habit, Additional Mathematics
1. Introduction

Generally, students think that mathematics is difficult to master. Therefore, some students perform very well while some fail to master this subject even when they are facing the easy topics within the subject. Students have their own styles and approaches in understanding and processing mathematical information. Hence, several reasons have been given for this disparity in mathematics achievement. Among them is that individuals possess different, unique and personal orientation in mathematics (Berita Matematik, 1993). It is noteworthy that despite its utility and importance, mathematics is perceived by most pupils as difficult, boring, not very practical, abstract, etc., and its learning as requiring a special ability that is not always within everyone’s reach (Ignacio, Nieto & Barona, 2006).

The 60:40 policy of the Ministry of Education, Malaysia which targets 60 per cent of the students in the Science and Technology streams in upper secondary schools has still not been met. In 2004, there were only 43.18 per cent students in the Science and Technology streams. This shows that the students failed to master mathematics considering that a good grade in mathematics was a requirement for selection into the Science and Technology streams (Hashim Yaacob, 2004).

Studies on intellectual development and the nature of learning have resulted in various theories of learning. One of the important learning theories is the Theory of Cognitive Development of Children (Piaget, 1965). This theory differs and varies with changes in age, that is, the sensory motor stage (0-2 years), the pre-operational stage (2-6 years), the concrete operational stage (7-12 years) and the formal operational stage (after 12 years). In this study, emphasis was given to the last stage of cognitive development as the students involved were in the 16-year age group (Form Four) in secondary schools. Learning theories are descriptive in nature, that is, they analyse the mental activities that can be performed by students according to the intellectual development in certain subjects. Teachers who are aware of the child development theory can understand how students learn and solve mathematical problems. Skemp (1971) in his book *The Psychology of Learning Mathematics* conjectures “Problems of learning and teaching are psychological problems, and before we can make much improvement in the teaching of mathematics we need to know more about how it is learned” (pp. 14).

Basically learning is understood as an orientation which brings changes in each individual. After undergoing the learning orientation, a person will know, execute or think about something that he has not known before. Besides this, learning cannot be separated from the activities related to obtaining and using knowledge. When knowledge is obtained and used, then the expected changes will be realized (Wan Zah, 2000).

Polya (1973) mentions that four phases, namely understanding the problem, planning the problem planner, solving the problem and checking the answers, should be followed by the students to solve mathematical problems. These four phases are important to understand how to solve mathematical problems. The development of mathematics at the school level involved three main areas, namely Numbers, Shapes and Relationship. The development and foundation of mathematics start with the area of Numbers in the Integrated Curriculum for Primary Schools (KBSR), while at the Integrated Curriculum for Secondary Schools (KBSM) level, the areas of Shapes and the Relationship are given more attention besides the area of Number at the upper secondary level. Many school students experience difficulty in learning because they are seldom taught how to study. The difficulty in learning among students is only slightly connected to natural ability (Lashley & Best, 2001). A student’s views regarding learning influences the way the individual studies. However, views,
according to Saljo (1982) cannot be considered a stable characteristic built within a student. They are formed according to the learning environment situation and culture which surround the student’s life.

Although students in a class are approximately of the same age, their needs and interests are different. According to the theory of human psychological development (Piaget, 1965) environmental effect in an individual’s growth is very important and it plays a role in the formation of human behaviour. Environment has a very complex power that can influence an individual’s behaviour.

Learning orientation is based on the perception that only the student himself can carry out learning to the optimum. Teachers, parents or peers, are unable to do the learning for the student (Arsaythamy, 2010). This view is further strengthened through observation that students differ from one another in manner, needs and rate of learning. It is important that students decide on the best learning strategy that suits them. This will produce individuals who can think and be responsible for their learning (Pusat Perkembangan Kurikulum, 2001).

Two theoretical models, namely Interference Model and Deficit Model, have influenced anxiety in mathematics. The Interference Model, introduced by Liebert and Morris (1967), Mandler and Sarason (1952) and Wine (1971), explained anxiety in mathematics as recall interference coming before knowledge and mathematical experience. Consequently, an increase in the level of anxiety will produce a low level of achievement in mathematics. In the Deficit Model, Tobias (1985) connects mathematical anxiety to memories of previous low mathematical performance and believes that this performance is caused by high anxiety. According to the Deficit Model, students perform badly because of poor study behaviour and poor examination-taking skills. Mathematical anxiety exists because of insufficient preparation in mathematics.

Mathematical anxiety is also known as mathematical phobia. Studies have shown that that anxiety always begins at the primary schools, although these symptoms were not proven until Burns’ (1998) study. According to Burns, the traditional way of teaching mathematics has proven that mathematical phobia is difficult to overcome. Kennedy and Tipps (1991) listed five practices that contribute to anxiety in mathematics, namely stressing memorization, emphasizing students doing homework by themselves, authoritarian teaching, and lack of variety in the teaching and learning processes.

Mathematics attitudes

Learning attitude is an important attribute in student motivation. Students who are motivated and have the ability can do mathematics well. In general, students who are motivated are interested in learning. On the other hand, a negative attitude to performance leads to a lack of interest in studying mathematics (Steyn & Maree, 2002). Schreiber’s (2002) study establishes that there is a relationship between low attitudes towards mathematics achievement and poor results. In mathematics achievement, college students are identified as performance predictors of algebra and calculus (House, 1995). Learning attitude is the basic element of psychological and sociological theories (Aronson, Wilson & Akert, 1999). Arslan, Carli and Sabo (2012) in their research shows that affect of attitude towards mathematics achievement. According to Mueller (1996), attitude is important in oneself and it influences every decision made. In the field of psychology, attitude is defined as a situation that exists as mental or physical. Attitude is one’s willingness to act in an appropriate way towards things, people, situations, places, ideas and behaviour. Besides this, attitudes are also noticed through motivational power or pressure from within oneself.
Mathematics Anxiety

Arem (2003) opined that mathematics anxiety can be linked directly to poor test preparation and psychological tension felt by students. Mathematical anxiety is often referred to as lack of comfort which might be experienced by someone asked to perform a mathematical activity (Wood, 1999) or pressure, feeling less able and an unprepared mind to manipulate numbers and shapes (Tobias, 1985). Mathematical anxiety is measured in various forms such as dislike (attribute element), anxiety (cognitive element) and fear (emotional element) (Hart, 1989). Hembree (1990) in his meta-analysis focused on the relationship between mathematical anxiety and mathematics achievement.

Mathematics Learning Habit

This variable measures the learning habit attribute in mathematics. Behaviour refers to something that can be possessed, is consistent, effective learning methods and habits (preparation, practising past examination questions, practising popular questions in mathematics). The readiness of the students is not only for obtaining certain aspects in mathematics, but also to learn theorems, rules and definitions carefully and concentrate on doing assignments in mathematics (Maree, 1997).

Mathematics assignments and exercises are completed immediately, homework is completed from time to time without any wastage of time. Besides these are readiness to do mathematics consistently, and doing more interesting activities as replacements. This field determines the limit that the attitude to learn mathematics can be stated specifically for mathematics learning habits.

In conclusion learning mathematics should not be seen from the cognitive aspect like only test results but also from non-cognitive factors like SOM influencing students’ success (Anneke, Adelene & Karel, 2001). Anneke et al. (2001) suggested that mathematics achievement is very complex to predict by using one factor, but needs many more factors to measure mathematics achievement. Tocci and Engelhard (1991) stated that affective variables are as important as cognitive variables (mathematics achievement) in achieving results in learning. Students’ abilities in school should not be confined to achievement but should also include students’ affective variables.

2. Research Objective

- To identify the relationship between attitude, anxiety and habits toward Additional Mathematics achievement among technical secondary schools students.
- To identify which is the best predictor of attitude, anxiety and habits toward Additional Mathematics achievement.

3. Method

The sample consisted of 250 Form Four students in technical secondary schools in the state of Kedah in Malaysia. 160 (64%) were male students while 90 (36%) were female students. Data collection was based on two types of instruments. The first instrument, the Study Orientation in Mathematics (SOM) questionnaire
(Arsaythamby, 2010) was used to measure students’ behaviour related to aspects of learning and mathematics achievement. SOM consisted of five variables: attitude in learning mathematics, anxiety in learning mathematics, habit in learning mathematics, behaviour in solving mathematical problems, and environment in learning mathematics. In this study only three major variables were used as affective variables (attitude, anxiety & habit). This questions used the agreement scale with four options: Option 1 (strongly disagree), 2 (disagree), 3 (agree) and 4 (strongly agree).

The second instrument is the multiple-choice mathematics test which was prepared by the Kedah State Education Department. The questionnaire was designed by four teachers who were recognized as specialists in mathematics at the national level. This test consisted of 40 items and it was the first paper which took one hour 15 minutes. The correlation test was used to answer the first research question and multiple regression was used to answer the second question.

4. Results

4.1. Correlation between affective variables and additional mathematics achievement

Table 1 shows a significant positive relationship between attitudes and habits with Additional Mathematics achievement but the relationship is not strong. The results of this correlation show that generally r values are low but significant because the sample size is large.

Table 1: Pearson Correlation between affective and additional mathematics achievement

<table>
<thead>
<tr>
<th>Affective variables</th>
<th>Additional Mathematics achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.Attitude</td>
<td>.34**</td>
</tr>
<tr>
<td>2.Anxiety</td>
<td>-.34**</td>
</tr>
<tr>
<td>3.Habit</td>
<td>.23**</td>
</tr>
</tbody>
</table>

** p < .01 (2-tailed)

Attitude in learning mathematics has a positive significant relationship with additional mathematics achievement. Attitude in learning mathematics has a low positive relationship with mathematics achievement ($r = .34, p < .01$). Mathematics learning habit has a significant positive correlation with mathematics achievement. Habit in learning mathematics has a relatively low positive relationship with mathematics achievement ($r = .23, p < .01$). Anxiety in learning mathematics has a significant negative correlation with mathematics achievement. Anxiety in learning mathematics has a low negative relationship with achievement in the mathematics achievement ($r = -.34, p < .01$).

4.2. Affective Variable which is the best predictor of additional mathematics achievement

Table 2 shows the results of the multiple regression analysis with mathematics achievement as the dependent variable. The regression model has a coefficient determinator $R^2$ with an average value of 0.17. This indicates that 17% of variance in mathematics achievement can be explained jointly by the three affective
variables; attitude, anxiety and habit. F statistics which test \( H_0 : R^2 = 0 \) is significant for the regression model, that is mathematics achievement score \( (R^2 = 0.17; p < .05) \). This means that at least one regression coefficient in each regression model differs significantly from zero. The t-values for attitude and anxiety contributed significantly to additional mathematics achievement but habit was insignificant. The findings of this study indicate that attitude and anxiety in learning additional mathematics are the only predictors (17.40%) for learning mathematics (Table 2).

Table 2: Multiple Regression Analysis between Additional Mathematics Achievement and Affective Variables

<table>
<thead>
<tr>
<th>Affective variables</th>
<th>Dependent variable (Additional Mathematics Achievement)</th>
<th>Unstandardized coefficients</th>
<th>Standardized coefficients</th>
<th>t Statistics</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td></td>
<td>15.86</td>
<td>6.74</td>
<td>2.36</td>
<td>.02</td>
</tr>
<tr>
<td>Attitude</td>
<td></td>
<td>5.35</td>
<td>2.06</td>
<td>2.60</td>
<td>.01*</td>
</tr>
<tr>
<td>Anxiety</td>
<td></td>
<td>-4.33</td>
<td>1.35</td>
<td>-3.20</td>
<td>.00*</td>
</tr>
<tr>
<td>Habit</td>
<td></td>
<td>0.87</td>
<td>1.88</td>
<td>0.47</td>
<td>.64</td>
</tr>
</tbody>
</table>

*p < .01

5. Conclusions

The mathematics learning attitude variable has a significant positive correlation with mathematics achievement. The importance of attitude in learning mathematics is consistent with the studies of Schreiber (2002) and Moodaley, Grobler and Lens (2006) which showed that students with low mathematics learning attitude towards mathematics tests had low achievement. On the whole Form Four students have poor attitudes and habits as well as anxiety in mathematics. Although most students are peers in class or are in the same stream they have different needs and interests in mastering KBSM mathematics. Each student has the ability to master mathematics but the level of mastery depends on the effectiveness of his or her learning process (Pusat Perkembangan Kurikulum, 2001). Therefore, students should be proactive in affective variables. This means that affective variables are based on the perception that only students themselves can perform optimum learning based on their abilities.

The mathematics learning habit variable has a relatively low positive correlation which is 0.23. This finding is consistent with the Deficit Model introduced by Tobias (1985) which states that the causes for students obtaining low achievement are poor learning habits and insufficient test-taking skills. The variable for anxiety in mathematics learning has a negative correlation with mathematics achievement. High anxiety in learning mathematics is also related to low mathematics achievement. This research finding is consistent with the meta-analysis conducted by Hembree (1990) which stated that there is a negative relationship between mathematical anxiety and mathematics achievement. This finding is consistent with the studies of Moodaley, Grobler and Lens (2006), Wood (1999) and Tobias (1985) which state that students with anxiety in mathematics feel less comfortable in performing calculations and problem-solving activities in manipulating the Numbers and Shapes Areas in mathematics.
A high attitude and habit score are important for encouraging cognitive ability and thus improve mathematics (Steyn & Maree, 2002; Anneke, et al., 2001). The affective ability model states that strong affective abilities among students can trigger cognitive abilities which can improve mathematics achievement (Arsaythamby, 2010). Attitude, anxiety and habit are collectively operated in multiple regression analysis and show that only attitude and anxiety are significant predictor of additional mathematics achievement. The findings of this study are similar to previous studies (Schreiber, 2002; Arsaythamby, 2010) in which attitude has positive relationships with mathematics achievement. The variable for anxiety in mathematics learning has a negative relationship with mathematics achievement.

All the three variables accounted for 17% of the variance towards Additional Mathematics achievement and this contribution can be adopted as the main predictor within the limitation of this study. Attitude and anxiety in mathematics learning are significant contributors which explain 17% of the variance, whereas habit is not significant. The Tobias (1985) Deficit Model states the causes for the low attainers in mathematics are poor study habits and insufficient test taking skills. According to Piaget (1965), cognitive development of secondary school students should be at the level of formal operations. Although this is the case, cognitive development at the concrete operational level is possible among secondary school students. There are times when cognitive development among secondary school students in the same form are not consistent. Students in Form Four should be at the level of formal operation but some students are still at the concrete operational stage of cognitive development. This study has implications for the affective and cognitive aspects of learning mathematics (Hand, 1982).

The application of this model is important in learning mathematics with the hope of improving mathematics achievement. However, teachers rarely test students’ affective abilities, but they continue to give priority to testing cognitive abilities. The implications of this study show how important affective ability is in helping students’ cognitive ability directly to improve their mathematics learning. Students who have yet to master mathematics need to be given guidance and appropriate remedial classes. Even though the students are studying in Form Four, they should be taught about mathematics which they have failed to master during their previous years of schooling. This is because in Form Five, the students will be taught new topics which will build upon the topics taught in Form Four. Therefore, teachers could identify the weaknesses in learning mathematics while the the students are in Form Four. It is necessary to analyse how these Form Four students learn mathematics which could ultimately determine their success or failure in attaining the mathematics goals ascribed within the mathematics curriculum.

References


