

## Factors Affecting Attitudes towards Mathematics

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DOI Link: <http://dx.doi.org/10.6007/IJARBS/v7-i11/3548>

Published Date: 19 November 2017

### Abstract

Various factors are believed to affect attitudes towards mathematics, including factors related to opportunity to learn. However, since opportunity to learn factors that affect attitudes towards mathematics were somehow sketchily elaborated in previous studies, therefore this paper aims at investigating and discussing in further detail the link between opportunity to learn factors and attitudes towards mathematics. The results showed that attitudes towards mathematics is influenced by three key factors of opportunity to learn, that are content coverage, teaching practice and teaching quality.

**Keywords:** Opportunity to Learn, Attitudes Towards Mathematics, Content Coverage, Teaching Practice, Teaching Quality

### 1. Introduction

Studies across the globe have revealed that affective domain such as attitudes towards mathematics and student achievement are both lucidly interrelated (Abu & Leong, 2014; Altawallbeh, Soon, Thiam, & Alshourah, 2015; Bayaga & Wadesango, 2014; M. Yasin, Ramayah, Mohamad, & Lim, 2009; Mahanta, 2012; Mensah, Okyere, & Kuranchie, 2013; Thomas, 2000; Wan & Qiping, 2015; Zainal, Harun, & Lili, 2017; Zan, 2013). In the context of mathematics education, researchers seem to concede that student achievement is not only bound by cognitive domain, but is also influenced by students' attitudes (Abu & Leong, 2014; Bayaga & Wadesango, 2014; Mahanta, 2012; Mensah et al., 2013; Thomas, 2000; Zan, 2013). In general, students with positive perceptions of mathematics learning are believed to indirectly develop positive attitudes towards Mathematics, and thus might lead them to obtain higher achievements. On the contrary, students with negative perceptions towards mathematics learning often form negative attitudes towards mathematics, which in turns could affect their learning and achievement (Bayaga & Wadesango, 2014; Mahanta, 2012; Mensah et al., 2013; Thomas, 2000). Due to the fact that attitudes towards mathematics have significant roles in the learning processes and hence student achievement, therefore it is no surprise that past scholars were immersed in investigating factors that influence attitudes towards mathematics.

Mounting evidence suggests that attitudes towards mathematics are believed to be influenced by many factors, including factors related to opportunity to learn (Aiken 1970;

Behr 1973; Hannula 2002; Lawsha M & Hussain W 2011; Ma & Kishor 1997; Marchis 2011; Mistima et al. 2010; Wang & Goldschmidt 1999; Yabatan & Kasapo 2012). Nonetheless, the emphasis of opportunity to learn factors in previous studies seemed to appear in rather implicit manners, often resulting in imperceptible connections between the opportunity to learn factors and attitudes towards mathematics. Hence, this paper discusses explicitly opportunity to learn factors that may affect attitudes towards mathematics. Opportunity to learn factors, which are closely related to classroom teaching and learning processes, are emphasized in this study because they, to some extent, echo the implementation of educational equity and accountability of schools and teachers (Elliott & Bartlett 2016; EOGOAC 2015; Welner & Carter 2013). However, in order to rationalize opportunity to learn factors affecting attitudes towards mathematics, we firstly need to comprehend the definition and components of attitudes towards mathematics.

## 2. Attitudes Towards Mathematics

### 2.1 Definition and Components of Attitudes Towards Mathematics

Definition of attitudes towards mathematics is not established in a straightforward and flawless manner (Di Martino & Zan, 2001, 2010, 2011; Hannula, 2002; McLeod, 1992). The complex element of attitude itself has lured various perceptions about the true meaning of attitude towards mathematics. Essentially, since attitude originates from social psychology discipline, therefore it is only logical that the understanding of attitudes towards mathematics needs to be linked to the attitude's definition used in social psychology.

In general, the key definition of attitude in social psychology is the one that was proposed by Allport (1935) decades ago:

*"... a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon individual's response to all objects and situations with which it is related"*

In short, this definition directly implies an individual's mental state towards his/her own behavior in a particular situation. This definition of attitude was then used as the underlying principle for the development of definition of attitudes towards mathematics depicted in previous studies (Di Martino & Zan, 2001; McLeod, 1992). However, since the definition of attitude commonly rests on the prevailing phenomena in the social psychology discipline, such as voting, buying goods, etc., therefore the definition of attitudes towards mathematics has slightly been revised to suit its context.

Previous researchers, such as Aiken (1970) concisely defined attitudes towards mathematics as an individual's tendency to respond positively or negatively to an attitude object (i.e. situation, concept, or other person). Coherent with this simple definition given by Aiken (1970), McLeod (1992) also considered attitudes towards Mathematics as affective responses that embody simple positive and negative feelings and involve reasonable stabilities. Whereas Hart (1989) and Hannula (2002) provided more comprehensive definition by emphasizing that attitudes should comprise three components, namely emotion, belief and behaviour. In specific, the latter definition encompasses an individual's emotion towards mathematics (either positive or negative), belief in mathematics and also how that individual behaves towards mathematics (Hart, 1989).

Nevertheless, there were some disagreements among researchers on these simple and comprehensive definitions of attitudes towards mathematics. For example, Martino dan Zan (2010) believed that cognitive component must also be integrated as part of attitudes towards mathematics. With this addition of a new component, the definition of attitudes

towards mathematics once again has been expanded by including the following components: affective (i.e. emotions and beliefs), cognitive and behaviour. After a long period of deliberation amongst Western scholars, it is undeniable that these three components of attitudes towards mathematics are in fact aligned with the three components of the general attitude employed in social psychology (Fazio & Olson, 2003; Katz, 1960).

### **2.1.1 Affective Component**

Affective component of attitude designates emotional reactions, either likes or dislikes, towards an attitude object (Fazio & Olson, 2003; Katz, 1960). For attitudes towards mathematics, affective component indicates emotion and feeling towards mathematical subjects. In specific, emotion refers to the feeling of liking or interest in mathematics, or the feeling of disliking or disinterest in mathematics. Not only that, psychologists have also identified three types of learning that shape attitude based on affective components, namely *classical conditioning*, *operant conditioning* and *observational conditioning* (Fazio & Olson, 2003; Lineros & Hinojosa, 2012; Mensah et al., 2013).

*Classical conditioning* refers to learning that takes place through repeated experiences with the environment as well as with stimuli (Lineros & Hinojosa, 2012; Mensah et al., 2013). In the context of teaching and learning mathematics, students who are exposed to various forms of stimuli (such as concepts, exercises and others) are believed to eventually develop attitudes towards Mathematics.

While *operant conditioning* is a learning which is based on the belief that an individual has a tendency to repeat behaviours that produce positive effects, and does not reiterate behaviours that cause negative effects (Fazio & Olson, 2003; Lineros & Hinojosa, 2012; Mensah et al., 2013). For example, when students are rewarded after completing mathematics tasks, they will imply such tasks as fun, and thus motivate them to do more of such similar tasks. On the contrary, when students are punished or penalized for not completing mathematics tasks, they might relate such tasks with unpleasant feelings, and hence demotivate them to do more of such tasks.

*Observational conditioning* refers to an individual using their assessments towards other people's actions and their consequences, in order to drive their thoughts, feelings and behaviors (Mensah et al., 2013). Observational conditioning reflects that an individual learns something indirectly, and learning can happen at anytime and anywhere. In the context of teaching and learning Mathematics, students are believed to form attitudes towards Mathematics through their observations of various teacher's actions in the classroom (such as the way teachers solve mathematics problems etc).

### **2.1.2 Cognitive Component**

Cognitive components include individual's beliefs that an attitude object would produce desirable or undesirable effects (Fazio & Olson 2003; Lineros & Hinojosa 2012; Mensah et al. 2013). In the context of teaching and learning mathematics, cognitive component indicates students' confidence in their mathematical abilities (Di Martino & Zan, 2001). The cognitive component of attitudes towards mathematics also indicates students' perception of the importance of mathematics in their daily lives, either at the present time or in the future (Di Martino & Zan, 2001).

### **2.1.3 Behavior Component**

Behaviour component refers to actions or responses, either verbal or non-verbal, towards attitude objects that are exhibited by an individual (Fazio & Olson, 2003; Katz, 1960). The actions or responses, either positive or negative, are believed to be more consistent if they occur recurrently. Moreover, unlike affective and cognitive components which cannot be inferred visibly with naked eyes, behaviour component can somehow be noticeably observed. For example, students who determinedly perform mathematics tasks would often possess positive attitudes towards mathematics (Di Martino & Zan, 2001).

### 3. Opportunity to Learn Factors Affecting Attitudes Towards Mathematics

For the past four decades, studies showed that attitudes towards mathematics have been influenced by various factors which can be divided into five categories, namely self; teacher; teaching and learning; parent; and peers (Aiken 1970; Behr 1973; Hannula 2002; Lawsha & Hussain, 2011; Ma & Kishor 1997; Marchis 2011; Mistima et al. 2010; Wang & Goldschmidt 1999; Yaratana & Kasapo 2012) (see Table 1).

Table 1.

Factors affecting attitudes towards mathematics by category

Category	Factor
Self	Mathematics anxiety
	Self efficacy
	Self concept
	Extrinsic motivation
	Student's opinion regarding mathematics
	Ability level
	Student engagement
Teacher	Teacher's content knowledge
	Teacher's personality
	Teacher's belief towards mathematics
	Teacher's attitude towards mathematics
Teaching and Learning	*Teaching material
	*Content emphasis
	*Task orientation
	*Tasks based on daily life situation
	*Instructional method
	*Classroom management
	*Classroom organization
Parent	Socioeconomic status
	Parents' educational background

	Parents' jobs
	Parents' expectations
	Parents' motivation
	Parents' attitudes towards mathematics
Peer	Peer's attitudes towards mathematics

\* Factors related to opportunity to learn

Source: (Aiken 1970; Lawsha & Hussain 2011; OECD 2012a) (Cheung 1988; Lawsha & Hussain 2011; Yilmaz et al. 2010) (Lawsha & Hussain 2011; Yilmaz et al. 2010) (Hamed et al. 2008) (Siti Mistima dan Zakaria 2010)

Among these factors, several factors have been identified to be related to opportunity to learn. In general, the opportunity to learn factors have strong linkages with classroom teaching and learning processes, and can be divided into three categories, namely content coverage, teaching practice and quality of teaching (see Figure 1)

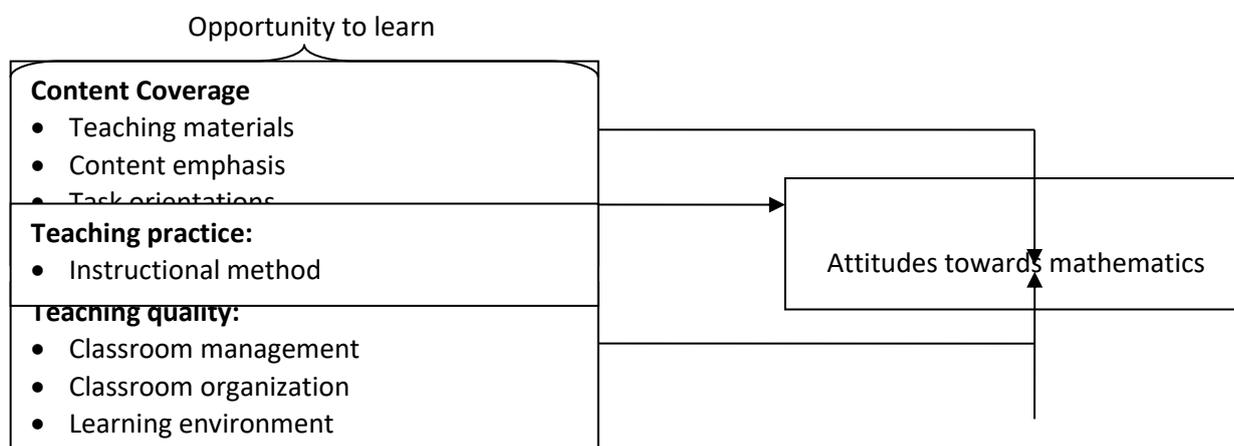


Figure 1. Opportunity to learn factors affecting attitudes towards mathematics

Factors related to *content coverage* that are believed to affect students' attitudes towards mathematics are teaching materials, content emphasis, task orientation, and tasks based on daily life situations (Aiken, 1970; Cheung, 1988; Lawsha M & Hussain W, 2011; OECD, 2012; Veloo & Muhammad, 2011; Yilmaz, Altun, & Olkum, 2010). Specifically, students who are given more exposures to various tasks, including pure and applied mathematics, are more likely to be interested in mathematics (Hamed, Bahari, & Abdullah, 2008). In addition, content emphasis that focuses on development of mathematical concept is found to have positive effect on students' attitudes towards mathematics (Hamed et al., 2008).

Furthermore, *teaching practice*, which is related to instructional method, is also important in shaping students' attitudes towards mathematics (Mensah et al., 2013). Precisely, instructional methods include both teacher-directed and student-oriented instructions, as well as formative assessment. For example, students who are given more teacher-directed instructions (i.e. teachers set clear goals for students' learning and encourage students to communicate their thinking or reasoning) tend to develop more positive attitudes towards Mathematics (Gherasim, Butnaru, Boza, & Iacob, 2011). In addition, when teacher emphasise student-oriented teaching (i.e. assign tasks according to students' ability, and encourage collaborative work among students when solving mathematics problems), students would be

inspired to perceive mathematics in positive fashions (Hamed et al., 2008). Furthermore, by accentuating effective formative assessments (i.e. inform students of their progresses and performance levels in mathematics, and provide students with feedback on their strengths and weaknesses in mathematics), teachers would indirectly increase students' motivation in learning, and hence help cultivate students' positive attitudes towards mathematics (Gherasim et al., 2011).

Besides content coverage and teaching practice, students' attitudes towards mathematics may also be influenced by teaching quality, particularly in terms of classroom organization, classroom management, learning environment (Mensah et al., 2013). Previous studies have demonstrated that attitude towards mathematics can be enhanced if teachers activate his or her students' cognitive (Clark et al. 2006; Sweller, Sweller & Sweller 1994), give support to students (Gherasim et al., 2011; Hamed et al., 2008), ensure conducive disciplinary climate (Gherasim et al., 2011; Hamed et al., 2008) and implement good classroom management (Gherasim et al., 2011). For example, Hamed et al. (2008)'s study showed that students studying in conducive learning environments tend to exhibit more positive attitudes towards mathematics. Another recent study by Gherasim et al. (2011) involving 171 Year 8 students in Romania also revealed that teachers who are successful in creating caring learning environments that encourage motivation can help mold students' positive attitudes towards mathematics.

#### 4. Conclusion

The effects of opportunity to learn factors on students' attitudes towards mathematics have been shown in many previous studies (Aiken 1970; Behr 1973; Hannula 2002; Lawsha M & Hussain W 2011; Ma & Kishor 1997; Marchis 2011; Mistima et al. 2010; Wang & Goldschmidt 1999; Yaratan & Kasapo 2012). Thus, understanding opportunity to learn factors that may influence students' attitudes towards mathematics is believed to help policy makers and teachers plan appropriate interventions to improve students' attitudes towards mathematics, and hence further improve their achievement. In other words, attitudes towards mathematics must be accentuated in teaching and learning processes if higher mathematics achievement is to be realized (Abu & Leong, 2014; Altawallbeh et al., 2015; Bayaga & Wadesango, 2014; M. Yasin et al., 2009; Mahanta, 2012; Mensah et al., 2013; Thomas, 2000; Wan & Qiping, 2015; Zainal et al., 2017; Zan, 2013). Likewise, attitudes towards mathematics has notably been recognised as one of the determinants of an individual's success, as described below:

*"The winner's edge is not in a gifted birth, a high IQ, or in talent. The winner's edge is all in the attitude, not aptitude. Attitude is the criterion for success"*

Denis Waitley, *The Winners Edge* (1989)

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