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Attitude in Mathematics

A Thematic Literature Review

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February 2013

Learning mathematics is not only a cognitive challenge, but also an affective one. Scholars such as Hardy (1967) consider the relationship between cognition and emotion within the learning of mathematics to be interdependent. McLeod (1992) states that "affect plays a significant role in mathematics learning and instruction," and he suggests three categories of affect related to mathematics learning: beliefs, attitudes, and emotions (p. 575). In fact, it is McLeod's 1992 article titled "Research on Affect in Mathematics Education: A Reconceptualization" which acts as a central work in this literature review. McLeod (1992) considers beliefs to be completely cognitive and stable, emotions to be completely affective and unstable, and attitudes to be somewhere in between. Attitudes, in particular, are often used by teachers to explain their students' success or failure as well as an excuse for not being able to help a student (Martino & Zan, 2010, 2009; Polo & Zan, 2006). However, since there is ambiguity in the definition of attitude and a lack of adequate instruments used to measure attitude, there has been no significant correlation established between attitude and achievement (Ma & Kishor, 1997). Despite this, it has been found that both achievement in mathematics and attitude toward mathematics are "the most important factors affecting participation in advanced mathematics," thus bearing importance on further clarifying the framework for attitude in mathematics education (Ma, 2001). This paper will discuss literature before and after McLeod's 1992 article on issues pertaining to the definition of attitude, the measurement of attitude, and the stability of attitude within the context of mathematics education.

There have been several attempts at defining and redefining attitude in the context of mathematics education (Aiken, 1970; Allport, 1935; Hart, 1989; Haladyna, Shaughnessy, &

Shaughnessy, 1983; Hannula, 2012; Martino & Zan, 2009; McLeod, 1992; Neale, 1969). However, there seems to be "no universally accepted definition for the term attitude" (Walsh, 1991). The original definition of attitude by Allport (1935) focuses on the effects of an individual's mental state on their behaviours within a particular situation. Since then, there have been many other definitions which focus on the causal nature of attitude as evidenced by behaviour. Aiken (1970) includes in a footnote stating that "although there is no standard definition of the term attitude, in general it refers to a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person" (p. 551). Aiken's definition is simple, one-dimensional, and assumes a yes or no answer to a student's attitude. Haladyna et al. (1983) also define attitude similarly; they classify attitude as either a positive or negative emotional disposition towards mathematics. However, there exist definitions of attitude in which multidimensionality of attitude is considered; Neale (1969) defines attitude as "a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless" (p. 632). Several others also include beliefs within the realm of attitude (Fennema & Sherman, 1976; Hart, 1989; Kulm, 1980; Leder, 1987; Reyes, 1984). For example, Hart (1989) offers a tripartite definition of attitude which includes emotions, beliefs, and behaviour. In the effort of establishing a framework for studies on affect, McLeod (1992) distinguishes between beliefs, attitudes, and emotions as three separate components of affect and defines attitude as "affective responses that involve positive or negative feelings of moderate intensity and reasonable stability" (p. 581). Although McLeod's reconceptualization of affect has been very influential in studies on the affective domain within

mathematics education, several authors have indicated that there is a need to move beyond his conceptualization (Hannula, 2006; Hannula, Opt'Eynde, Schlogmann, & Wedege, 2007). Martino & Zan (2009) offer that "a variety of definitions of attitude is not limiting but rather enriching for researchers, since different research problems can require different definitions" (p. 29). Further, Martino & Zan (2009) criticize the search for causal relationships between beliefs and behaviour because "the same belief can elicit different emotions in different individuals" (p. 30). Using an interpretive approach in their study of 1496 student narratives on their relationship with mathematics, Martino & Zan (2009) identify three dimensions within attitude towards mathematics: emotional disposition, vision of mathematics, and perceived competence. More recent studies on disaffection towards mathematics seem to consider attitude more broadly than that of McLeod's definition and include aspects such as motivation and emotion (Lewis, 2013; Wong & Chen, 2012). More importantly, the purpose of studying attitudes is being reassessed.

In studying attitude towards mathematics, many instruments have been developed based on various definitions of attitude and have generally moved from being quantitative to being qualitative in nature. Attitude was first measured by observation of actual and intended behaviours, but was deemed inaccurate due to the potential misinterpretations that could occur (Dwyer, 1993). The next most prominent method of measuring attitude has been through self-report questionnaires which use a variety of scales such as the Thurstone scale, the Likert scale, the Guttman scale, and the semantic differential scale (Dwyer, 1993; Leder, 1985). The most common of these has been the Likert scale (Leder, 1985; Martino & Zan, 2011). Likert scales were developed for both one-dimensional definitions of attitude, such as by Aiken

(1972), and for multidimensional definitions of attitude, such as by Fennema & Sherman (1976). The Fennema & Sherman (1976) scale includes factors such as attitudes towards success in mathematics, confidence in mathematics, usefulness of mathematics, perceptions of the teacher, mathematics anxiety, as well as gender roles and "still has significant influence" in current research (Wilson, 2011, p. 68). Several other instruments have been developed based on the Fennema-Sherman scale such as in Tapia & Marsh (2004) and Wong & Chen (2012). However, there has been some dissatisfaction with the use of positivistic quantitative methods because the "complicated statistical analyses of questionable questionnaire data [have] not necessarily [been] reflecting accurately what students [have been] thinking and feeling" (McLeod, 1994, p. 640). McLeod (1994) mentions that the dissatisfaction may be rooted in the "difficulty of finding adequate explanations of the relationship between attitudes and achievement" (p. 640). In relation to research on problem solving, narrative and interpretive methods are being more widely used for assessing attitude. An early example of this is a projective technique employed by Leder (1982) who uses written response prompts to collect narrative data (Leder, 1985). A more modern example of this is Martino's (2009) "Me and Maths" study which uses an interpretive approach to evaluate student narrative essays on their relationship with mathematics. Martino (2009) discovers three prominent components to attitude: emotional disposition, vision of mathematics, and perceived competence. Within each of these dimensions, there is a dichotomy, and the combinations of these can be used to build profiles that can more accurately classify the attitude of a student towards mathematics. This reflects the general shift from quantitative research methods to qualitative research methods as constructivist methodology becomes more widely accepted.

Further, several factors have been found to affect the stability of attitude such as learning environment, teacher quality, and meaningful teaching methods. McLeod (1992) establishes that beliefs are the most stable and that attitudes are relatively stable once formed. However, a more recent analysis of past research has proven that the stability of beliefs is unsupported and therefore the stability of attitudes is also unsupported (P. Liljedahl, Oesterle, & Bernèche, 2010; P. Liljedahl, 2012). This implies that attitudes have the potential to be modified. Learning environment, teacher quality, and meaningful teaching methods have been considered as factors of change in studies on modification of attitude. A recent study shows no direct association between learning environment and student attitudes towards mathematics, but the results suggest that "learning environment is associated with the enjoyment of mathematics [and] students enjoy mathematics to a higher extent when the teacher motivates to exert learning, activates towards self-regulated learning, provides feedback and coaches, and structures and steers" (Vandecandelaere, Speybroeck, Vanlaar, De Fraine, & Van Damme, 2012, p. 116). Brassell, Petry, & Brooks (1980) find that "students' attitude toward the teacher may be important in the formation of mathematics attitudes" (p. 28). Haladyna et al. (1983) find that "attitude toward mathematics seems to be most influenced by teacher quality and the social-psychological dimension [whereas] the management-organization dimension shows no effect on attitude but may have had some influence on student motivation" (p. 27). Student motivation and emotion have also been considered as factors of negative attitudes towards mathematics (Lewis, 2013). Further, Townsend & Wilton (2003) find support for the theory that attitudes towards mathematics, although resistant to change, can be improved through the use of cooperative learning methods. Liljedahl (2005; 2012) supports this through his study on

positive “AHA!” moments in problem solving scenarios where learners experience not only slow and resistant changes, but drastic changes in beliefs and attitudes towards mathematics. This brings light to the need for further research on the specific circumstances which have positive effects on students’ affective experiences with mathematics. The implication here for teachers is to pay closer attention to the affective responses of their students.

Finally, due to the ambiguous results of past research on attitudes towards mathematics, it is evident that further research is required to determine a more unanimous definition of attitude, a more effective method of measurement, and further classification of experiences which modify attitudes. Recent studies suggest that a general disaffection or negative attitude towards mathematics is highly dependent on student’s emotions in the learning process and that such a disaffection is most evident when using narrative techniques to understand student relationships with mathematics (Lewis, 2013; Martino & Zan, 2011). This demonstrates the evolvement of the definition of attitude as well as the instruments used to measure it. The purpose of this literature review has been to overview the evolution of the framework for attitude in mathematics education before and after McLeod’s 1992 reconceptualization of affect. Since McLeod’s article, there have been challenges to both his division of affect into the separate domains of beliefs, attitudes, and emotions and his characterizations of stability within each division. Beliefs and attitudes are no longer thought of as being stable like McLeod had envisioned. This alone has great implications for teachers and researchers to continue developing specific criteria for modifying attitudes.

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