FACTORS INFLUENCING THE DEVELOPMENT OF MIDDLE SCHOOL STUDENTS' INTEREST IN STATISTICAL LITERACY

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ABSTRACT

This paper reviews factors that contribute to the development of middle school students' interest in statistical literacy and its motivational influence on learning. To date very little research has specifically examined the influence of positive affect such as interest on learning in the middle-school statistics context. Two bodies of associated research are available: interest research in a mathematics education context and attitudinal research in a tertiary statistics context. A content analysis of this literature suggests that interest development in middle school statistics will be the result of a complex interplay of classroom influences and individual factors such as: students' knowledge of statistics, their enjoyment of statistics and their perceptions of competency in relation to the learning of statistics.

Keywords: *Literature review; Attitudes; Statistics education*

1. INTRODUCTION

There is currently a shortage of mathematics and statistics graduates in Australia. In their review of mathematical sciences research, the Australian Academy of Science (2006), reported that in 2003 only 0.4% of Australian graduates majored in either mathematics or statistics, which compared unfavorably with an OECD average of 1%. Further, the Australian Bureau of Statistics has reported difficulty in obtaining suitably qualified statistics graduates (Trewin, 2005). Such shortages have their origins in the secondary school context, where the number of students enrolled in higher level mathematics courses is showing a declining trend (McPhan, Morony, Pegg, Cooksey, & Lynch, 2008). In addition to this, McPhan et al. reported that students' lack of interest and

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liking for mathematics during their middle school education was one of five factors that contributed to this decline, the other factors being their previous achievement in mathematics, their mathematics self-concept, and their perceptions regarding the usefulness and difficulty of mathematics. This paper seeks to address the issues associated with national skill shortages in statistics through a review of factors that could contribute to middle school students' interest in statistical literacy.

Statistically literate adults should be able to interpret and critically evaluate messages that contain statistical elements (Gal, 2003). For example, they should be able to recognize bias as a possible source of error in media reports of survey data. Models have been conceptualized that describe the development of statistical literacy in learners (Gal, 2002; Watson, 2006). In his model of statistical literacy, Gal (2002) identified several key knowledge bases that were essential for the development of statistical literacy. He concluded, however, that such knowledge was of minor consequence if a person was unwilling to apply this knowledge. Gal's model of statistical literacy, therefore, included a dispositional component: A statistically literate adult should possess a readiness to criticize messages that contain statistical elements. Such a disposition, he argued, emerges when a person has a belief in their capabilities and an interest and willingness to engage in statistical thinking. In her model of statistical literacy development, Watson (2006) also included dispositional elements, under the broader category of task motivation. These dispositions included skepticism, imagination, and curiosity. It is argued that the dispositions identified by Gal and Watson are themselves developed as a result of positive emotional learning experiences with data. Such experiences formally commence in school and reach necessary levels of sophistication towards the end of middle school (grade 9), where it is argued dispositions are less likely to change. The development of positive affect in the middle school years is therefore a prerequisite to the acquisition of dispositions necessary for statistical literacy. It is also argued that the development of positive affect in the middle school has a considerable bearing on the subject choices that students make in senior secondary and tertiary contexts, thus influencing later skill shortages.

Students in a middle school context (grades 6 to 9) are typically in early adolescence, which appears to be a critical stage in their affective development. In the mathematics education context, for example, evidence points to a decline in levels of positive affect as a student progresses through school (Fredricks & Eccles, 2002) with such levels reaching a minimum in year 10 (Watt, 2004). The correlation between student attitudes towards mathematics and their achievement in mathematics, however, appears to be strongest for students in grades 8 to 10 (Ma & Kishor, 1997; Ma & Xu, 2004). The influence of affect on learning appears to be more pronounced for this group of students. Such findings are supported by reported physiological changes to the brain that occur during adolescence (Wigfield, Byrnes, & Eccles, 2006), changes that result in the greater likelihood of affective activity.

The preceding discussion highlights the need for research into the influence of affect on learning in a middle school statistics context. The next section argues that interest, a commonly used term, is a positive affect that is essential for human psychological development. Interest is therefore of particular relevance to the current context.

1.1. INTEREST AS A POSITIVE AFFECT

The Macquarie Dictionary (Delbridge et al., 1987, p. 910) defines interest as "the feeling of one whose attention or curiosity is particularly engaged by something." Therefore interest can be regarded as a positive affect that is specifically directed towards some object, termed the "object of interest." Deci (1992) argued that interest is fundamental in the development of a person's concept of self. Moreover recent research suggests that interest is necessary for psychological growth, with absence of interest in adolescents being linked with psychological disorders such as depression (Hunter & Csikszentmihalyi, 2003).

In the psychological literature the term "affect" is assumed to be "a broad rubric that refers to all things emotional" (Rosenberg, 1998, p. 247). Affective elements vary on a hierarchical continuum from emotional states, which are typically short in duration but characterized by high levels of arousal, to traits which are stable predispositions to respond in certain ways. As an affect, interest is regarded as having both trait and state characteristics (Schiefele, 1991). At the trait level "individual interest" is described as a "person's relatively enduring predisposition to reengage particular content over time" (Hidi & Renninger, 2006, p. 113). Interest at the state level is more transitory and is typified by a positive emotion akin to excitement. In a state of interest a learner may become so absorbed in the object of interest that they lose sense of time: They experience "flow" (Csikszentmihalyi, 1991). The state of interest can be induced by aspects of the environment and in such instances is termed "situational interest." Alternatively the state of interest can be induced from the individual's predisposition to engage and in such instances is termed "actualized interest." It is believed that individual interest can emerge from situational interest. Thus the requisite dispositions for statistical literacy may emerge from students experiencing the state of interest during their learning.

In a learning context, students' interest can explain some of their motivation to engage in learning activities. Such interest-driven motivation is termed "intrinsic motivation" and is the doing of an activity for its inherent value. The concept of intrinsic motivation features prominently in Self Determination Theory (Deci & Ryan, 1985) which posits that individuals are motivated to behave in seemingly unrewarded ways in order to meet basic psychological needs, including the need to be self-determined. Students who are motivated intrinsically, that is out of an interest in the subject, are known to produce qualitatively superior learning outcomes to their extrinsically motivated peers. For example, Schiefele (1991) reported that student interest was positively associated with deeper levels of cognitive processing, the use of self-regulatory learning strategies and students' ratings on the quality of their learning experience. Further, there is significant correlation between student interest and both academic achievement (Schiefele, Krapp, & Winteler, 1992), and choice of subjects (Köller, Baumert, & Schnabel, 2001). Given the importance of interest development in adolescence and its association with learning, a study of the development of affect in students should include the development of their interest.

1.2. THE DEVELOPMENT OF INTEREST

Current theories of interest development suggest that students' interest in statistical literacy will emerge as they gain expertise in the area. As an example, the Model of Domain Learning (Alexander, 2003) posits that students' interest in a given domain will increase as they gain knowledge in that domain. Further, the model suggests that in the early stages of knowledge acquisition, levels of individual interest will be quite low and learners will rely on situational interest for motivation. As learners move through the domain towards expertise, they will increasingly rely on their individual interest for motivation, with situational interest becoming of less importance. This relationship between levels of situational and individual interest during the development of domain expertise implies that the latter will emerge from the former. Indeed, Hidi and Renninger

(2006) argued that individual interest will emerge from situational interest. In particular they argued that if situational interest can be maintained then it will develop into an emerging individual interest and then finally into an enduring individual interest. The mechanism by which this transformation occurs is explained by Silvia (2001). He proposed that interest occurs when an individual resolves the cognitive conflict that is created when he or she interacts with the object of interest. More specifically, Silvia (2001) argued that during the person-object interaction, incoming stimuli are assembled with current personal information on the basis of a number of "collative" variables that are associated with the learner's response to the stimuli. These collative variables include novelty, uncertainty, and complexity. During this interaction, the learner will fail to engage in any significant way with stimuli that are considered routine (low levels of novelty). Similarly the learner will fail to engage when the stimuli are too unknown or frightening (high levels of novelty). For optimal levels of these variables a state of curiosity will be evoked that is characterised by high levels of arousal and positive emotions, including interest. In this state the learner will be motivated to resolve the conflict created by the particular collating variable. If this conflict cannot be resolved quickly, the learner will be motivated to persist with the object, even returning to it at later times. Such persistence with the object may uncover further stimuli that in turn create a conflict in need of resolution. In such a way it is hypothesized that both knowledge and interest in the object will develop, with people losing interest in simple objects and pursuing those with more complex associated knowledge.

The emergence of interest in statistical literacy may also occur as the result of the individual's unique set of "interests," those interest objects with which he or she is particularly interested. Krapp (2002) identified a number of ways that interests could develop. For example, he argued that a new interest could emerge as a result of the increased differentiation of one aspect of an existing interest. In the statistical literacy context, students with a particular interest in sports may gain an interest in statistical literacy through the analysis of sports related statistical reports. The highly idiosyncratic patterns of interests that students bring to the classroom, however, pose a number of challenges to the educator. Foremost among these is being able to identify and cater for such interests. It is argued that educators have the most influence in the creation of situational interest and the development of knowledge and skills that relate to statistical literacy.

1.3. RESEARCH QUESTION

In the preceding section, interest is identified as a positive affect that is necessary for psychological development and intrinsically motivated behaviors. In the statistics education area, research into interest per se is limited; related attitudinal research, however, may provide information on factors that lead to the development of interest in statistics. A review of the theoretical interest-based literature reveals that both knowledge and prior interests should contribute to the development of students' interest in statistical literacy. The preceding discussion, however, has not specifically examined interest development in the statistical literacy context. Accordingly, this paper seeks to answer the following question: what are the factors documented in the literature that influence the positive development of middle school students' interest in statistical literacy?

2. METHODOLOGY

The literature review was conducted in three phases, commencing with a search on the specific question and then generalising the search to encompass interest development in secondary mathematics contexts, and then to the development of positive affect in the tertiary statistics education context. Searches in all phases commenced with databases of academic journals and abstracts including: *A+Education*, *Emerald*, *ERIC*, *Expanded Academic*, *JSTOR Education*, *Proquest*, *PsycINFO*, *SAGE*, *SpringerLink* and *Wiley Interscience*. In addition *Google Scholar* was found to be a particularly useful search engine. Secondary searches of others' bibliographies and searches using citation indexes were also conducted in each phase.

The initial search specifically addressed the research question using the keywords interest and statistics (or statistical) in the article title. In addition to the databases discussed above, a search was conducted on specific statistics education journal archives including: *Statistics Education Research Journal*, *Journal of Statistics Education*, and *Teaching Statistics*. Further, an archive of statistics education dissertations retained by the International Association for Statistical Education was also searched. Only one study located in the search specifically examined the concept of interest as it relates to the learning of statistics in a school context. In the second phase the search was expanded to include interest development in both secondary school mathematics and tertiary statistics contexts. In the third phase the search was expanded to include attitudinal-related research in both school and tertiary contexts. The search keywords in this phase included attitude and statistics (or statistical) in the article title.

After retrieving relevant research articles, a content analysis (Krippendorff, 1980) identified common and conflicting outcomes that were related to the research question. The results of this review and analysis are discussed in the next section.

3. RESULTS

The results from the first two phases of the search are presented in Section 3.1. This section presents research, which is in the main part situated in a secondary mathematics context. The results from the last phase of the search, which is tertiary statistics related, are presented in Section 3.2. The relevance of both mathematics education and tertiary attitudinal research to the current context is then addressed in the discussion section of this paper.

3.1. MATHEMATICS EDUCATION RELATED RESEARCH FINDINGS

The final search from the first two phases resulted in 38 hits with publication dates that ranged from 1976 to 2008 Thirteen of these could not be readily accessed and in most cases were published prior to 1995. Of the remaining 25 articles, six were discarded as the term interest was used generically to describe a feeling of well-being that was neither defined nor measured. Three articles were also discarded as they had included interest items in larger mathematics attitudinal scales, but had not reported specific interest outcomes. A further two validation studies were not used in this review as they reported technical aspects of interest scales rather than empirical evidence that could contribute to the research question. The majority of the remaining studies (9 of 14) were in a secondary-school mathematics context and specific details of these studies are shown in Appendix A.

The content analysis of this literature revealed a number of common outcomes but also differences in the way the interest construct was operationalised. These commonalities and differences are reported below.

Common outcomes from the mathematics education literature A number of common factors were identified from the mathematics education literature as having a positive influence on interest development. These can be broadly classified into those that are situational and those that are individual (see Table 1). Situational factors include pedagogical strategies and aspects of the learning environment. Individual factors include the prior experiences and beliefs of the learners.

Pedagogical practices, including the types of learning experiences that students encounter and the classroom management strategies used by teachers, have been shown to promote interest. Several studies provide supporting evidence: Heinze, Reiss, and Rudolph (2005), Kunter, Baumert, and Köller (2007), Mitchell (1997), Mitchell and Gilson (1997), and Sciutto (1995). As an example, Mitchell (1997) noted that learning activities that involve puzzles, computers, and group work will catch students' interest. Similarly, teaching strategies that promote student involvement and which students find meaningful will hold students' interest. Mitchell was able to provide some evidence to suggest that the individual interest of students in environments high in situational interest will increase in both a mathematics (Mitchell & Gilson, 1997) and statistics (Mitchell, 1997) secondary-school context. It is arguable whether changes in interest reported after a period of only 14 weeks, the period used in these studies, reflect changes in individual interest. Nevertheless, pedagogical practices undoubtedly influence the situational interest in the classroom, which it is argued will ultimately develop into individual interest.

Table 1. Common study outcomes from the mathematics education literature

Situational factors	• Pedagogical practices can promote interest in mathematics (Bikner-Ahsbahs, 2004; Heinze et al., 2005; Mitchell, 1997, Mitchell & Gilson, 1997; Sciutto, 1995; Trautwein, Ludtke, Köller, Marsh, & Baumert, 2006). • The social climate of the classroom can promote interest development (Bikner-Ahsbahs, 2004). • The classroom management strategies used by teachers (Kunter et al., 2007) and the views of significant others (Fox, 1982) can promote interest in mathematics.
Individual factors	• Interest in mathematics is associated with students' prior knowledge and their competency-based beliefs (Fox, 1982; Köller et al., 2001; Lawless & Kulikowich, 2006; Lopez, Brown, Lent, & Gore, 1997; Marsh, Trautwein, Ludtke, Köller, & Baumert, 2005; Preckel, Goetz, Pekrun, & Kleine, 2008; Trautwein et al., 2006); and also their age (Köller et al., 2001).

The social climate of the learning environment also plays an important role in developing interest. Bikner-Ahsbahs (2004) argued that a type of interest, termed "situated collective interest," will emerge in a group situation where one-by-one students become involved in an activity and come to value the activity. Through observations of children she was able to provide some evidence to support this theory. In relation to the social environment, Fox (1982) found the views of significant others, including parents and teachers, influence student ratings of "career interest" (the type of career they would be interested in pursuing), but indirectly through their ratings of confidence and the utility of mathematics. Also in a secondary mathematics context, Kunter et al. (2007) were able to demonstrate that students' interest was influenced by their evaluation of their teacher's classroom management strategies. In particular, interest was predicted by student perceptions on the extent to which teachers clearly outlined class rules and the extent to which teachers monitored student progress.

At an individual level, several studies demonstrated an association between prior knowledge and interest (see Table 1). The direction of this relationship has also been explored. Köller et al. (2001) reported that achievement in early adolescence (grade 7) predicts interest in mid adolescence (grade 10). However, achievement in mid adolescence does not predict subsequent levels of interest. They concluded that age is a factor in interest development and argued that younger adolescents are more sensitive to achievement feedback than older adolescents who presumably have more stable interests. In addition, Köller et al. reported that interest in grade 7 does not predict achievement in grade 10 but interest in grade 10 does predict achievement in grade 12. The strength of the association between interest and prior knowledge is known to be influenced by the structure of the knowledge domain in question. Lawless and Kulikowich (2006), for example, reported a stronger association for statistics than for psychology, and argued that the former is a more structured knowledge domain.

Several studies also demonstrated a link between students' conceptions of their competency and their level of interest. Lopez et al. (1997) provided evidence to suggest that students' self-efficacy beliefs predict their interest in mathematics. Marsh et al. (2005) and Trautwein et al. (2006) both demonstrated the link between students' academic self-concept and interest in mathematics, with Trautwein et al. asserting that self-concept is a strong predictor of interest, which almost entirely mediates the influence of achievement and tracking (the assigned level of class). Moreover, Trautwein et al. argued that this relationship is influenced by the frame of reference used by students to judge their competency: High achievement students who are in a group of even higher achieving students report low levels of interest in mathematics while low achieving students in a group of even lower achieving students report high levels of interest.

Differences in the operationalisation of the interest construct In the mathematics education context, differences were evident regarding the operationalisation of the interest construct. The German studies (Köller et al., 2001; Kunter et al., 2007; Marsh et al., 2005; Trautwein et al., 2006) regarded interest as having both a value and an emotion component, with the former including the importance of the task and the latter the enjoyment of the task. The concept of importance may assess the usefulness or utility of the task, an extrinsic motivator. Students, who report mathematics as important, may do so because they perceive it to be necessary for future job prospects. Such importance may not reflect interest, although some evidence suggests that it may predict interest (Fox, 1982). Other studies operationalised interest through asking students to indicate their level of interest in a given task (Lawless & Kulikowich, 2006; Lopez et al., 1997; Sciutto, 1995). Of concern, is whether students' assessment of interest is similar to their assessment of enjoyment? Some authors suggest the two are quite distinct emotions (Izard, 1984; Reeve, 1989; Silvia, 2001).

3.2. TERTIARY STATISTICS RELATED RESEARCH FINDINGS

Expanding the search to include attitudinal research in a statistics education context resulted in more hits. In this phase there were 51 hits with publication dates ranging from 1980 to 2008. Of these hits, nine could not be readily accessed. Two theoretical discussion studies that highlighted the shortfalls of using attitudinal instruments were not used in the analysis. In addition, a further five validation studies were also discarded from the current review. These studies reported technical aspects of proposed statistics attitude scales rather than empirical evidence that could support the research question. The resulting 35 papers are described in Appendix B, which reports that the majority of these papers (31 of 35) were empirical studies and a majority (32 of 35) were based in a tertiary education context. This prevalence of tertiary based studies is of concern to the current review. As discussed earlier, the influence of affect on learning during adolescence, which is the context for this paper, appears to be more pronounced than for other stages of life. Nevertheless, the findings from tertiary based research may inform the current study.

The content analysis of this literature revealed a number of common outcomes (see Table 2), some conflicting outcomes (see Table 3) and differences in the way studies operationalised attitudes toward statistics. These are reported below.

Common outcomes from the tertiary statistics education literature At a situational level, the social climate of the classroom was shown to influence the value that students place on statistics (Cobb & Hodge, 2002). Moreover, Mvududu (2003) found that aspects of a constructivist classroom, in particular personal relevance and student negotiation, are associated with positive attitudes towards the field of statistics.

At an individual level, competency-based beliefs are known to be associated with attitudes towards statistics (Finney & Schraw, 2003; Sorge & Schau, 2002). The nature of this relationship was explored by Tempelaar, Schim Van Der Loeff, and Gijselaers (2007) who reported a strong correlation (r = 0.8) between the cognitive competence and affect subscales of the "Survey of Attitudes toward Statistics (SATS)" instrument (Schau, Stevens, Dauphinee, & Ann, 1995). This result suggests that a strong relationship exists between competency based beliefs and positive affect in the statistics education context: Students enjoy doing those tasks that they believe can be undertaken successfully.

Table 2. Common study outcomes from the tertiary statistics education literature

Situational factors	The social climate of the classroom can promote positive attitudes towards statistics (Cobb & Hodge, 2002; Mvududu, 2003).
Individual factors	Attitudes towards statistics are associated with students' prior knowledge of both mathematics and statistics (Carmona, 2004; Estrada, Batanero, Fortuny, & Diaz, 2005; Perney & Ravid, 1990) and their attributional (Budé et al., 2007) and competency based beliefs (Finney & Schraw, 2003; Sorge & Schau, 2002).

Conflicting outcomes from the tertiary statistics education literature Many studies sought to establish that innovative pedagogical strategies and the use of technology enhanced learning environments would be associated with positive student attitudes. As is summarised in Table 3, not all were successful.

Innovative pedagogical strategies were shown to promote positive attitudes towards statistics and presumably interest in statistics. These included the use of video clips that demonstrate real-life applications of statistics (Allredge, Johnson, & Sanchez, 2006), the embedding of statistical activities in stories (D'Andrea & Waters, 2002), and the use of real-life and person based scenarios (Leong, 2006). There is some evidence, however, to suggest that pedagogical practices that aim to improve attitudes towards statistics in fact promote attitudes to the particular class (or teacher) where the learning occurs. D'Andrea & Waters (2002), for example, found that attitude improvements in their study were directed towards the statistics course and not towards the field of statistics.

Table 3. Conflicting study outcomes from the tertiary statistics education literature

- Innovative pedagogical strategies were associated with positive student attitudes in some studies (Allredge et al., 2006; D'Andrea & Waters, 2002; Leong, 2006) but not in others (Carnell, 2008; Faghihi & Rakow, 1995).
- Technology enhanced learning environments were associated with positive student attitudes in some studies (Meletiou-Mavrotheris, Lee, & Fouladi, 2007; Schou, 2007; Suanpang, Petocz, & Kalceff, 2004) but not in others (Alajaaski, 2006; Cybinski & Selvanathan, 2005; Elmore, Lewis, & Bay, 1993; Gratz, Volpe, & Kind, 1993).

Not all studies were successful in establishing a positive link between innovative pedagogical strategies and changes in student attitudes. For example, in a recent quasi-experiment, Carnell (2008) prescribed one class of undergraduate statistics students with a data-collection project that they themselves designed and implemented. A second class, used as a control, did not have this option. Surprisingly, in a pre-test/post-test situation, there were no positive changes in attitudes for either group. In fact both groups showed a significant loss in interest during the course. It is likely that other, unreported, course conditions had a far greater impact on student attitudes than the teaching innovation in question.

Several studies demonstrated that the use of technology enhanced learning environments such as those employing integrated technology (Meletiou-Mavrotheris et al., 2007) and those using an online environment (Schou, 2007; Suanpang et al., 2004), could enhance attitudes towards statistics. Not all studies, however, were able to demonstrate this association (Alajaaski, 2006; Cybinski & Selvanathan, 2005; Elmore et al., 1993; Gratz et al., 1993). Unfortunately these latter studies provided scant details on how the technology was used to promote learning, concentrating instead on the statistical analysis of results. For example, Cybinski and Selvanathan (2005) described a quasi-experiment involving two groups. The first group attended a lecture, a tutorial, and a computer laboratory session. The second opted to receive their materials from an online environment but also attended the computer laboratory session. Students in the second group reported significantly lower levels of affect towards statistics (p-value = 0.09). Most students in this group (77%), however, had not completed high school mathematics. Further, the authors failed to report whether students using the online environment were able to interact with each other and with their teachers, that is, whether they received social support. It is likely, therefore, that these different outcomes are the result of how the technology was used rather than whether it was used.

Differences in the operationalisation of attitudes toward statistics In the statistics education context the focus of attitudinal instruments varied considerably. In his study relating attitudes towards assessment in statistics, Onwuegbuzie (2000) used an instrument that focussed entirely on statistical anxiety. On the other hand, many of the studies (10 of the 30 empirical studies) used SATS, which assesses affect and a broad range of beliefs. The choice of scales also varied considerably. Some evaluative studies developed their own small attitudinal instruments (Alajaaski, 2006; Garfield & Ahlgren, 1994) whereas many others used previously validated scales. Several studies also used a mix of mathematics education and statistics education attitudinal instruments (Lalonde & Gardner, 1993; Perney & Ravid, 1990; Tremblay, Gardner, & Heipel, 2000), not with the intention of exploring differences between the two disciplines but rather under the assumption that student attitudes to the two are equivalent.

4. DISCUSSION

The results of this research review raise two broad issues for statistics educators. The first concerns the possible divergence of mathematics education research and statistics research. The second concerns the relevance of tertiary statistics attitudinal research to the current context in high schools. In addition to these broad issues, the noted differences in the operationalisation of the interest construct suggest the need for further exploration of the relationship between the learning emotions of interest and enjoyment, and student beliefs regarding the value of statistics. In this section an overview of those factors that influence students' interest, as detailed in the research reviewed, is provided. The discussion then examines the relevance of the secondary mathematics and tertiary statistics contexts to the research question. It then explores the relationship between interest, enjoyment, and student beliefs; and, concludes with a brief account of how interest development may occur in the current context.

4.1. FACTORS THAT INFLUENCE MIDDLE SCHOOL STUDENTS' INTEREST IN STATISTICAL LITERACY

Self-determination Theory (Deci & Ryan, 1985) provides a unifying framework for interest (or attitudinal) studies such as those described in this paper. Deci (1992) argued that a person will experience interest when he or she encounters novel activities in a context that allows for the satisfaction of his or her basic psychological needs; namely,, competence, autonomy, and social-relatedness. In a middle school context, a student's need for autonomy (being able to choose what he or she does) and social-relatedness can be met if aspects of the classroom environment are conducive. The content analysis identified the social climate as a factor that positively influenced students' attitudes. Mvududu (2003), for example, reported a statistically significant association between student negotiation and positive attitudes towards statistics (r = 0.25). A student's need for competence in statistical literacy, however, will be met if he or she possesses the necessary individual factors; namely, a sufficient knowledge of statistical literacy and positive competency-based beliefs regarding his or her ability to acquire statistical literacy. The content analysis identified prior knowledge, competency-based beliefs, and prior interests as individual factors that contributed to interest and/or positive attitudes.

Overarching the meeting of basic psychological needs is the requirement that students encounter novel activities. The content analysis identified pedagogical factors that contributed to both interest and attitudes. The extent to which these strategies utilized novel activities, however, is unclear. In his study of interest development, Mitchell (1997) utilized learning activities that were meaningful to students and which encouraged student involvement. Arguably true involvement comes from collative sources that include novelty. In the statistics-education context, Allredge et al. (2006), D'Andrea & Waters (2002), and Leong (2006) provided students with familiar contexts and reported positive changes in attitudes. The use or otherwise of novel activities is perhaps the point at which interest development as opposed to attitude development, differ.

This review has established a significant gap in the literature. Of the studies cited in this review, several examined interest but in a mathematics education context, and a large proportion examined positive affect, but in tertiary statistics education context. Only one study (Mitchell, 1997) examined the concept of interest in a secondary school context, although an evaluative attitudinal study in that context by Garfield and Ahlgren (1994) used items that could be regarded as interest-based. As is discussed in the next sections, it is unclear whether mathematics education findings are relevant to the statistics education context. Similarly, it is also unclear whether findings associated with the affective development of adults are relevant to a middle school context. The evidence, as is discussed, suggests that adults have more stable attitudes than adolescents.

4.2. THE POSSIBLE DIVERGENCE OF MATHEMATICS AND STATISTICS RELATED RESEARCH

Statistics educators, such as Moore (1988) strenuously argue that statistics is a distinct methodological discipline from mathematics. Yet in most cases statistics is taught in mathematics classrooms by mathematics teachers, so that students themselves may see few differences between statistics and mathematics. Indeed many studies in this review reported prior mathematics experiences as having a significant influence on students' attitudes towards statistics. Despite the distinctive nature of statistics as a field of study it is likely that mathematics-related research into affect and/or interest will apply equally to statistics education contexts. There is a trend, however, to move the teaching of statistics away from a computational formula-driven approach to a practical data-oriented approach. Most current Australian secondary-school syllabi encourage a hands-on approach to the teaching of statistical concepts. Further, professional development of mathematics teachers in the teaching of statistics is occurring. The *StatSmart* project, described in Callingham and Watson (2007), is an innovative Australian-based professional development program that aims to develop teaching skills in statistical concepts. It is in this atmosphere, where the learning of statistical concepts is becoming less computationally driven, and where students are able to play with data, that possibilities exist for a divergence of mathematics and statistics related affective research.

4.3. THE RELEVANCE OF TERTIARY BASED ATTITUDINAL RESEARCH TO THE CURRENT CONTEXT

A substantial proportion of the statistics education studies in this review is based in a tertiary context. Of concern is the extent to which these studies are applicable to students in a middle school context. In their study of secondary school students, Köller et al. (2001) concluded that junior secondary students may be more sensitive to achievement feedback than their older peers. Such a conclusion is supported by related research into the emotional development of children. In a longitudinal study of 220 students across grades 5 to 12, Larson, Moneta, Richards, and Wilson (2002) reported that junior students show a greater variability in their emotions than older students: Emotional stability increases during adolescence. It is argued that the adults studying statistics in a tertiary context will have more stable emotions than adolescents in a middle school context; indeed they should have developed mechanisms for controlling changes in emotions. The situational and individual factors that the literature identified as contributing to positive attitudes in adults should apply to young adolescents. Young adolescents, however, will be prone to greater variation in emotions than adults: They will become more excited with interesting activities, but increasingly bored with mundane activities. It is therefore beholden on educators to harness the extreme positive emotions that younger adolescents may experience in their learning. That is, to utilise and develop their interest.

4.4. INTEREST, ENJOYMENT, AND STUDENT BELIEFS

The reported differences in the operationalisation of the interest construct suggest the need to distinguish between the emotions of enjoyment and interest. Reeve (1989) provided evidence to demonstrate that interest is derived from collative sources and enjoyment from the feelings of satisfaction that accompany task competency. He argued that both emotions were necessary for intrinsically motivated learning. Students enjoy success and are likely to reengage with tasks with which they perceive likely success. With no interest, however, they are likely to tire of the task. In a learning context, an item such as 'I enjoy statistics' is a poor operationalisation of the interest construct with students reflecting upon either their success in statistics, their interest in statistics, or both.

Given that interest has a value dimension it is necessary to differentiate between a student's belief regarding the personal value of an interest object and his or her belief regarding its utility. As noted by Tempelaar et al. (2007), the value sub-scale of SATS is broad in that it seeks to assess both the utility of statistics and its personal value. In a middle-school context students may be extrinsically motivated to learn statistics because it is perceived as being useful rather than because of a personal valuing of the subject. The learning of statistics for its intrinsic value and hence the development of interest, may come later. Such an argument is supported by Ryan and Deci (2000) who proposed that extrinsically motivated behaviour may develop, over time and through stages, to intrinsically motivated behaviour and therefore to the emergence of interest.

4.5. THE DEVELOPMENT OF INTEREST IN STATISTICAL LITERACY

Watson and Callingham (2003) argued that the development of statistical literacy will occur in stages that reflect an increasing interaction with an increasingly unfamiliar context. The Model of Domain Learning (Alexander, 2003) predicts that during this development, students' individual interest in statistical literacy will also increase, although Alexander cautions that students leaving school will likely reach competence rather than expertise in any domain of knowledge. It is argued that the development of statistical literacy and interest in statistical literacy will be interwoven and will occur in a time-frame that extends beyond the secondary school years. During this development, individual interest in statistical literacy will provide the motivation for re-engagement, while features of the context and/or task will provide the collative motivation for interest development.

The content analysis in this review highlighted a number of factors that may contribute to interest growth in the short term. But it is the short-term with which this review is concerned. Creating and nurturing interest in statistical literacy during the important developmental years of adolescence will rely on pedagogical practices that trigger situational interest and support adolescents' needs for competence, autonomy, and social-relatedness. Long term development of such interest, however, will be a complex interplay of students' knowledge of statistical literacy, their beliefs regarding their competency in this field, and their enjoyment of learning.

5. IMPLICATIONS

The literature review reported in this paper identifies a significant gap in the literature as it relates to interest in statistics and indeed statistical literacy. Related research in the mathematics education context indicates that interest in mathematics is predictive of later achievement for mid adolescent (grade 10) students but not for younger middle school students (Köller et al., 2001). This result suggests that interests stabilise towards the end of middle school and reinforces the need for further research into interest development during adolescence. Further, there appears to be a difference in the strength of this relationship according to the knowledge domain in question (Lawless & Kulikowich, 2006). Given that a difference exists between students' perceptions of mathematics and statistics, this result reinforces the need for study into students' interest in statistics as opposed to mathematics.

Given the need for research in the middle school statistics context and the differences in the way that interest has been operationalised, there arises a need for the development of a suitable instrument for undertaking large scale quantitative analyses. In the tertiary statistics context, the multi-faceted instrument SATS is extensively used, however it was developed specifically for undergraduate and graduate students who complete specific statistics courses. Consequently many items within SATS are not appropriate in a middle school context.

The research review also identifies factors that have been shown to promote positive affect and interest in students. Some studies identified situational factors, such as teaching strategies, others identified individual factors such as prior knowledge, but only one explored the relative influence of both of these types of factors. Kunter et al. (2007) reported that only 10% of the variation in students' interest in mathematics is explained by class membership, which suggests that individual factors may account for a much larger proportion of the variance. Future research into the development of students' interest should consider both situational and individual factors and the relationship between them.

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APPENDIX A: INTEREST BASED STUDIES IN A MATHEMATICS OR STATISTICS EDUCATION, SCHOOL BASED CONTEXT

Article	Description	Context
Bikner-Ahsbahs (2004)	Observational	Sixth grade mathematics class (Germany)
Fox (1982)	Empirical (n = 125)	Junior-secondary (year 7) mathematics (US)
Heinze et al. (2005)	Empirical (n = 500)	Junior-secondary (years 7 and 8) mathematics (Germany)
Köller et al. (2001)	Empirical (n = 602)	Secondary (years 7 to 12) mathematics (Germany)
Kunter et al. (2007)	Empirical (n = 1900)	Secondary (years 7 & 8) mathematics (Germany)
Lawless and Kulikowich (2006)	Empirical (n = 267)	Tertiary statistics (US)
Lopez et al. (1997)	Empirical (n = 296)	Secondary (age 15 -16) mathematics (US)
Marsh et al. (2005)	Empirical (n = 7913)	Secondary (years 7 to 12) mathematics (Germany)
Mitchell (1997)	Empirical (n = 51)	High-school statistics (US)
Mitchell and Gilson (1997)	Empirical (n = 598)	School and tertiary mathematics (US)
Preckel, Goetz, Pekrun, and Kleine (2008)	Empirical (n = 362)	Secondary (years 7 to 12) mathematics (Germany)
Renninger, Ewen, and Lasher (2002)	Observational	Primary school mathematics (age 11)
Sciutto (1995)	Evaluative (n = 17)	Tertiary statistics (US)
Trautwein et al. (2006)	Empirical (n = 14341)	Secondary (grade 9) mathematics students (Germany)

APPENDIX B: ATTITUDINAL BASED STUDIES IN A STATISTICS EDUCATION CONTEXT

Article	Description	Context
Alajaaski (2006)	Empirical (*n* = 53)	Undergraduate
Allredge et al. (2006)	Empirical (*n* = 203)	Undergraduate
Biajone (2006)	Observational	Undergraduate
Budé et al. (2007)	Empirical (*n* = 200)	Undergraduate
Carmona (2004)	Empirical (*n* = 827)	Undergraduate
Carnell (2008)	Empirical (*n* = 42)	Undergraduate
Cobb and Hodge (2002)	Observational	High-school
D’Andrea and Waters (2002)	Empirical (*n* = 17)	Graduate
Cybinski and Selvanathan (2005)	Empirical (*n* = 99)	Undergraduate
Elmore et al. (1993)	Empirical (*n = 289*)	Undergraduate
Estrada et al. (2005)	Empirical (*n* = 367)	Undergraduate
Faghihi and Rakow (1995)	Empirical (*n* = 75)	Undergraduate
Finney and Schraw (2003)	Empirical (*n* = 140)	Undergraduate
Fullerton and Umphrey (2001)	Empirical (*n* = 275)	Undergraduate
Garfield and Ahlgren (1994)	Empirical (*n* = 917)	High-school
Gordon (2004)	Empirical (*n* = 259)	Undergraduate
Gratz et al. (1993)	Empirical (*n* = 55)	Undergraduate
Gunnarsson (2001)	Empirical (*n* = 42)	Graduate
Kaplan (2006)	Empirical (*n* = 434)	Undergraduate
Lalonde and Gardner (1993)	Empirical (*n* = 91)	Undergraduate
Leong (2006)	Observational	High-school
Meletiou-Mavrotheris et al. (2007)	Observational	Undergraduate
Mills (2004)	Empirical (*n* = 203)	Undergraduate
Mvududu (2003)	Empirical (*n* = 229)	Undergraduate
Onwuegbuzie (2000)	Empirical (*n* = 225)	Graduate
Perney and Ravid (1990)	Empirical (*n* = 68)	Graduate
Schou (2007)	Empirical (*n* = 31)	Undergraduate
Schultz, Drogosz, White, and Distefano (1998)	Empirical (*n* = 94)	Graduate
Sorge and Schau (2002)	Empirical (*n* = 264)	Undergraduate
Suanpang et al. (2004)	Empirical (*n* = 230)	Undergraduate
Tempelaar et al. (2007)	Empirical (*n* = 1618)	Undergraduate
Tremblay et al. (2000)	Empirical (*n* = 166)	Undergraduate
Vaisanen, Rautopuro, and Sakari (2004)	Empirical (*n* = 123)	Undergraduate
Vanhoof (2006)	Empirical (*n* = 264)	Undergraduate
Zanakis and Valenzi (1997)	Empirical (*n* = 102)	Undergraduate