Impact of Metacognitive Journal Writing
on Student Attitudes Toward Mathematics

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Abstract

The purpose of this study was to determine the impact of metacognitive journal writing on improving student attitudes toward mathematics. The study included a review of research literature that examined attitude, metacognition, and journal writing. Students responded metacognitively (awareness, reflection and development) to prompts related to contributing factors to attitude. Math attitudes related to enjoyment, self-confidence, motivation and value were measured using Tapia’s Attitudes Toward Mathematics Inventory (ATMI). Experimental research compared changes in attitude of two Math 10 Applications classes, one that wrote in journals and one that did not. Data analysis revealed that journal writing had a significant positive effect on student attitude toward math related to value/importance (p < 0.05). Correlational research examined the relationship between journal level of metacognition rubric scores and attitude change for the journal writing group. Although the correlational analysis showed no significant relationship journal responses would suggest the need to look more closely at individual student results.

The results of this study may encourage teachers to explore ways to implement metacognitive journal writing at secondary school to help assess, understand and improve student attitudes toward math. Recommendations for further study into how journal writing could inform teaching, deepen understanding, develop relationships, and improve learning for all students is needed. Research suggests that improved student attitude towards math leads to increased engagement, understanding of a technological society, and contribution to the work force. To ensure we can meet the future math needs of our society we must construct a framework that aims to support a more positive attitude toward math.
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Chapter One: Problem to Be Investigated

Purpose

The purpose of this study was to experiment with the use of metacognitive thinking, through journaling, to have students identify factors that contributed to their attitude towards math and to encourage students to create strategies that helped to improve their attitude towards math. The study was also used to determine the strength of the correlation between the level of a student’s metacognitive thinking and the change in student’s attitudes toward math. The study focused on secondary school students, since research suggests that students find less success, less enjoyment, and less perceived importance in math as they move from elementary to secondary school (Jackson & Leffingwell, 1999; Midgley, Feldlaufer, & Eccles, 1989; Wigfield & Meece, 1988). Some of the factors identified in the literature as contributors to student attitudes included: gender bias, cultural bias, self-confidence, importance, relevance, enjoyment, motivation, anxiety, achievement, content, school structure, teacher influence, and parent influence (Wiggan & Toronto Board of Education Mathematics Dept., 1981).

It was assumed that, if found effective, the implementation of journal writing to promote metacognitive thinking would be recommended for regular use in secondary school math classrooms to help improve student attitudes. Borasi and Rose (1989) also suggested that the process of journal writing helped teachers develop a more understanding, supportive relationship with their students through communication that extended beyond course content to how students were thinking and feeling about math.

Justification

As students develop more negative attitudes toward math, they report less enjoyment of math, have less confidence in their math abilities, perform poorly on standardized tests, and find
less relevance and usefulness of math in their everyday lives (Berch & Mazzocco, 2007).

Students with positive attitudes consistently show improved math performance, and exhibit less math avoidance behaviours (Hembree, 1990; Wiggan & Toronto Board of Education Mathematics Dept, 1981). According to Berch and Mazocco, students exhibiting math avoidance behaviours spent less time on homework, asked fewer questions in class, came for extra help less often, paid less attention during class, participated less in group work, and traded speed for accuracy. These behaviours led to students who learned less in class, had weaker number sense, struggled with complex problems, and became anxious in timed (testing) or social (writing on board) situations (Berch & Mazocco). Anxiety or negative attitudes prevented students from pursuing courses or careers in mathematics or the sciences (Richardson & Suinn, 1972; Wiggan & Toronto Board of Education Mathematics Dept, 1981; Ma, 2006).

The teacher must also take responsibility and be aware of his or her role. Teachers must exhibit behaviours that show they care and support their students, have skill and confidence in their teaching of mathematics, and believe math is important (Sousa, 2008). Communication through journals provided teachers another way to access student feelings and attitudes towards math that couldn’t be found through content-type questions and activities. A teacher who knows (understands) their students may be better able to identify student weaknesses and be more willing to implement strategies for remediation (Wiggan et al, 1981).

Students (and teachers) need to be encouraged to challenge their own beliefs to move forward to find understanding, relevance, enjoyment and success in math. Students who are encouraged, through writing, to activate prior knowledge and put situations in context, are more motivated to learn (Winstead, 2004). They also have increased ability to process, learn and store new information. Peterson and Barnes (1996) stated,
Learning at higher levels in mathematics requires teachers and students to take risks, admit what they do not know, take responsibility for their own learning, and stretch toward new understandings. Finding the balance between support and challenge always involves struggle (p. 486).

Improving students’ attitudes in math is extremely important in our globally competitive world, where technology requires our students to have the knowledge and confidence in their abilities to do math. As a society we need to be concerned with reduced participation leading to deficiencies in the workforce in areas such as business, engineering, science and other math related fields. Of greater concern are non-traditional disciplines such as social, behavioural, managerial and life sciences, which rely increasingly on math to quantify their planning and accountability goals through measurement (statistics), bargaining, and human resources (skills and attitude assessments). Beyond the workforce, the importance of math to an individual’s everyday life in areas of personal finance, planning, critical citizenship, politics, and media savvy is crucial. To ensure we can meet the future math needs of our society we must construct a framework that aims to support a more positive attitude toward math. We need to provide more opportunities that help individuals realize that they can be successful in math and that math is an important part of everyday life.

Research question

The increased importance of mathematics in our technological world, the benefits of journal writing and metacognitive thinking in the math classroom, and the impact of secondary student math attitudes on choosing math related coursework and careers were what led the author of this study to the following research question. Does metacognitive journaling in mathematics have any effect on improving secondary student attitudes toward mathematics; if effect is found,
is the change in attitude related to the level of metacognition? The metacognitive journaling specifically targeted those factors that were identified as having a negative impact on student attitudes toward math.

Definitions

In an effort to clarify the meaning and context of the research question further, information on the journal prompts (Appendix A) and definition of secondary students was provided. Each of the journal entries consisted of a written prompt and the response was focused on the student’s thinking and feelings towards math. The journals were not limited to daily reflections or math content. For example, students were asked to reflect on how they found a certain math topic difficult, comment on past experiences with the topic and on the importance of the topic beyond school. In an effort to control variables, the definition of secondary students in this study was limited to students taking Applications of Math 10. Further definition of the sample and control variables will be provided in the Methods section.

To ensure the reader has a comprehensive understanding of what was being researched it was necessary to define metacognitive journaling and attitudes (positive and negative) more explicitly (Appendix B). The terms were initially defined constitutively to provide a clear, specific definition consistent with the researchers understanding. The terms were further defined operationally to show what actions or operations were used to measure or identify each term by the researcher.

The constitutive definition of metacognition was described as “knowledge or beliefs about factors affecting one’s own thinking processes and strategies, and the ability to consciously reflect and act on the knowledge of cognition to modify those processes and strategies” (North American Division Adventist Education, 2009).
Metacognitive journaling was introduced to the students as a series of questions they could consider when responding to journal prompts related to factors contributing to their attitudes toward math. Students asked themselves questions that would identify current thinking (awareness). To begin they were asked to consider the following questions: 1) Why do you think (or behave) this way? 2) When did you start thinking (or behaving) this way? 3) What prior experiences led to this way of thinking (or behaving)? 4) Who were the individuals that influenced this way of thinking (or behaving)? 5) Where did this thinking (or behaving) come from? At this point students were asked to consciously assess the impact of current thinking (reflection). They were then asked to consider the following additional questions: 1) How was this way of thinking (or behaving) affecting them now? 2) What strategies have you used in the past that were successful (and/or unsuccessful)? 3) What strategies have you observed that others have used that were successful (and/or unsuccessful)? Using what they had discovered or identified, students were then asked to develop new strategies to move current thinking forward (development). To finish they were asked to contemplate the following questions: 1) How could you modify or adapt this way of thinking (or behaviour) so you can improve your attitude towards math? 2) What experiences could you draw from the past or the present that could help you improve your attitude towards math? 3) How likely do you think you will be to try your new strategies in the future? 4) How successful do you think these new strategies will be in improving your attitude toward math? As a conclusion to the journal entry students were encouraged to comment on how likely they would be to try the new strategies, and the perceived impact on future experiences.

The operational definition of metacognitive journaling was assessed by the researcher using a Metacognition Rubric (Appendix C). The rubric, developed by the researcher, was used
to assess the student’s level of metacognition in each of their journal responses. The rubric was based on three criteria (awareness, reflection and development) with six levels of performance expectations (no evidence of meeting, not yet meeting, minimally meeting, meeting, exceeding, and extensively exceeding).

The constitutive definition of attitude was described as “a complex mental state involving beliefs, feelings, values and dispositions that cause individuals to act in certain ways.” (Cognitive Science Laboratory, Princeton University, 2006).

The constitutive definition of positive or negative attitudes in math has not been clearly defined. A multidimensional definition by Hart (1989) for math attitudes was used that included three components: emotions, beliefs, and behaviours. Research done by Ruffell, Mason, and Allen (1998) was also considered when defining each of the following components of math attitude for the purpose of this research. Each component of the definition represented a continuum from negative attitude to positive attitude. The first component, emotion, ranged from dislike to like. The second component, belief, when related to ability, ranged from I can’t do math to I can do math. The second component, belief, was also related to relevance, ranged from math is not important to math is important. The third component, behaviour, ranged from avoidance (not motivated) to engagement (motivated).

The operational definition of attitudes toward math was measured and identified by Tapia’s (1996) Attitudes Toward Math Inventory (ATMI) (Appendix D). The ATMI focused on the following four factors related to attitudes toward math: self-confidence, value, enjoyment, and motivation.
Overview

The main purpose of the study was to address the problem of poor attitudes toward math. The action research was rooted in the teacher’s interest in promoting positive attitudes in mathematics through metacognitive journaling and was supported by research found in the literature review. Each metacognitive journal prompt went beyond math content and encouraged students to think about their thinking. It was important to remember the focus of this research was not to label students with positive or negative attitudes, but rather to identify a change in attitude after metacognitive journaling. Varying degrees of both positive and negative attitudes towards math related to emotion, belief and behavior were possible (e.g., a student may believe math is relevant (positive), but does not like math (negative)).

This research study was experimental in design and compared the changes in math attitudes of a journal writing (treatment) group to a non-journal writing (no treatment) group. Statistical analysis of means and standard deviations between the two groups were used to determine the effect of the journal writing treatment on student attitudes. The information obtained from this action research was used to inform teachers as to how metacognitive journaling could be used as an effective tool in the classroom to help students uncover the origin of their attitudes and develop (and share) strategies to improve their attitudes. The strength of the relationship between level of metacognition and change in math attitude identified in this study, could also be used to motivate teachers to further develop a students metacognitive thinking skills in an effort to improve one or more of their specific math attitude factors (self-confidence, value, enjoyment and motivation). Finally, recommendations for future research to study the effect that metacognitive journaling has on: 1) improving student attitudes in other math streams and grade levels; 2) improving student attitudes as related to other contributing
factors (achievement, parental influence) or 3) improving student–teacher communication and relationships were made based on the findings of this study.
Chapter Two: Literature Review

The review of the literature provided the author of this study with a survey of some of the research in the areas of attitudes, metacognition, and journal writing in math. Although much of the research appeared to focus on writing to improve students understanding or achievement in math, the following studies also emphasized the importance of considering attitude. A review of the literature has provided key components that are important to the current study. These include the positive effects of teaching writing with respect to metacognition in math and the importance of developing more positive student attitudes towards math. The literature provided the theoretical framework, procedural ideas, and future research recommendations to assist in the design and implementation of the current study. The references within each of the studies reviewed also provided the author with valuable information for planning and building on what has already been done, or not been done, in the areas of metacognition and attitudes in math.

Theory

Research on Affect in Mathematics Education: A Reconceptualization. A comprehensive review and synthesis study was taken on by McLeod (1992) in an effort to suggest improved theoretical frameworks and alternative methods for future research on the role of affect in mathematics learning and instruction. The purpose of his discussion was to: 1) consider alternative theoretical foundations on affect; 2) present a framework for research on affect; 3) link research on affective domain to the proposed framework; and 4) explore how qualitative and quantitative research methods can be used in future affect research. The purpose of this study was extremely ambitious in its effort to address such an enormous topic, which explains the emphasis on breadth, not depth.
The extensive literature reviewed included both theoretical and empirical research that was directly and indirectly related to the study of affect in math. In an effort to identify a theoretical foundation for affect research, McLeod looked at the relationship between affect and various psychological theories (i.e. behaviourism, cognitive, differential, developmental, and social.). As suggested by McLeod, the purpose was only to provide a framework for future research. Therefore, to deepen knowledge/understanding, further examination of the diverse works cited in the reference section would be necessary. McLeod placed great emphasis on the rising influence of cognitive psychology, especially the theories of Mandler (1984, 1985, 1989) as he defined affect by reorganizing the literature into beliefs, attitudes and emotions. His definition was based on the idea that the beliefs we hold are highly cognitive (less affective) in nature, emotions we experience are highly affective (less cognitive) in nature, and attitudes we develop as we respond to our beliefs and emotions are cognitive and affective in nature. The varying degree of intensity of the response tends to relate strongly to the role of affect and varying degree of stability of the response tends to relate to the role of cognition. His development of a research framework suggested that “any reconceptualization of the affective domain should attempt to be compatible with cognitive-processing models of the learner” (p. 578). His thoughts on the importance of using combined qualitative and quantitative research methods were clear in the following statement:

If researchers are to make progress in building theory and gathering relevant data about the role of the affective domain in the learning and teaching of mathematics, they need to provide data on a wide range of issues. Some of these issues (for example, beliefs and attitudes) can be analyzed through the use of traditional quantitative techniques, but
qualitative data will add substantially to the completeness of our understanding of these issues. (p. 588).

McLeod’s view that affect plays a significant role in mathematics learning and instruction is supported by the idea that both student’s and teacher’s responses when asked about math are just as likely to be cognitive (i.e. achievement) as they are affective (i.e. like or dislike). Research has supported how you do in math is often linked to how you feel about math, but as mentioned by McLeod the need to ask why you feel a certain way about math needs further study. McLeod’s ability to make the connections between these studies, which would direct future researchers of affect to take a more integrated approach, is convincing. The impact of McLeod’s work, despite being two decades old, is evident by the number of attitudinal studies found by the researcher of the current study, that have cited him. McLeod has provided a succinct summary/synthesis of the findings of numerous large scale, long term studies by national and international agencies (i.e. National Council of Teachers of Mathematics, Commission on Standards for School Mathematics, and Second International Mathematics Study). Specific examples of educational research studies in mathematics that integrated the cognitive and affective domains by successfully combining qualitative and quantitative research methods were also included.

McLeod’s work raised a number of questions and ideas as to how to develop more effective researchers of affect on math. The impact of McLeod’s suggestions led the current researcher to look at the integrated nature of metacognition (cognition) and attitudes (affect) related to math using journal writing. It would seem that the role of metacognitive thinking/writing in journals could be a useful tool for extracting the processes and experiences that have led students to the attitude they have formed. Although the current research study is
quantitative in nature it would be natural for the researcher to repeat the current study with the integration of qualitative research methods that might involve examining individual student journal responses, observations of peers collaboratively responding to journal prompts or interviews/dialogue between the student and teacher more closely. Further to this it was identified that little research on student beliefs about math teaching has been done. This type of research that solicits student’s opinions and suggestions related to improving instruction will be of great importance to teachers in British Columbia as we begin a new math program that focuses on constructivism and assessment for learning practices, which may be unfamiliar to many math educators. When one considers the hours children have seen and experienced a variety of examples of math teaching, it would appear student input into classroom activities has been an underutilized resource. McLeod briefly mentioned the impact of affect on higher order thinking in math as another reason for the need to change affective responses to math in children and adults. Suggestions to look into the development of a child’s beliefs have long interested the current researcher and were a major influence on the journal prompts created by the researcher. To prevent students from using the journals as a rant session, the inclusion of a metacognitive approach to journaling allowed students to think more deeply about what their attitude is, how it is impacting their lives and what they can do to improve their attitude. Through guided journal prompts our students may be better able to understand their own attitude, remove attitudinal barriers to learning, and develop strategies that lead to more intense positive responses related to mathematics.

*Scaffolding and Metacognition.* This paper by Holton and Clarke (2006) proposed an expanded conception of scaffolding and compared the equivalence of scaffolding acts to metacognitive acts. The purpose of Holton and Clarke’s paper was to broaden the idea of
scaffolding to include the following four elements: 1) scaffolding agency (expert, reciprocal and self); 2) scaffolding domain (conceptual and heuristic); 3) identification of self-scaffolding and metacognition; 4) identification of six zones of scaffolding activity.

Scaffolding was described by the authors of the study as “an act of teaching that i) supports the immediate construction of knowledge by the learner; and ii) provides the basis for future independent learning of the individual.” (p. 131). All four elements were derived from examples found in research studies that looked at the role of the individual student, peers, and teachers in the construction of knowledge. To understand how this paper related to and impacted the design of the current study the terminology introduced needed to be explained.

Element 1: the scaffolding agent provides “tools” for the learner to overcome a problem. The agent can be described as an expert (i.e. “teacher”, parent, or classmate with more content knowledge/understanding and involves external authority), reciprocal (i.e. peer collaboration and involves mutual authority) and self (i.e. metacognition and involves internal authority).

Element 2: the scaffolding domain is described as i) conceptual scaffolding that promotes development of specific content knowledge or ii) heuristic scaffolding that relates to the development of general approaches. The expectation of Holton and Clarke is that there is a graduation through the types of scaffolding (expert to reciprocal to self), scaffolding agent (teacher to peer to student), locus of authority (external to mutual to internal) and scaffolding domains (conceptual to heuristic). Element 3: the identification of scaffolding and metacognition will be discussed later. This paper was heavy in highly specific terminology that seemed somewhat disconnected until Element 4: the six zones of scaffolding activities were explained using specific examples. “What distinguishes one zone from another is the matter under construction and the relative positioning of the participants in the act of scaffolding” (p.137)
Zone 1: Conceptual scaffolding by an expert
Zone 2: Heuristic scaffolding by an expert
Zone 3: Conceptual scaffolding in the situation of reciprocal scaffolding
Zone 4: Heuristic scaffolding in the situation of reciprocal scaffolding
Zone 5: Conceptual scaffolding by a self-scaffolder
Zone 6: Heuristic scaffolding by a self-scaffolder

The teacher role in scaffolding gradually releases as the learner progresses through the zones toward the ultimate goal of taking control of their own learning. Although only a small number of studies were referenced, the attention from and inclusion of works by Alan Schoenfeld was impressive and added credibility to the proposal.

Schoenfeld’s work on metacognition in mathematics problem solving is well respected, well documented and frequently cited. Several definitions for metacognition were included in this study and provided the current researcher with a better understanding of how metacognition could be used to link journal writing and attitudes. Schoenfeld’s (1992) definition includes: control or self regulation; thought processes knowledge; and beliefs and intuition. Wilson and Clarke (2002) define metacognition as the awareness, evaluation, and regulation of thinking. The definitions of self-scaffolding and metacognition provided by Holton and Clarke (2006) did not appear equivalent at first, but a comparison of the list of questions on the Scaffolding Questions (Holton, Anderson & Thomas, 1997) and the Metacognitive Action Cards (Wilson & Clarke) for use with math problem solving provided would support the claim of the authors that scaffolding acts are analogous to metacognitive acts. “Challenging tasks require metacognition”, (Wilson & Clarke) and improving individual and societal attitudes is a challenging task.
The researcher of the current study felt the guided questions related to metacognition and scaffolding were generic enough to be of value in a variety of situations such as metacognitive math attitude journaling. The idea that we can provide the tools or scaffolding questions (i.e. What exactly are you doing? Why are you doing it? How does it help you? Schoenfeld, (1992)) that enable learners to solve math problems otherwise thought to be beyond the learner’s capacity could be transferable to “improve” their attitude problems. Metacognitive journaling was introduced to the students as a series of questions (scaffolding act) that they needed to consider when forming their journal response (metacognitive act). Follow up research will be needed to see if journaling provided an important bridge between instructional support of the guiding (scaffolding) questions provided by the researcher and the student’s development of metacognitive (self-scaffolding) expertise resulting in increased long term attitude self-control.

**Journal Writing and Mathematics Instruction.** In an effort to contribute to an understanding of the educational value of writing to learn Borasi and Rose (1989) examined the literature and explored the use of journals in mathematics courses. The purpose of Borasi and Rose’s study was to provide a comprehensive conceptual and empirical analysis of the potential benefits of journal writing in mathematics for the 1) student as writer, 2) teacher as reader and 3) classroom interaction that added to previous findings.

The research consisted of an extensive review of major theories and literature on using journals and qualitative data collection from 23 students in a college mathematics course that wrote in journals. The instructor also recorded their own reactions to the experience. The instructors approach to teaching was not modified, except to include journal writing as a regular and valuable part of the course. Students were expected to write three journal entries per week that were assessed with descriptive feedback from the teacher and credit towards the course that
was based on completion and volume not grammar or content. The theoretical data obtained from the review was used as a background to interpret and analyze empirical data obtained from the students journals. A content analysis of the data (responses) was conducted to identify any recurring patterns. The results included a conceptual argument about the benefits of journal writing, supported by the recurring pattern and followed by a complementary quote taken from student journal responses to reinforce the argument. The results of this study aimed to provide convincing evidence about how and why journal writing contributed to the improvement of math instruction for both student and teacher. Three recurring themes led to a taxonomy of potential benefits of journal writing related to 1) students write their journal, 2) teacher reads the student’s journals; and 3) student and teacher dialogue in the journals. It was important to recognize the benefits to journal writing were dependent upon the degree of teacher-student trust and student engagement in the activity. At the end of the study students were asked to write an evaluation that included a series of questions about their journal writing experience.

Although the study left some questions unanswered it clearly reached its’ goal of contributing to a body of research that shows the benefits to journal writing for student and teacher. Some limitations of their work were the absence of discussion on building trust or engaging students in the process. There was also no mention of how journaling was squeezed into an existing course. What was omitted from the course to include journaling? Was journaling done completely outside of class time? The evaluation at the end of provided the current research study with ideas for what questions to ask students about journal writing: How it affected their learning? How they felt about it? What were the benefits? and How could it have been more useful or effective? The portion of the taxonomy related to the potential benefits as students write in their journals provided the current researcher with evidence to suggest that
journal writing could be a useful tool to help students improve their attitudes toward math. The following benefits have particular relevance to improving attitude: “A therapeutic effect on the emotional components of learning mathematics can result as students express and reflect on their feelings about the course, mathematics and schooling; An improvement in learning and problem solving skills can result from articulation of and reflection of their process of doing math; and “Steps towards achieving a more appropriate view of mathematics can be taken as one’s beliefs on the nature of the discipline are made explicit and consequently re-evaluated.” (Borasi & Rose, 1989, p. 352).

Although open ended journal entries for college students seemed appropriate, it would probably not be as effective with younger students who may lack the maturity or confidence to know what to write. The current research study was specifically targeting factors that contributed to attitude. Therefore, journal prompts were posed as a series of questions, which may have resulted in more specific responses but less immediate relevance to the student. Recommendations for future research on teacher as reader of journals could have immense benefits for ensuring appropriate evaluation and remediation related to individual learning and/or timely changes and improvements related to group instruction occurs. Further research into student-teacher journal dialogue could also be influential in the creation of more positive, trusting, relationships that help teachers be more responsive and better able to create a caring and supportive environment for students. “Expressing their apprehension about mathematics, reporting past experiences of failure and success, and communicating feelings of incompetence or discomfort about the course could help the journal writers learn about themselves and take steps towards overcoming their perceived difficulties” (Borasi & Rose, 1989, p. 354) or in the case of the current study it is the hope that students will also develop strategies towards
improving their attitude towards math. Clearly by reading student responses the process of writing to learn using journals facilitated a more personal and meaningful approach to mathematics for both students and teachers.

*Studies Directly Related*

*Effects of Journal Writing on Attitudes Toward Math.* An effort to explore (substantiate) the claims of others, that journal writing has a positive impact on both cognitive and affective variables as they relate to learning mathematics (Borasi and Rose, 1989) was the motivation for Jurdak and Zein’s (1998) study. The purposes of Jurdak and Zein’s study were to: 1) investigate the effect of journal writing on the cognitive (achievement) and affective (attitude) aspects involved in learning math; 2) identify the effect of gender, language, and prior achievement (in writing and math) on learning math, and 3) study the student’s self-evaluation of their experience with journal writing.

The purpose of Jurdak and Zein’s (1998) study was clearly written, but appears to lack focus. The research was an experimental design that involved the study of the affects of journal writing (JW-treatment) and non-journal writing (NJW-control) on affective and cognitive variables specifically related to learning math. The results were exploratory in nature and made no claims as to expected results. The results were analyzed quantitatively using descriptive statistics (means, standard deviations and percentages). The sample involved in the study included 104 middle school students enrolled in a baccalaureate program at a multicultural international college in Beirut, Lebanon. The student’s socioeconomic status was identified as middle to high. The entire sample was split into 4 groups with 26 students in each: French–JW, French–NJW, English–JW, and English–NJW. A pre-test and post-test related to attitudes
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(Attitudes Toward Mathematics Questionnaire) and achievement (Mathematics Evaluation Test (MET) were given to all students in the study. Journal prompts were designed to allow students to explore both cognitive (specific to learning of math related concepts) and affective (goals, strategies, reactions, feelings) variables that may impact their attitudes and achievement in math. At the end of the study, students completed an open ended questionnaire that was a self-evaluation of their journal writing experience. Jurdak and Zein (1998) found that journal writing had a significant affect on only cognitive variables identified as conceptual understanding, procedural understanding and math communication. Although no significant change in attitude was identified by the attitude scale between the JW and NJW groups, it was clear from the responses to the evaluation of journal writing that students were interested in writing and felt it was a valuable experience.

The teacher was the same for all students, which was a very important control. (However, it should be noted that the teacher was also the co-author and had a vested interest in the results of the study). Great care was taken to ensure each class had an equal balance of abilities through a process that ranked students by ability and then randomly assigned them to each class. The instruments used in the study were translated from French into English and it was unclear if any of the intent (validity and reliability) of the test could have been lost in translation or interpreted differently by each group of students. Statistical analysis related to internal consistency for the Mathematics Evaluation Test subscales and Attitudes Toward Mathematics Questionnaire were not convincing and may have contributed to poor results. The positive student responses to journal writing could have been due to the teacher’s overwhelmingly positive responses and comments in the journals. Jurdak and Zein (1998) highlighted that a major motivational factor towards writing was the students’ “keen interest in
the teacher’s response” (p. 415), possibly suggesting the student-teacher relationship had more impact than the writing itself. A question of how much “guidance” was needed or provided, since journal writing was new to the students, may also have had some impact on their opinions or content related to journal writing. One area that was not discussed was the lack of improvement in student achievement (classroom tests) despite improved procedural and conceptual understanding. The possibility that the concepts in the journal prompts were not related to the content on the classroom tests may be one explanation. More information regarding the relationship (or lack thereof) between the content of the journal prompts and the concepts assessed on classroom tests was needed to investigate further. Another factor that may need to be considered was the impact of test anxiety on the student’s achievement. Most students were recognized as high achievers with high language proficiency, thus it may be difficult to see significant changes in such a homogeneous sample. With a more diverse sample the results could vary greatly and be more revealing of the impact of journal writing on learning mathematics. Results from the student’s evaluation of journal writing revealed many responses labelled cognitive in nature, which might suggest more focus on affective prompts could lead to a more significant change in attitude.

As Jurdak and Zein (1998) suggested, the area of mathematics writing and learning is rich in theories, but lacking an adequate research base. Much of the research that studied effects of journal writing on attitudes or achievement in math was based heavily on anecdotal evidence, which could be considered highly subjective and often inconclusive. The study was ambitious in the sense that it was very broad and aimed to add experimental research to the body of knowledge surrounding attitudes and using journals in math. Numerous references, a promising framework and ideas to refine future research in this area are an important contribution of this
experiment. Comments by both the students and the teacher promote the journal’s ability to let teachers see how students think and feel are promising for improving both teaching and learning. Unfortunately, it is impossible to generalize these results due to a highly specific sample of admittedly proficient writers. Future research needs to be concerned with the motivation to write about math by students who are not proficient writers, have not had prior success in math and are not going to get a grade on their journal. Providing students with thoughtful journal prompts that engage metacognitive thinking skills and encourage students to explore and improve upon their current attitudes, values, and behaviours towards math, could lead to an improved attitude toward and relationship with math.

*Studies Tangentially Related*

*Effect of Teacher Support and Transitions on Attitude Towards Math.* This study by Midgley, Feldlaufer, and Eccles (1989) addressed the factors that appear to contribute to declines in student achievement as well as beliefs and values related to mathematics after transition to junior high. A previous study by Feldlaufer, Midgley, and Eccles (1988) identified classroom environment as one significant contributing factor. The purpose of the 1989 study was to examine how a student’s perception of the relationship with their teacher before and after transition to junior high influenced their valuing of math. The impact of perceived teacher-student relationship was further explored by comparing its influence on high and low achieving students. It was hypothesized that the deterioration of this relationship may contribute to a decline in the student’s academic motivation.

To test this hypothesis, information was collected from 2501 students from middle income families in Southeastern Michigan involved in the 2 year Transitions at
Early Adolescence Project. Questionnaires, scored on Likert scales, were designed to obtain information related to value of math, importance/usefulness of math, and perceived student-teacher relationships. These questionnaires were administered twice before the transition and twice after the transition. The forms of analysis were quantitative and descriptive statistics including comparisons of means and standard deviations. A subset from the original Transitions Project sample included 1301 students whose achievement had also been tested using the Michigan Education Assessment Program (MEAP). The achievement test was used to distinguish between low and high achieving students. Change in teacher support was defined by perceived teacher support before transition (elementary school) and perceived teacher support after transition (junior high) which resulted in four categories (high to high, high to low, low to high, low to low). Two main comparisons were looked at: 1) perceived change in teacher support to intrinsic value of mathematics and 2) perceived change in teacher support to importance/usefulness of math.

Results for each comparison were further scrutinized for effects on low achieving students and high achieving students. Midgley et al. (1989) found that intrinsic value increased and usefulness/importance saw no change with a low to high perceived change in teacher support. For all other categories, intrinsic value of math and usefulness/importance declined. The most significant declines were seen when support changed from high to low, especially for low achieving students. The authors’ findings supported the hypothesis that student motivation towards math declined when the perceived change in relationship declined. However, the results also showed that usefulness/importance and intrinsic value declined even with a high to high perceived
change in teacher support, suggesting teacher relationship is not the only factor contributing to this decline.

The loss of data was minimal and the size of the sample was impressive, but lacked diversity (90% Caucasian, middle income). Statistical measures were used to verify the reliability (internal consistency) and validity of each of the instruments used. The instrument used to measure student’s perception of teacher support asked students to look at the overall perception not their individual perception (e.g. “The teacher is friendly to us” rather than “the teacher is friendly to me”). Students at this age may have found it difficult to interpret or separate their own direct feelings and experiences with a teacher. Identification of low and high achievers was clearly defined using the MEAP test for minimum performance standards but limitations discriminating low and high achievers accurately may be compromised. The fact that low achievers represented 25% (referred to as “truly low achievers”) and high achievers represented 75% of the sample is somewhat misleading, since the term “high achievers” would include students of a very wide range of abilities. The tables and graphs were especially useful in making comparisons quickly and clearly. The effects of timing of the transition in the student’s life such as age and puberty (Simmons & Blyth, 1987) were acknowledged as having an impact on declines in values and importance and the suggestion that more attention to classroom environment and teacher student relationship should be considered around transitions. Several other factors, such as departmentalized structure, increased volume of content, and heavy focus on assessment at junior high schools may also contribute to the decline in the student-teacher relationship (Feldlaufer et al., 1988). The discussion failed to consider that comparing a student’s feeling of support at elementary school
(where they had attended for several years, had the same teacher most of the day) to junior high school (where they had barely attended for one year, had the teacher for only one block a day) may not be fair. It would seem that a decline in relationships at a school you are new to and with a teacher who you have far less time with in a day is inevitable. The mention of so many other possible contributing factors such as teacher recruitment/training, school size (Barker & Gump, 1964), and peer influence, made it difficult to believe that teacher student relationship could be isolated from the rest to show a clear impact.

The recognition that the student’s environment, which includes teacher-student relationships, played a significant role during transition would suggest the need for further study. Having the same math teacher over a few years at high school could help to improve teacher-student relationships and may be an area for future study. Midgley, Feldlaufer and Eccles (1989) study supported research into meta-cognitive journal writing aimed at gaining important information regarding student feelings, attitudes, perceptions and understanding. The author of the current study felt journals provided another form of communication between student and teacher that helped the teacher identify factors at play in the classroom and make immediate adjustments aimed at developing a more supportive environment and relationship. Future research with journals may help students find the value and importance of math in their world through writing.

Effect of Cognitive and Affective Changes on Participation in Mathematics. The main reason for Ma’s (2006) study was to understand how and why participation rates in advanced mathematics coursework, such as Calculus, was declining at a time when the
global economy had expanded/advanced technology needs (National Council of Teachers of Mathematics, 1989, 1991, 2000; U.S. Department of Education, 1997). Calculus involves the application of mathematics to real world problems in a variety of areas such as economics and engineering. Schoenfeld (1992) suggested that previous studies identified and provided theories why enrollment in advanced mathematics courses was declining, but lacked the research to support such theories. Ma’s purpose for the study was to see how changes in cognitive and affective impact factors during the middle and high school years influence participation in advanced math courses, while attempting to adjust for contributing factors associated with student background.

The data used by Ma (2006) was obtained from the Longitudinal Study of American Youth (LSAY). The LSAY was a national, multiyear study of math and science education (Miller, Kimmel, Hoffer, & Nelson, 2000) that collected information from each participant from Grade 7 through to Grade 12. The diversity of the LSAY sample spanned geographic regions, community types and was proportional to school enrollment at that time. Ma chose a stratified random sample that studied 3116 students and looked at changes in achievement tests and student questionnaires for each year of the study. The study was highly quantitative using descriptive statistics (i.e., means and standard deviations) to identify rates of changes in cognitive, affective and historical (course related) factors. A recently developed, somewhat complicated, classification and regression tree (CART) statistical analysis was done to separate out student background factors (gender, age, race, each parents education level and socioeconomic status (SES), siblings, and family structure). The final phase of the quantitative analysis involved adjusting the effects of cognitive and affective factors on participation in advanced math with the effect of the background factor analysis (CART). The author found that
all cognitive or achievement factors (basic skills, quantitative literacy and to a lesser extent
gometry and algebra), and one of the affective factors (attitude, but not anxiety) had significant
impact on participation in advanced mathematics. The greatest impact on participation was
clearly identified as attitude.

The size and diversity of the sample was impressive and by choosing a stratified random
sample one could generalize the results to the greater population. The reliability and validity of
the instruments used to measure achievement and attitudes were impressive. The CART was
described as a newer, statistical method of identifying and assigning value to the contributing
factors. The statistical analysis was convincing and appeared to be a useful tool to separate out
the background factors. The impact of cognitive and affective factors on participation in
advanced math was clear. Throughout the author’s discussion the general theme could be
summarized by Simon’s (1986) idea that cognition serves affect and affect organizes cognition,
which supports Ma’s (2006) findings that both cognitive and affective factors determine
students choice of math courses or streams. If a student believes that not taking an advanced
math course could close doors or limit career choice then they may choose to take the course
despite prior achievement. Although the CART analysis was used to identify and carry out
adjustments for background factors it also provided insight into what type’s of students were
more likely (i.e., Asian, high mother education, father high SES) or less likely (i.e., older
students, low mother education) to participate in advanced mathematics. This background
information could be used to help educators identify students who may be at risk and begin to
develop more focused intervention strategies, that could provide those less likely to take
advanced math with greater opportunities for participation. One of the main flaws of this study
was the almost complete absence or mention of teacher influence on affective and cognitive factors.

One important contribution Ma (2006) provided was the development of an understanding of the link between cognition and affect, but more importantly the identification of the larger role attitude appears to play on participation in advanced mathematics, and so needs to be researched further. A more detailed look at adjusting for a number of other factors such as school context/climate, teacher–student relationship, curriculum, nature of mathematics needs to be considered also. The CART method offered an interesting tool to help look at specific factors (and adjusting for others’ influence), but further studies on its effectiveness are needed. This study provided rich resources to help support/clarify the evolving definition of attitude. Aiken (1970) as cited by Ma described attitudes as “learned predispositions to respond positively or negatively to certain objects, situations, concepts or persons” and attitudes “possess cognitive (beliefs or knowledge), affective (emotional or motivational) and performance (behaviour or action tendencies) components” (p.125). The emphasis on meaningful connections has great importance when studying meta-cognitive journaling. Journal prompts should be created to access a students thinking and feeling (attitudes) toward math and encourage students to develop strategies that could help them see the value of math and hopefully overcome obstacles that prevent their success or enjoyment of math. Ma also provided promise that despite some of the cognitive difficulties students may have, if they perceive math to be important they may not avoid it in the future. So how do we help students gain more positive attitudes towards math and could this change in student attitude transform society to have a more positive attitude towards math?
It was clear from the literature reviewed by the author of the present study that students’ attitudes have an impact on their success, enjoyment, valuing and future selection of math courses or careers. The literature also identified some key factors that influence student attitudes in math previously mentioned as the purpose for this study. These factors included importance, relevance, achievement, content, school structure, teacher influence, and parent influence. Evidence was also provided that suggested students enjoyed writing in mathematics and that teachers developed a more understanding, supportive environment in their math classrooms. In addition, a positive impact on the student-teacher relationship was suggested as a result of communication through journal writing. The literature reviewed did not clearly indicate that journal writing improved student attitudes toward math. It was this lack of clarity that inspired the current author to design a study that would focus on the impact of metacognitive journal writing on improving student attitudes toward math.
Chapter Three: Procedures & Methods

Research Design

The problem that the present research intended to address was the implication that poor attitudes lead to the avoidance of course work and careers related to math. The purpose of the research was to see if metacognitive journaling 1) improved students overall attitude toward math and/or 2) improved their attitude in one or more of the four factors identified on Tapia’s (1996) ATMI (self confidence, value, enjoyment, and motivation). A detailed description of the procedures and methods used to assess the effects of metacognitive journaling on student’s attitudes toward math in this action research follows. The experimental research design used according to Fraenkel and Wallen (2009) was the “Static-Group Pretest-Posttest Design” (p. 266). The sample consisted of two Applications Math 10 classes (groups) that were already formed (static) for the journal writing (treatment) class and the non-journal writing (comparison or control) class. The instrument used to measure student attitudes was Tapia’s ATMI. To determine change in attitude toward math, each student’s pre-test ATMI score was compared to his or her post-test ATMI score written 10 weeks later. Additional data obtained from the journal writing group was collected using a teacher created rubric to evaluate the student’s level of metacognition in journal entries. Limitations and threats to validity were discussed and efforts to control these threats were also included.

To address the research question the following statistical analysis was completed. The data analysis included descriptive statistics (means and standard deviations), to identify the mean change in attitude towards math between the experimental group and comparison group. An additional correlational analysis was performed on data collected from the journal writing group to examine the relationship between level of metacognition and change in attitude toward math.
Sample

The study took place in a Grade 8-12 high school located on central Vancouver Island in British Columbia, with a population of 950 students which included approximately 15% French Immersion. The language of instruction in Mathematics at the Grade 10-12 level was strictly English. Students in Grade 10 took math every day for 75 minutes over a period of one semester. Grade 10 is the first year that students are officially streamed in mathematics in the province of British Columbia. Student placement in one of the three available streams took all of the following factors into consideration: prior achievement, attitude, work habits, future career path, interest, parental (guardian) wishes, special needs (learning disabilities) and teacher recommendations. The student and their parents or guardians were given the right to make the final decision regarding placement. At this school, approximately 15% take Essentials of Math 10, 30% take Applications of Math 10 and 50% take Principles of Math 10.

The participants in this study included 53 students enrolled in Applications of Math 10 at the school that year. According to the British Columbia Ministry of Education (2006), “The aim of Applications of Mathematics 10-12 is to prepare students for non-calculus based post-secondary programs of study such as certificate programs, diploma programs, continuing education programs, trades programs, technical programs, and some university programs” (p. 4). Due to timetable and scheduling issues, random sampling could not be used. Therefore, a convenience sampling resulted in two classes of 27 and 26 students respectively.

One class was assigned to be the journal writing group (treatment) and the other class was then assigned to be the non-journal writing group (control). Further details regarding the size, gender, composition (special needs), prior achievement, and number of students repeating in each class was provided. Students who transferred from Principles of Math 10 into either of
the Applications of Math 10 class’s part way through the study were not included in the data or results. Students who did not complete: pre-ATMI, post-ATMI, or at least 7 journal entries were not included in the results of the study. The teacher for both classes was the researcher who was in her 11th year of teaching mathematics. The teacher had taught Math 10 Applications to six classes prior to this study. Although the results from this action research cannot be generalized beyond the school, grade or stream studied, they can be used to inform teaching practice and to provide information for those who wish to replicate the study.

Instruments

To ensure results of this research study were meaningful, careful consideration was taken to ensure appropriate, reliable and valid instruments were chosen to collect data regarding student attitudes and level of metacognition. The instruments used in this study were the Attitudes Toward Mathematics Inventory (ATMI) created by Tapia (1996) and the Metacognition Rubric created by the researcher. The rubric created by the researcher was evaluated by respected colleagues familiar with one or more of the following areas: mathematics, metacognition and journal writing. Students were also consulted with regard to the appropriate use of language and content for the grade 10 level on the researcher created instrument. In addition to these two instruments, the teacher maintained a journal (see Appendix E) to record student comments/questions and teacher answers/responses directly related to the metacognitive journal writing. This information will not be reported in the results, but was mentioned in the discussion for future research. Information that was used to describe the sample, such as class size, class composition, prior achievement (including number of students repeating) and age
was obtained from students through a Demographic Survey (see Appendix F) at the end of the study.

*Attitudes Toward Mathematics Inventory* (Tapia, 1996). The ATMI (see Appendix B) used current statistical standards for instrument development and was recommended as an “effective and efficient research tool to assess factors that influence expectations and performance in math because of its content validity, reliable factor scores, test-retest reliability and brevity” (Tapia & Marsh, 2004, p. 19). The most widely used attitude survey, developed by Fennema and Sherman (1976) was not chosen for use in this study primarily due to its age and administration time. The ATMI (Tapia, 1996) was developed to address recent concerns related to the validity, reliability, and integrity of Fennema and Sherman’s attitude survey. The ATMI was used as a pre-test and a post-test to measure student attitudes towards math. The ATMI consists of 40 items designed to measure students’ attitudes toward math. Each item uses a Likert-format scale that includes 5 responses (1—strongly disagree, 2—disagree, 3—neutral, 4—agree, 5—strongly agree). Eleven of the items are reversed, so these item’s values will be assigned accordingly for data purposes. The students score is the sum of their ratings. The ATMI measures four factors related to attitude (self-confidence, motivation, value and enjoyment). Student scores within each of the four factors will be analyzed and reported separately also. Previous studies, which included diverse samples of middle school and secondary school students have shown convincing results related to the reliability and validity of the ATMI (Tapia, 1996; Tapia & Marsh, 2000, 2002, 2004, 2005), thus making it an appropriate instrument to measure students attitudes toward math.
Level of Metacognition in Journal Rubric. Each journal entry was assessed by the researcher for its overall level of metacognition using a rubric designed by the researcher (see Appendix C). The development of the rubric was based on the definition of metacognition by the author of this study and the levels of performance standards in numeracy as defined by the Ministry of Education in British Columbia (2002). The three main criteria in the rubric designed by the author of this study included awareness, reflection, and development. The students proficiency level in each of these criteria were sorted into six categories which included: no evidence of meeting expectations (level 0), not yet meeting expectations (level 1), minimally meeting expectations (level 2), meeting expectations (level 3), exceeding expectations (level 4) and extensively exceeding expectations (level 5). The overall level of metacognition resulted in a minimum score of 0 to a maximum score of 15 for each student’s journal entry.

Within the rubric each of the criteria were described in detail with reference to the level of performance the student achieved. Detailed descriptors were included within the rubric to further differentiate between each of the levels and each of the criteria. The development and modification of these descriptors were guided by the research and readings that were used to define metacognition earlier and by consultations with colleagues. The content on the rubric was discussed in detail, especially the criteria as it relates to metacognition, with the students prior to their first journal entry. The level of performance language was similar to that currently being used throughout the province to report on student achievement and was already familiar to students. The content and format of the rubric was consistent with both the definition of metacognition and the
sample of Grade 10 students to be measured, thus making it an appropriate instrument to assess the level of metacognition in the student’s journal writing.

Procedure

The two Applications of Math 10 classes were assigned to be either the metacognitive-journal writing group or the non-journal writing group. The teacher had no information related to class size, class composition, prior achievement (including number of students repeating), or age for either of the groups until after each class was assigned journal writing or non-journal writing. The researcher used the first two weeks of school to contact, inform and obtain written consent/permission from parents regarding their child’s participation in the study (see Appendix G). The first two weeks were also used to allow for student timetable changes, ensuring that a more stable sample was obtained. During the third week of school, participating students in each of the groups were administered the Attitudes Toward Mathematics Inventory (ATMI), as a pre-test. The ATMI was used to assess their attitude (self-confidence, motivation, value and enjoyment) towards math. Students were not given their pre-test ATMI scores until the end of the study. To respond to the amount of learning outcomes/curriculum covered in Applications of Math 10 it was necessary to reduce the volume of some of the assignments for the class writing the journals. The reduction in assignment allowed for adequate explanation of metacognitive journaling and provided at least a half hour per week for journal writing. Each class covered the same material over the study’s ten weeks and was assessed the same way with one exception: students in the treatment group wrote in journals and had reduced volume (not content) assignments. It should also be noted that students in the journal writing group were encouraged to do the entire assignment but were only required to do the reduced assignment for full marks.
Prior to any journal writing, 30 minutes of time was taken to explore, discuss and clarify the teacher’s definition of metacognition (awareness, reflection and development) with the journal writing group. Students were then given an additional 30 minutes the next day to practice and further discuss what metacognitive journal writing in math looked like and how it would be measured by the teacher. Students were given a practice journal prompt, and the handout Describing Attitude and Metacognition which included a set of guiding questions to help them create their practice journal writing response. The teacher read and returned the students practice journal response, then shared general observations/suggestions about writing metacognitively. At this point the teacher made clear that the student participation in journal writing over the next ten weeks would have no direct impact on their mark. The teacher explained to students that the focus of the journals was to have them honestly discuss their own thoughts and feelings toward the math prompt they were provided. Grammar, spelling and sentence structure were not emphasized. Students were assured that each of their journal entries was kept in their own personal duotang in a locked cupboard in the classroom to ensure privacy and ready access journal writing day. The teacher was the only person permitted to look at the journal, unless stated otherwise by the student. Students were given access to computers for journal writing to ensure that students with motor or writing difficulties were accommodated. Students were also encouraged to use computers, to allow for anonymity and reduce researcher bias. Students were also made aware that they should put their student number, not their name on their journal entries. Journal responses done on the computer were printed off and handed in to the researcher’s folder. Students were not required to save their response electronically. Students were encouraged to put their journal entry in their own personal duotang, once returned by the researcher.
It was explained to students that the math prompts over the ten weeks were related to factors that were identified in previous studies as contributing to student attitudes. These prompts were mainly affective in nature and were designed to direct students to “express their goals, strategies, reactions, accomplishments, positive and negative feelings, frustrations and suggestions for improvement” (Jurdak & Zein, 1998, p.415). Once per week, for 20 to 30 minutes, students responded metacognitively to a prompt provided by the teacher related to self-confidence, anxiety, value (relevance), enjoyment, nature of mathematics, parent influence, teacher roles and responsibilities, student perception, motivation, gender bias, school system, and achievement. In each journal entry, students were expected to identify current thinking (awareness), explain where this thinking originated (reflection) and suggest strategies to extend or move this thinking forward (development). The level of metacognition score obtained from the rubric for each journal entry was kept by the researcher, and upon request was shared with students at the end of the study. Students who were absent on journal writing days completed the missed entry upon their return to class. Throughout the ten weeks the teacher maintained a journal (see Appendix E) to record observations made in the journal writing class. These observations included: 1) students that were absent, 2) time, date and location of journal writing, 3) journal prompt and instructions given by teacher, and 4) student comments/questions and teacher responses/answers directly related to metacognitive journal writing.

At the end of the ten weeks participating students in each of the groups were administered the same Attitudes Toward Mathematics Inventory (ATMI) that they completed at the beginning of the course, as a post-test. Information used to describe the sample, such as class size, class composition (gender and special needs), prior achievement (including number of students repeating) and age was obtained from students with a demographic survey at the end of
the study. Students did not identify themselves with their student numbers on the Demographic Survey (see Appendix F), since the information was only to assess the equivalence of the groups. Students were given their pre-test and post-test ATMI scores and metacognition rubric scores upon request. Upon completion of the data collection, the researcher provided students and parents with an educational debriefing form (see Appendix H), and opportunity for a question session that reviewed the purpose and brief description of the study. The researcher answered any questions the participants had, and provided the participants a list of references where they could find more information if they were interested. The results of the overall study were made available to parents and students upon request.

Validity and Limitations

Threats to internal validity, especially those most prevalent in action research, experimental, and correlation studies were carefully considered when planning the study to determine the effects of metacognitive journal writing on attitudes toward math. The attempts made by the researcher to address and minimize the threats to internal validity (subject characteristics, loss of subjects, location, instrumentation, testing, history, maturation, attitude of subjects, regression, and implementation) follows. The importance of controlling these threats was to ensure these factors would not reduce or even prevent the chances of a relationship being found between metacognitive journal writing and change in math attitudes. Action research studies have weak external validity and cannot be generalized to the greater population without replication (Fraenkel & Wallen, 2009). Discussions of other feasible explanations of the results were also included.

Subject Characteristics. Although strongly recommended when doing experimental research, random assignment (to ensure treatment and control groups are equivalent) was not
possible. Subject characteristics obtained from the Demographic Survey completed by all participants was reported as raw scores, class averages and percentages so as to assess how well-matched the groups were. Average age and average pre-test ATMI score were reported. Percentages related to prior achievement (from Grade 9) and class composition (students repeating and gender) were also reported. Raw score of class size and gender was included. The difference between groups was less significant since pre-test and post-test change in scores reduced the impact of the characteristics of the subject. Because students in Math 10 Applied were streamed (through a detailed selection process) based on effort, achievement, attitude, and career ambitions the range of differences between the groups is expected to be smaller than if we used the entire population of Grade 10’s taking math. For example students with a C or C+ in Grade 9 and who are interested in trades or non science/math related careers were encouraged to take Applications of Math 10. Student writing ability posed a minimal threat since grammar and sentence structure were not emphasized. The teacher read the prompts to the entire class, provided computer access and ample time to complete the weekly journal to accommodate students with special needs.

*Mortality.* It was not uncommon for a handful of students to move between math streams or encounter timetable switches in the first two weeks of a semester, therefore the study started two weeks into the term which reduced the number of students lost due to timetable/schedule changes. Students who left the study, joined late or did not complete pre-ATMI, post-ATMI, or at least 7 journal entries were discussed, but their results were not used. Due to the nature of experimental design their data was lost to both the control and treatment group.

*Location.* Threat was minimized since both groups were located in the same classroom, with the exception of going to write journals in a computer lab. The participants had access to
the same resources, and had the same teacher. Both classes involved in the study were scheduled in the same semester thus reducing any problems associated with time of school year that may impact motivation and student commitments (e.g. sports, jobs). Another variable was that Learning Assistance or Opportunities students could chose to work in alternate locations with supports that could differ from that provided by the classroom teacher.

**Instrumentation.** The same instrument (ATMI) was used as a pre-test and post-test to assess attitudes. The survey questions were clearly written and were distinctly assigned to each of the four factors related to attitude. Cronbach’s alpha for each of the four factors ranged from .88-.95, indicating a high level of reliability in previous studies completed on a variety of samples (Tapia, 1996; Tapia & Marsh, 2000, 2002, 2004, 2005). Tapia and Marsh tested the reliability and validity of the inventory on middle school, high school and college samples of varying demographics with convincing results.

The ATMI was only applied twice in the current study, resulting in reduced instrument decay. The ATMI was chosen due to its reduced length and accuracy identifying student attitudes toward math. Clearly defined scoring ensured resulting scores were not directly influenced by researcher/data collector. It was difficult to control data collector character and bias in the action research study since the teacher was the researcher and may have inadvertently influenced student responses. The teacher was aware of this and made every attempt to be consistent with both groups when the ATMI was administered.

The rubric created to measure level of metacognition was consistent with the definition of metacognition and appropriate language for the Applications of Math 10 sample was used. Colleagues with experience in journal writing, metacognition and math curriculum were consulted to ensure that the rubric was an effective tool to measure metacognition in math.
Student consultation and clarification regarding language and performance standards and criteria were also considered during Rubric creation and implementation. The teacher was careful when scoring rubrics so as not to influence results. Students were identified by student numbers and were encouraged to type entries to ensure increased anonymity. The rubric criteria and levels were distinctly defined and included detailed descriptors to reduce the threat of biased scoring. Time and care was taken by the researcher to ensure student understanding was clear by doing a practice journal entry, referring to guiding questions and providing general feedback related to writing metacognitively.

Testing. The ATMI was administered far enough apart that the threat of the pre-test directly influencing the post-test was small. Students were given scores at the end of the study so they could not try to purposefully adjust their attitude rating. Students were obviously sensitized to the fact that attitudes were being assessed by both the ATMI and the journal prompts, which may have influenced their post-test. The threat was minimized since it was the same for both groups overall. The mean size of the change in attitude between the treatment and control group were compared. The metacognitive journal writing group was expected to have a larger positive mean change.

Journals were only written once per week to ensure the teacher had adequate time to assess each journal entry with the rubric, and the students had adequate time to try their new strategies to improve their attitude towards math. The time between journals also gave students who were absent on journal writing days time to come in and complete their journal response before the next prompt. To ensure the teacher did not influence or appear to play favourites, individual descriptive comments on rubric/journal entries were not given. The teacher provided general feedback to the class regarding their metacognitive journal writing. The feedback did
not include any comments related to the personal content of any of the student’s journal responses. This reduced the threat of the teacher developing or influencing their relationship with the student. This contributing factor did not exist in the non-journal writing group. The threat to the correlational component of the study was reduced since students in the journal writing group may not have been aware of the researcher looking at the relationship between level of metacognition and change in attitude since the comparison with the non-journal writing group was being done at the same time.

**History.** Any event or experience that happened would have the same impact each group since they were in the same semester. Although beyond the researcher’s control, any significant event that occurred during the course of the study was noted in the teacher journal and reported in the discussion section of this paper.

**Maturation.** Change in age and experience posed little threat since both classes were in the same semester. The average age of each class was stated when describing the sample groups to identify whether age may have posed a greater than expected threat. More students repeating the course in one group also posed a threat related to maturation. It should be noted that Midgley, Fedlaufer and Eccles (1989) study on transitions to high school showed that student’s value/importance related to math declines as students get older regardless of teacher support. Looking at the change in attitude helped reduce these threats.

**Subject Attitude.** The subject’s attitude was a challenge with this experimental research study. There was a moderate threat that the treatment group may perform better due to novelty of treatment or feeling special. The group not getting the treatment may have been resentful and may have increased their efforts since they felt left out. Students may have become tired, bored or not interested in responding to some of the journal prompts, thus affecting the level of
metacognition scores (attitude vs. ability). Perhaps the greatest threat was students who did not take the journal writing seriously since it was not for marks. To minimize these threats the teacher attempted to have students believe the treatment was a regular part of the course and did not emphasize that the activities were part of an experiment, other than the initial introduction. Since groups were in the same semester this threat was increased, since students were aware the other class was being treated or not treated. Motivation for the journal writing group was increased through engaging prompts, novelty (variety) of doing journals, only doing it once per week (not overdoing it), meaningful teacher feedback (general comments), receiving a metacognition score (at the end of the study), reduced math assignments, and going to the computer lab. Student reluctance to share their feelings due to trust/confidentiality posed a threat due to reduced metacognition scores. By having students identify themselves with their student numbers and typing in their journals some anonymity was provided. Using student numbers on both the ATMI surveys and journals as well as encouraging typing in responses reduced the ability of the teacher to be biased when assessing journals but still allowed the teacher to determine change in ATMI pre-test and post test scores and do a correlational analysis of with the change in attitude and level of metacognition. The journals were stored in a locked cupboard between use to ensure they did not get lost and the student’s privacy was protected.

Regression. Regression posed a minimal threat due to the fact that two Applications of Math 10 classes were compared. Most low-performing students were assigned to Essentials Math 10 and most high-performing students were assigned to Principles Math 10. Since random assignment was not used there was still a possibility for some imbalances between the groups, especially when one group had more students repeating or designated special needs than the other. Special needs students also had access to an educational assistant, and were able to work
in the learning center rather than in class. Class dynamics such as size and composition could pose threats also. The researcher reported such differences and by being aware of these differences tried to ensure the classroom environment/dynamics between the groups was as constant as possible under the circumstances.

*Implementation.* Standardized conditions such as same teacher, curriculum, classroom, resources, and ages were an important way to minimize implementation threats. Sensitivity and awareness related to their own personal bias toward the treatment method and treatment group was necessary to reduce the teacher’s influence on the results in this experimental action research study. To minimize these threats it should be noted that the researcher’s primary reason for the study was student attitudes. The researcher had no agenda or preference towards the treatment, metacognitive journal writing, and could have chosen one of any number of other classroom strategies such as differentiated instruction, project based learning, etc. Implementation of journal writing in the same semester made it difficult for the researcher to downplay the experiment from the two classes. The researcher was in her 11th year teaching and had taught six Applications of Math 10 classes over a period of seven years at the time of the study. Careful attention by the researcher, to make the experiment appear as a natural part of class was made easier due to the teachers experience and familiarity with the content and types of students who enrol in Applications of Math 10.

The threats to internal validity related to this study were greatly reduced by planning which included choosing an appropriate design, standardizing the conditions, and consulting literature related to the nature of the both the study and the subjects to be investigated. The results of this action research were limited to answering the research question, informing teaching practice and developing a plan of action related to improving student attitudes with metacognitive journaling.
Due to the nature of action research the results were not generalized, but recommendations for future research that considered the other possible explanations of the results of this study related to attitudes and metacognitive journaling in math were made.

Data Analysis

The data analysis consisted of three parts that were used to answer the research question: Does metacognitive journaling in mathematics have any affect on improving secondary student attitudes toward mathematics; if affect is found, is the change in attitude related to the level of metacognition? The first part provided class information used to compare the equivalence of the experimental and control groups. This information was used to address some of the validity threats and limitations related to experimental, correlation action research. The second part of the analysis involved comparing the experimental and control group results regarding the effect of metacognitive journal writing (treatment) on student attitudes toward math. If an effect was found the third part involved a correlational analysis with data collected from the journal writing group only. The strength of the relationship between attitudes toward math and the level of metacognition in the students’ journal responses was calculated. Change in attitudes toward math results were reported in five ways for both the experimental and correlation component of the data analysis. Change in overall attitude, and change in each of the four factors identified by the ATMI which included change in self-confidence, motivation, value, and enjoyment.

Statistical Package for the Social Sciences (SPSS) was used to complete all calculations (i.e. percentages, means, standard deviations, correlation coefficients) and EXCEL was used to complete all graphics (i.e. tables) needed for the data analysis.

The equivalence of the sample was first addressed in a table that provided descriptive statistics in the form of percentages, averages (means) or raw scores from data collected from the
students Demographic Surveys. For experimental research, where random assignment was not done, the researcher looked at the equivalence of the two groups (experimental and control) and identified possible threats to the results due to the sample dynamics. Data related to gender differences, composition (special needs), prior achievement in Grade 9 Math (A, B, C, C+, C, C-, F), and students repeating were converted into percentages. Class size, average student age and students initial attitude toward math score obtained from the pre-test ATMI (as a class average) were reported in the results section.

The second component of the study involved comparing the experimental and control group data. The overall pre-test ATMI and post-test ATMI scores for each student in the study were calculated. The overall post-test ATMI score minus the overall pre-test ATMI score for each student was calculated to show the overall change in attitude after the 10 week experiment. A positive result indicated a student had a more positive attitude toward math at the end of the study. A negative result indicated a more negative attitude toward math. This process was repeated for each of the four factors (self confidence, motivation, value, enjoyment). For example: The self confidence pre-test ATMI and post-test ATMI scores for each student in the study were calculated. The self confidence post test ATMI score minus self confidence pre-test ATMI score equalled the change in attitude related to students self confidence. For each group the mean change in attitude was determined by averaging the change in attitude for overall, and each of the four factors. These results were reported in a table, and on bar graphs. The comparison of the experimental and control group was then made to determine if the research question was supported by the results. The difference between the two groups was determined by taking the average change in overall attitude toward math (journal writing group) minus the average change in overall attitude toward math (non-journal writing group). The difference
between the writing group (treatment) mean change and the non-writing (control) mean change for each of the four factors and overall was calculated. A difference that resulted in a positive value indicated metacognitive journal writing had a positive effect on student attitudes. A difference that resulted in a negative value indicated that metacognitive journal writing had a negative effect on student attitudes. The same process was repeated for each of the four factors. An independent t-test was performed to determine the significance of the comparison between means. The research question was supported if any of the factor differences showed a positive result. The rationale for looking at each of the factors separately was to see if metacognitive journal writing had more impact on one factor over another.

It should be noted that the author of this study expected possible declines in changes in attitude toward math for both groups as suggested in Midgley, Fedlaufer and Eccles (1989) study that revealed students value and importance on math appears to naturally decline as they get older. The research question in this study was still supported if the decline for the metacognitive journal writing groups was a smaller decline than that of the non – journal writing group. For example: A change in attitude of -5 for journal writing group minus a change in attitude of -10 for the non journal writing group shows a difference of +5. The positive difference suggested that metacognitive journal writing may have helped to reduce the size of the negative attitude that could have developed if the treatment weren’t used.

The final component of the study involved data collected from only the journal writing group. Change in each student’s attitude toward math, previously calculated by taking posttest ATMI score minus pre-test ATMI score, was reported for overall, self confidence motivation, value and enjoyment. The level of metacognition score (out of a possible 15 marks) on the ten journal responses were averaged (mean) for each student. The averaged (mean) level of
metacognition and changes in student attitude (overall, and the 4 factors) were also displayed in the table. A scatterplot to display the data was included, given significance, where the average level of metacognition was on the x-axis and the change in overall attitude towards math was on the y-axis. Each point represented the data related to a single student (average level of metacognition, overall change in attitude). The Pearson correlation coefficient (r) was calculated to determine the strength of the relationship between these two variables. According to Frankel and Wallen (2009) a correlation between 0.4 and 0.6 has theoretical or practical value in educational studies. To support the research question the results were expected to show a positive correlation that would indicate that a higher level of metacognition was related to a positive (or greater) change in overall attitude toward math. This process was repeated four more times with level of metacognition and each of the four factors. This resulted in four more correlation coefficients. These results allowed for comparisons to determine which factors appeared to have a stronger relationship with metacognitive journal writing.

The researcher maintained a field journal (see Appendix E) to record observations related to the administering of the journal prompts. These observations included a record of allotted time, absents students (dates prompts were actually written), and teacher instructions were not included in the results section. Student comments/questions and corresponding teacher responses/answers were carefully recorded. The initial comparison between the writing (treatment) and non-writing (control) groups was to determine if metacognitive journal writing had any effect on students’ attitudes in math. The correlation was done with the journal writing group only, to determine how strongly the effect on attitude toward math (overall, self confidence, motivation, value, and enjoyment) was related to average level of metacognition. Together the statistical analyses of the data were used to answer and support the research
question. The description of the equivalence of the sample and the teacher field journal were provided to give a more complete picture of the sample being studied and the classroom environment that the experiment was performed in as was deemed appropriate.
Chapter Four: Results

This study examined the effects of journal writing and metacognitive thinking on secondary student attitudes toward math. The students studied were all taking Math 10 Applications at a Grade 8-12 dual track (French Immersion and English) secondary school on central Vancouver Island. The two classes involved in the study were taught by the researcher during the same semester, in the same classroom. The non-journal writing class was the control or comparison group and the journal writing class was the treatment group. Overall group data was obtained from demographic survey responses, and individual student attitude data was defined by Attitudes Toward Mathematics Inventory (pre-test and post-test) scores. Individual student level of metacognition scores were assessed by the teacher using a rubric for the journal writing group. The following tables will provide a summary of the data collected and analyses that include descriptive and inferential statistics. The descriptive statistics include summary of the data that includes raw scores, percentages, means, mean differences (change in mean) and standard deviations. The inferential statistics include the results of 1) a comparison of change in attitude means using an independent samples t-test between the non-journal writing (control or comparison) and journal writing groups (treatment); and a correlational analysis using the Pearson product-moment coefficient (r) to determine the strength of the relationship between change in math attitude and level of metacognition in journal writing. All analyses were performed using the Statistical Package for the Social Sciences (SPSS).

Sample Demographic Findings – Equivalence of Groups

Students were assigned to each of the classes by British Columbia Enterprise Student Information system (BCeSIS), administration, or counselors. The researcher had no input on the assignment of students to each group. The researcher felt that it was important to look at the
equivalence of each of the groups, to identify any extraneous variables (i.e. class size, gender, age, composition (special needs), prior achievement, and number of students repeating Math 10) that could affect the outcome or validity of the results of the study. Table 4.1 displays the descriptive statistics used to identify each group dynamics.

Table 4.1

*Demographic Survey Results and Analysis*

<table>
<thead>
<tr>
<th>Demographic Information</th>
<th>Non-Journal Writing</th>
<th>Journal Writing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class Size</td>
<td>N = 27</td>
<td>N = 22</td>
</tr>
<tr>
<td>Gender – Male</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>59.26%</td>
<td>45.45%</td>
</tr>
<tr>
<td>Gender – Female</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>40.74%</td>
<td>54.55%</td>
</tr>
<tr>
<td>Mean current age</td>
<td>15 years 9 months</td>
<td>15 years 9 months</td>
</tr>
<tr>
<td>Mean math 9 grade</td>
<td>C+</td>
<td>C+</td>
</tr>
<tr>
<td>Took Essentials Math 10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7.41%</td>
<td>4.55%</td>
</tr>
<tr>
<td>Took Applications Math 10</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7.41%</td>
<td>4.55%</td>
</tr>
<tr>
<td>Took Principles Math 10</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>14.81%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Attended Learning Assistance</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0.00%</td>
<td>0.00%</td>
</tr>
<tr>
<td>Attended Opportunities</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>3.70%</td>
<td>4.55%</td>
</tr>
</tbody>
</table>

Note. Data was self reported by students on Demographic Survey. Results for the Journal Writing Group does not include four students whose data was removed from study. Students repeating Math 10 are those who took Math 10 Essentials, Math 10 Applications or Math 10 Principles. All students who attended Learning Assistance or Opportunities (Behaviour Program) had access to additional math support outside of class time.
It should be noted that the journal writing class included 26 students. Data and analyses for four students were removed from the study for one of the following reasons: refused to do the journals, did not complete the post-ATMI, did not complete at least 7 journals (due to absence) or entered the course several weeks after the study began. The number of students repeating Math 10 in the non-journal writing group was 8 (approximately 30% of the class) and in the journal writing group was 2 (approximately 9% of the class). Due to the nature of streaming and school policies related to mathematics course selection, students could be “repeating a Math 10 course” due to failure, to improve grade, to upgrade course credit, or to gain additional graduation credits. Students who attended Learning Assistance and Opportunities did not do so during class time. These students may have had assigned support blocks or chose to attend these programs to get extra help after school or while on suspension.

Experimental Findings – Comparison of Journal Writing and Non-Journal Writing Groups

Student attitudes were measured using the Attitudes Toward Math Inventory (ATMI). Since this research study was designed as a quantitative experimental study, specific student journal responses were not reported in this chapter but were included in the interpretation and discussion of the results in the final chapter where appropriate. Comparisons between the non-journal writing (control or comparison) group with the journal writing (treatment) group related to overall attitude and each of the four factors identified on the ATMI (self confidence, value, enjoyment and motivation) were reported. To determine if the findings support the first half of the research question “Does metacognitive journaling in mathematics have any affect on improving secondary student attitudes toward mathematics?” the researcher initially examined mean pre-ATMI and mean post-ATMI scores for each group. Results reported in Table 4.2 show an improvement in overall attitude as well as enjoyment and value for the journal writing
group, which would partially support the research question. Students in the non-journal writing group only saw improved attitude towards math relating to self confidence.

Table 4.2

Results of the Attitude Towards Mathematics Inventory (Pre-test and Post-test)

<table>
<thead>
<tr>
<th></th>
<th>Overall</th>
<th>Enjoyment</th>
<th>Value</th>
<th>Motivation</th>
<th>Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max = 200</td>
<td>max = 50</td>
<td>Max = 50</td>
<td>max = 25</td>
<td>max = 75</td>
</tr>
<tr>
<td>Pre-test</td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
</tr>
<tr>
<td>Non-Journal Writing</td>
<td>129.00</td>
<td>23.71</td>
<td>28.89</td>
<td>7.21</td>
<td>36.52</td>
</tr>
<tr>
<td>Journal Writing</td>
<td>130.18</td>
<td>23.01</td>
<td>28.68</td>
<td>7.07</td>
<td>33.95</td>
</tr>
<tr>
<td>Post-test</td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
<td>SD</td>
<td>mean</td>
</tr>
<tr>
<td>Non-Journal Writing</td>
<td>126.89</td>
<td>22.04</td>
<td>28.11</td>
<td>6.51</td>
<td>34.93</td>
</tr>
<tr>
<td>Journal Writing</td>
<td>131.32</td>
<td>23.83</td>
<td>29.18</td>
<td>7.37</td>
<td>36.18</td>
</tr>
</tbody>
</table>

Note. Data taken from Attitude Towards Mathematics Inventory (Tapia, 1996)

N = 27 (Non-Journal Writing Group) and N = 22 (Journal Writing Group)

For each group the magnitude of the resulting mean change in attitude for each factor can be seen in Table 4.3. A positive mean change indicated that attitude improved whereas a negative mean change indicated that attitude declined between pre-ATMI and post-ATMI.
Table 4.3

*Results for Mean Change in Attitude*

<table>
<thead>
<tr>
<th></th>
<th>Overall Enjoyment</th>
<th>Value</th>
<th>Motivation</th>
<th>Self Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Non Journal Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 27)</td>
<td>-2.11</td>
<td>17.68</td>
<td>-0.78</td>
<td>5.32</td>
</tr>
<tr>
<td>Journal Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(N = 22)</td>
<td>1.14</td>
<td>16.30</td>
<td>0.50</td>
<td>5.39</td>
</tr>
</tbody>
</table>

Note. A positive mean change indicated that attitude improved between pre and post test.

Overall, enjoyment and value related to attitude improved for the journal writing group but declined for the non-journal writing group suggesting that journaling may have a positive impact on these factors. Motivation related to attitude declined for both groups leading the researcher to believe journaling had little or no impact on this factor. Self confidence related to attitude declined for the journal writing group but improved for the non-journal writing group suggesting that journaling may have a negative impact on this factor.

To determine the significance of the impact of metacognitive journal writing on student attitudes toward math, a t-test for independent means was used to compare the mean change in attitude scores of the journal writing group with the non-journal writing group. The results of this inferential statistical analysis are reported in Table 4.4.
Table 4.4

*Comparison of the Difference Between the Mean Change in Attitude of Journal Writing and Non-Journal Writing Groups*

<table>
<thead>
<tr>
<th>Overall</th>
<th>Enjoyment</th>
<th>Value</th>
<th>Motivation</th>
<th>Self Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene’s Test for Equality of Variances</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>0.146</td>
<td>0.001</td>
<td>0.022</td>
<td>1.669</td>
</tr>
<tr>
<td>Sig.</td>
<td>0.704</td>
<td>0.978</td>
<td>0.883</td>
<td>0.203</td>
</tr>
<tr>
<td>t-test for Equality of Means</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>0.662</td>
<td>0.832</td>
<td>2.392</td>
<td>-0.355</td>
</tr>
<tr>
<td>Df</td>
<td>47</td>
<td>47</td>
<td>47</td>
<td>47</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.511</td>
<td>0.410</td>
<td>0.021*</td>
<td>0.724</td>
</tr>
<tr>
<td>Mean Difference</td>
<td>3.248</td>
<td>1.278</td>
<td>3.820</td>
<td>-0.298</td>
</tr>
<tr>
<td>Standard Error Difference</td>
<td>4.905</td>
<td>1.536</td>
<td>1.597</td>
<td>0.840</td>
</tr>
<tr>
<td>95% Confidence Interval of the Difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>-6.620</td>
<td>-1.812</td>
<td>0.608</td>
<td>-1.988</td>
</tr>
<tr>
<td>Upper</td>
<td>13.115</td>
<td>4.368</td>
<td>7.032</td>
<td>1.392</td>
</tr>
</tbody>
</table>

Note. Data was analyzed using SPSS Independent Samples t-test.

Mean Difference = Mean Journal Writing - Mean Non-Journal Writing.

*p < .05, two tailed.

Using Levene’s test equal variances were assumed which implied the two groups do not differ significantly. The difference in results can be attributed to the treatment, not the differences in groups. The mean difference between the two groups ranged from positive impacts which
included value (3.820), overall (3.248), enjoyment (1.278) to negative impacts which included motivation (-0.298) and self confidence (-1.825). Mean differences can be somewhat misleading since each factor had different total scores to begin with. For example, a mean difference for overall of 3.248 has far less impact when you consider the overall ATMI score is out of 200. A mean difference for value of 3.820 has far greater impact when you consider the value ATMI factor score is out of 50. Only mean change in value (importance) related to attitude for the journal writing group was found to be significant at the p <.05 level. This finding supports the research question that journaling has a positive impact on attitude related to value. The findings related to change in overall attitude and each of the other factors (i.e. self confidence, motivation, and enjoyment) were not significant.

Correlational Findings – Relationship of Metacognition and Attitude in Journal Writing Group

Analysis of data from only the journal writing group was used to address the second portion of the research question related to determining whether or not the change in attitude was related to the level of metacognition in the journal responses. For each journal entry, the rubric created by the researcher was used to assess the student’s level of metacognition. Scores ranged from 0 to 15 for each journal response. During the study students received no individual feedback from the researcher. Level of metacognition scores and written comments were recorded by the researcher but not shared with the student to reduce the impact of teacher-student relationship on the results. Group feedback, which included general comments on how students could improve their metacognitive thinking / writing related to awareness, reflection and development was shared with the entire class on days when journal responses were returned and the next journal prompt was given. All students identified themselves with their student number and used computers to complete their journals to reduce teacher bias. A number of students were
unable to complete all 10 journal entries by the end of the study due to absences related to illness, suspension, skipping, extracurricular participation, or holidays. To reduce the number of students whose data would have been removed from the study the researcher felt that students who completed at least 7 of the 10 journals had experienced enough of the topics that related to each of contributing factors to attitude towards math. The level of metacognition scores from the journal entries (using anywhere from 7 to 10 scores) were calculated as a mean for each student. Using data obtained from responses on the pre-test and post-test ATMI, student change in attitude scores related to overall attitude and each of the four factors (self-confidence, motivation, enjoyment and value) were calculated. A correlational analysis on the journal writing group was done to identify the strength and significance of the relationship between the mean level of metacognition score and change in attitude for each of the factors including overall. The Pearson product-moment coefficient (r) was used to calculate the correlations reported in Table 4.5.

Table 4.5

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Enjoyment</th>
<th>Value</th>
<th>Motivation</th>
<th>Self Confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metacognition</td>
<td>0.136</td>
<td>-0.073</td>
<td>0.082</td>
<td>0.247</td>
<td>0.192</td>
</tr>
<tr>
<td>Sig. (2 tailed)</td>
<td>0.547</td>
<td>0.746</td>
<td>0.717</td>
<td>0.268</td>
<td>0.391</td>
</tr>
</tbody>
</table>

Note. Pearson product-moment coefficient (r) was used to calculate the correlation.

N = 22 (Journal Writing Group)
The values of the correlation coefficients given in brackets for motivation (0.247), self-confidence (0.192), overall (0.136), and value (0.082) indicate a weak positive relationship between level of metacognition and each of the attitude factors identified above. A correlation coefficient of -0.073 indicated a weak negative relationship between level of metacognition and enjoyment related to attitude. Correlation’s between -0.4 and 0.4 have no theoretical or practical value in educational studies this small (N = 22). The correlation analysis does not support the second part of the research question and the researcher concluded that it was unlikely that change in attitude was related to the level of metacognition score in the journal responses. Scatterplots for each correlation were not included since none of the attitude factors including overall showed significant relationships between the variables.

The findings in this action research study support the idea that metacognitive journal writing in mathematics has a significant positive affect on student attitude related to value/importance of mathematics. Although the research focused on quantitative analysis of changes in attitude it was necessary in the conclusion to share student reflections on the journaling experience. Students responded to the following questions in the final prompt: “Do you think metacognitive journal writing has helped to improve your attitude toward math? What were the benefits to metacognitive journal writing in math? and How could metacognitive journal writing be changed to be more effective in math? Student responses provided the researcher with some insight into the findings of the experimental research related to the negative impact of journaling on self-confidence and the findings of the correlational research related to the weak relationships between level of metacognition and change in attitude. As part of the discussion of limitations and further recommendations, additional comments related to student feelings/attitudes was included with the quantitative results. The researcher felt the interpretation of statistics was
incomplete without including student feelings just as the learning / teaching of mathematics was incomplete without considering student attitudes.
Chapter Five: Summary and Conclusions

Summary

The researcher’s interest in investigating student attitudes towards math and using writing in math led to the research question: Does metacognitive journaling in mathematics have any effect on improving secondary student attitudes toward mathematics; if effect is found, is the change in attitude related to the level of metacognition? This action research study involved an experimental component that compared the changes in attitude between two Applications of Math 10 classes taught by the researcher. The journal writing class (treatment) responded to attitudinal journal prompts metacognitively and the non journal writing class (control or comparison) did not. Factors such as overall attitude, enjoyment, motivation, value/importance and self confidence related to math were measured using Tapia’s Attitudes Toward Mathematics Inventory (ATMI). Pre-ATMI and post-ATMI scores were used to assess student changes in attitude after a 10 week period. Student level of metacognition in journal responses were scored using the Metacognition Rubric that assessed attitude awareness, reflection and development. A correlational analysis was then completed on the journal writing group to investigate the relationship between mean level of metacognition and change in attitude toward math. Although not directly linked to the research question, a demographic survey was used to assess the equivalence of the two groups involved in the study. The purpose of this survey was to identify/explain limitations of the study or possible misinterpretation of the results.

A comparison of raw scores, means and percentages between the two groups was important in assessing the possible impact of any extraneous variables (such as class size, gender, age, composition, prior achievement, and number of each student repeating) on the outcome of the study. The impact of these factors with the exception of number of students
repeating, which was slightly higher in the non-journal writing class, appeared negligible. The equivalence between the journal writing and non-journal writing classes provided confidence that the results obtained were more likely due to journal writing and less likely due to class dynamics.

To determine the impact of metacognitive journal writing on student attitudes toward math, a t-test for independent means was used to compare the mean change in attitude of the journal writing group with the non-journal writing group. This inferential analysis suggested metacognitive journaling in mathematics had a positive impact on improving secondary student overall attitudes toward mathematics and factors related to the value and enjoyment of math. Value was the only factor that was found to be significant (p < 0.05). The analysis also showed, without significance, that change in math attitude factors related to self-confidence and motivation declined for the journal writing group.

The correlational analysis produced Pearson product-moment coefficient (r) to determine the strength and significance of the relationship between mean level of metacognition and change in attitude of the journal writing group. The resulting analysis showed no significant relationship existed. Findings showed weak positive relationships for overall attitude, motivation, self-confidence, and value/importance and a weak negative relationship for enjoyment. The change in attitude does not appear to be related to the level of metacognition in student writing.

Despite this study being quantitative in nature it seemed important to include teacher observations of student comments and questions during journal writing, and student voices from their journal responses in the following discussion of findings. To understand and interpret these findings required further investigation into comparisons with literature reviewed, and limitations of the study to help direct suggestions for future research.
Discussion and Implication of Findings

It is important when discussing the findings of this research study that we consider the role of writing and attitude within the climate of implementation of a new mathematics program in the province of British Columbia. Students entering Grade 10 in September 2010 will be exposed to curriculum with greater emphasis on student engagement, relevance, communication, and attitude. The new math program promotes mathematical thinking, understanding, and communication where student learning is based on the connections between content, careers, interests and strengths. The timing of this study provided the researcher the opportunity to learn from theory, research and experience in an effort to understand how attitude may be a tool to deeper learning for all students in mathematics. This research would suggest that a balanced plan of action that supports and develops opportunities through metacognitive journaling for all learners (teachers and students) to recognize the potential benefits of integrating the cognitive and affective domains.

Through journaling, students entered into dialogue surrounding math aptitudes, personal interests that allowed them to make connections between their attitude and how it impacts their perceived enjoyment, relevance, importance and self confidence related to math in their own lives. Students were asked to develop skills and strategies related to life long learning in math related to inquiry, self regulation, metacognition, that would help them answer their own question about math: When am I ever going to use this? The journals encouraged students to ask themselves questions to help them: become aware of their beliefs, emotions and behaviours related to math; reflect on their past experiences as they assess the impact on current learning in math; and develop personal strategies to improve their attitude towards math. Responses showed many students were able to think metacognitively and inquire productively into the long term
benefits to learning mathematics with an improved attitude. Some students saw journaling as a means to understanding the origin of their current attitude, assessing its impact on current learning, and as a motivator for developing positive behaviours in the future. Student responses indicated that journals helped them realize that they needed to take responsibility for their attitude, and that blaming others was not going to help them in the future which may have unfortunately had an initial negative impact on self confidence. Students in the non journal writing group actually saw an increase in self confidence. In the long term, would students in the journal writing group eventually see their self confidence improve after having time to absorb their feelings, and then implement and hopefully benefit from their strategies? The research on the effect of metacognitive journal writing on attitudes toward math provided new experiences and invaluable tools that will help students reach the goals of the new math program. Students experienced the power of inquiry to engage and challenge their beliefs about math through reflection that encouraged them to take action and develop more effective strategies aimed at improving their attitude toward math. (e. g., student response: “Writing journals for math probably has helped realise some of the areas I need help in. It got me to think about what makes me tic, and what I need to think about more in mathematics”)

Research with metacognitive journal writing has helped students develop an inquiry mindset while providing the researcher with valuable information to critically analyze and grow their own teaching practice. It provided future opportunities to engage in collaboration and inquiry between student and teacher in meaningful ways based on the findings of current research related to attitudes, metacognition and journaling. Although not directly the purpose of the study it was difficult for the researcher to read what was being said in the journals and not have it impact teaching for both groups. Students provided valuable information on the teaching
and learning of mathematics that they have witnessed and experienced throughout their schooling. (e.g., student responses “...it could be a permanent thing used to reflect, give new ideas from our perspective, and also give insight into the effectiveness of different teaching methods” and “the information given by the students, assuming the majority of the class took it seriously, could be very useful for teachers to improve their lesson plans and the way they teach math. This could change future student’s attitudes toward math.”) The researcher found it impossible and unethical to not use student journal responses/suggestions to assist with subtle changes related to planning, remediation and engagement for both groups in an effort to better meet student needs. Since these changes were made to both classes, their effect on the results should have been minimal. The journals provided the researcher with a better understanding of student’s thinking and feeling towards mathematics that would ultimately benefit not only the researcher but also the teaching profession. Journals could help teachers respond to students in more individual/personal ways to further alleviate negative feelings, beliefs, and attitudes toward math, which is not possible in the typical class of 30 students. The researcher found students responses/strategies would be useful for directing future course planning that focused on connecting our actions to learner needs.

In an effort to help students learn for deeper understanding it’s important to know how they learn and help remove barriers to learning such as a negative attitude (e.g., student response “The journal writing we are doing helps me learn a bit as well, as it gives me a break from doing math, and lets me reflect on it instead. I think it might be helping me understand my learning style a bit more, and know what works for me and what doesn’t”). One of the guiding principles for the new secondary math courses was the need to incorporate current teaching/learning research (Alberta Council on Admissions and Transfer (ACAT), 2009; WNCP, 2008). The new
math program has a more universal design in it’s approach to mathematics as it aims to address learning styles and current research by encouraging teachers to provide students with opportunities to explore math in more creative ways and regulate their own learning. The creation of career related courses moves mathematics away from sorting for ability towards a pathway to learning that is more relevant and motivating. To improve attitude, increase effort and develop life long mathematical thinking skills, students must be engaged by the math they are learning. We hope through journaling to develop math learners who are curious, resourceful, reflective and collaborative.

The non-journal writing group saw attitudes decline related to relevance, enjoyment and motivation, which reinforced the findings in the literature (Berch and Mazocco, 2007; Midgley, Feldlaufer, & Eccles, 1989) that student’s attitude towards math decline as they get older. The implications for journal writing are significant in the sense that overall attitude, enjoyment and value improved. Although improved overall attitude and enjoyment were insignificant, it was clear from student journal responses, particularly those who do not like math, that the opportunity to explore their thinking and feeling about math with journals was enjoyable and useful. Conversely students who liked math or found it easy did not enjoy the journals and found them to be “stupid, boring, and a waste of time” (e.g., student response “I thought it was a waste of math time where I could have been doing something productive instead of writing about my feelings”). Due to the nature of previous course selection which is based on prior math achievement, most students involved in this study would be those who had struggled with and/or disliked math in the past.

Overall these results support Jurdak and Zein’s (1998) findings that most students were interested and felt journaling was valuable. As in Borasi and Rose’s (1989) study, many students
found the writing therapeutic and enjoyed having the time to reflect on their attitude (e.g.,
student response “we were able to release our stress and problems toward math…this was almost
like a rant journal but it also made us think towards the future, towards our careers which is
always good.”) Journals allowed students to ensure their voice was heard and respected.
Students were encouraged to be honest when sharing stories, reflecting on past struggles,
celebrating success, and brainstorming ways to do better or feel better about math. The journals
respected and recognized the differences in competence and experience, and ignited a range of
ideas and questions that allowed students to be more creative and understanding when
developing strategies to improve their attitude.

The relationship that would link the cognitive and affective domain through
metacognition and attitudes was not supported by the research. Correlational analysis on the
journal writing group showed extremely weak positive correlations for overall, motivation, and
value and an extremely weak negative correlation for enjoyment. The journal responses
appeared to tell a different story, so the real implications of this portion of the study would
require further examination of individual student results to reveal a possible explanation for these
weak correlations (e.g., student response “writing in a journal in math to explain how you feel
and what you are struggling with doesn’t really help; it is not improving your math skills”).

A major weakness with the correlation component stems from the fact that students who
like writing and dislike math (high metacognition low attitude score) may have seen improved
attitude while students who like math and dislike writing (low metacognition high attitude score)
may have seen a decline in attitude. A scatterplot that initially would have shown a negative
correlation between metacognition and attitude toward math (pre-journal writing) would tend
closer to a weak correlation (post-journal writing) with a value close to zero if attitudes of
students who initially liked math declined and students who initially disliked math improved while metacognition remained the same. This phenomenon may help to explain the weakness of all correlations (which would appear as a flat line of best fit on a scatterplot) between change in attitude and level of metacognition. A correlation under these circumstances would be conflicted and would not clearly support the research question relating change in attitude and metacognition for the entire class as a whole. It would be interesting to tease apart the data and analysis to identify and separate various subsets of the journal writing sample for comparison (e.g., student response “I think metacognitive writing in math helped me to realize why I had such a vivid dislike of math in the past, and helped me to realize I don’t mind it now. It can help you better understand your own learning style, and what works and what doesn’t work for you as an individual. It can lead you to realize the why’s behind your attitude.”)

Teacher observations, student comments and questions would indicate the need to look at the impact of ability/interest related to writing, gender related to sharing feelings, and engagement related to repeaters. Perhaps the results from these subsets might show that metacognition is positively related to attitude for certain subsets and negatively related to attitude for other subsets. For example students who like writing and dislike math initially may have seen a greater positive change in attitude when given the opportunity in math class to write metacognitively in journals. Further investigation of individual results that relate metacognition and attitude change may prove to be important evidence that promotes a more balanced approach to teaching mathematics that includes a variety of activities to support and challenge our students’ diverse learning needs.

The most significant finding of this study is the increased change in attitude related to value and importance of math of the journal writing group. In contrast to Jurdak & Zein’s (1998)
finding that journal writing had little impact on attitude, the results of the current study found that the valuing of math was found to be significantly affected by journal writing. The implications for this finding could mean less math avoidance behaviours and more students choosing math related careers. This study provided teachers with a strategy to slow or reverse the decline in value of mathematics that according to the literature (Feldlaufer et al., 1988; Simmons and Blyth, 1987) has seemed inevitable as students grow older. Further implications of this result, as identified by Ma (2006), is that students who value math more are more likely to choose math related coursework despite ability. Journal writing for this particular age group may be crucial since it is at the grade 10 level that students begin to choose math pathways that are based on careers (e.g., student responses “I find it frustrating that my worst subject is the one that I will the most needed in my future” “I have no idea what I would like to do as a career, so I think I better get good in math so that I’m prepared…” , “…many math topics have come into play in my work… you would not think right away that you would need math to work in culinary position”). We must be sensitive and consider the perceived importance and attitudes towards math of both parents and students, as these strongly influence course selection and career choices related to mathematics (Wiggan & Toronto Board of Education. Mathematics Dept, 1981).

Ma (2006) found attitude had a significant impact on participation in advanced math. An important follow up to this study would be to look at student course selection and work experience placements next year. Will more students from the journal writing group choose math related courses and careers? Ma also found “If a student believes not taking advanced math could close doors or limit choice they may chose to take further courses despite prior achievement”.
The implications of this study would lead educators to see the benefits to metacognitive journal writing on attitudes towards mathematics. The duration of the study was relatively short yet quantitative analysis yielded significant change in attitude related to value/importance. Although not reported in the findings of this research study, it was evident that qualitative analysis of student journal responses was an integral component of interpreting the results, recognizing limitations and directing future investigations. The journal process led the researcher to consider future discussions with colleagues as planning for new Math 10 courses is set to begin immediately. How we can effectively involve students more in course planning, improved collaboration and challenge existing beliefs in a respectful ways? The importance of including attitude journals into a regular math classroom has provided opportunities for students to not only feel valued but also value learning mathematics which may lead to better understanding of their role in developing and sustaining a positive climate that promotes math learning that consistently meets the needs of both the individual and the community. Student participation in journal writing and teacher incorporation of student strategies could lead to significant increases in the other attitudinal factors (enjoyment, self confidence and motivation) given more time, and ultimately yield a long term positive shift in societal attitude toward math?

Limitations and Weaknesses of the Study

As mentioned in the discussion, there are limitations related to the design, implementation and analysis of the study related to time, trust, relationships, and individual results. In an effort to control the influence the student-teacher relationship on attitude and the time constraints of semestered courses on building trust some of the weaknesses of the study were inevitable. A number of factors that could have influenced the results of the study such as equivalence of the samples, teacher, and time of the study were reduced.
One of the most crucial aspects of the success of journal writing is to cultivate trusting relationships that provide a foundation for honest and challenging responses. Trust is anchored by respect, personal regard, integrity and competence (Bryk & Schneider, 2002; Kaser & Halbert, 2009). The introduction of the journals occurred 3 weeks into the course and only lasted for 10 weeks. The researcher had never taught any of the students in the journal writing group prior to this course. In future it may be important to delay the introduction of the journal writing or reduce the frequency to allow the student and teacher to develop a more trusting relationship that encourages open and meaningful dialogue in the journals. This would be difficult in secondary schools with semestered courses which run for only 18 weeks. Despite the short time frame, the journals provided students an avenue to state their opinion and “talk” to their teacher in a safe anonymous way about topics not often discussed in a typical math classroom. Trusting relationships may have also been compromised when the researcher, who was asking students to be open and honest, withheld comments and scores on their journals in an effort to reduce the impact of relationship on the results (e.g., student response “I think the teacher/student relationship is very important. If you don’t like your teacher, you won’t want to work in their class or listen to what they have to say. You won’t want to respect them, especially if you feel that they have no respect for you”).

The choice of the researcher to provide descriptive feedback to the group rather than the individual seemed unnatural and impersonal. Although this choice was made to reduce the impact of relationship on attitude and allow students to remain anonymous Jurdak and Zein’s (1998) study identified student’s enjoyment of reading teacher feedback as a motivator for journal writing. Not providing feedback may have impacted student ability to improve metacognition and stay engaged in journal writing. Had students received rubric feedback/scores
and direct/specific researcher comments could they have gone deeper? Would students have benefited more from metacognitive journaling had the teacher posed questions to get students to explain thinking more clearly, explore past experiences more deeply and inquire about how strategies are working out? A general complaint of attitudinal research is that most has been exclusively anecdotal. Although the study was quantitative it was difficult to look at the resulting statistics without considering individual comments in student journals. Responding to the journals with descriptive feedback would have been more natural in a classroom setting and more beneficial to engage/motivate students who struggled with metacognition related to attitude, didn’t take journal writing seriously, or didn’t engage when it wasn’t for marks.

Another limitation of the study was adequate time for journal writing students to try, practice and improve their strategies. It was assumed by the researcher that students would not only develop new strategies, but they would actually try them. To hold students more accountable the researcher felt that students’ attitude may have benefited more if new journal prompts were less frequent and students were instead given time to discuss, share and comment on what they tried, how it went and where to next before responding to another prompt. The design of the study asked for honesty through anonymity but thereby limited the researcher’s ability to follow up on the use of these strategies.

A final limitation of the study was the impact of entire class results on the correlational analysis that looked at the relationship between level of metacognition and change in attitude. Despite the journal writing being anonymous it was evident through student comments and questions that gender, initial writing ability, and initial attitudes toward math could have a significant impact on the results when looked at individually. General observations, on journal writing days, made by the researcher would indicate distinct subsets within the class. Each of
these subsets seemed to respond to and be impacted by journal writing quite differently. Female students appeared to be more comfortable and interested in sharing their feelings and seemed to enjoy journal writing. Students who identify themselves with the arts or humanities also enjoyed journal writing and rejoiced in reduced math assignments. Students who liked math repeatedly complained and were reluctant to complete the journals since they already had a positive attitude. Although the journals were about student thoughts/ideas and not about grammar or punctuation, students who complained of poor writing skills struggled with journals. Before dismissing the resulting weak correlations it might be useful to look at the relationship of metacognition and change in attitude for each of the subsets. It would appear that analyzing each student individually would show if certain subsets of students benefit from journal writing rather than lumping all results together. It would be important to discover how gender, doing less math, writing ability, repeating the course, or initial attitude affected the results. Using a variety of journal prompts next time that extend beyond attitudinal to relate to specific math related problems may have provided a balance that would have engaged those students who already liked math.

Recommendations for Further Study

Student journal responses and attitude surveys from the current study would indicate the need for teachers to take action to improve student enjoyment, motivation, confidence and value of math. Students with more positive attitudes may choose more math related courses and careers. Building a math culture that includes positive attitudes toward life-long learning could be encouraged by journaling that helps students become more aware of their attitude and take personal responsibility for it’s development. As students discover the importance of math in their own lives, they become more motivated to learn, can build self confidence, and ultimately
enjoy mathematics. The following recommendations for further study would build on the findings of the current study on metacognition, journaling and attitudes toward math.

The researcher would recommend journal writing be implemented as a regular part of all secondary math classes. The role of student attitude could prove to be more of a factor as we implement the new curriculum that emphasizes student engagement, understanding, and life/career preparation in September 2010 for grade 10. Successful integration of changes related to curriculum, assessment and teaching/learning theories could benefit from student feedback through journals. The information students provide to their teachers could help to direct teachers toward more effective instruction that would help to further improve student attitudes. The journal prompts could relate to a variety of topics which include but are not limited to improving attitudes, achievement, and understanding of mathematics. Journal prompts could require students to state their opinion of the effectiveness of a new strategy the teacher tried in class, communicate with the teacher about what they are struggling with, explain in detail a problem assigned in class, or share an example of how math is used by a career they are interested in.

The researcher would also recommend using journals for further study into the impact of the teacher-student relationship on attitude toward math. Borasi and Rose (1989) recognized the importance of journals to help teachers recognize student weakness, seek appropriate remediation and provide a supportive environment (e.g., student response “Having a teacher that respects students who are slower while still giving faster students a challenge is hard to come by, but when I do have such a teacher, I flourish, and it gives me a new, more positive outlook on math… If a teacher manages to incorporate many learning styles into their teaching, then most students in the class will excel”).
Midgely, Feldlaufer, and Eccles (1989) found that students benefitted from teachers who were perceived to be supportive. More personal relationships could be fostered with students through dialogue and descriptive feedback in journals. Opportunities for involvement in course planning through journaling that solicits student discussions, opinions and suggestions could help teachers show they care by responding to student needs. A more understanding, supportive classroom environment built upon stronger teacher-student relationships focused on learning could result. Through journaling, teachers could engage in meaningful conversations with students to build relationships that help to improve understanding and attitudes towards math.

A third recommendation by the researcher for further study would be to repeat the current study, but with additional time for students to share and discuss their journal responses with each other. Students may feel more comfortable sharing with peers and may find suggestions from peers to be more creative, interesting and realistic than those shared with their teacher. Students may also find that working with a partner provides them with additional support and holds them more accountable to implement their strategy, assess its effectiveness and adapt the strategy as needed. This study would be consistent with current research related to assessment for learning (AFL) principles that encourage students to own their learning (Black & Wiliam, 2006; Kaser & Halbert, 2009). Journaling provides increased opportunities for engaging conversations with peers about attitude which incorporate metacognition, self/peer assessment, reflection, descriptive feedback, student ownership, and challenging questions. The opportunity for students to use metacognitive journaling and collaboration with their peers to develop a more positive attitude toward math will help them learn to embrace challenges, seek/provide support and skillfully adapt to upcoming changes in their lives.
The final recommendation by the researcher would involve a follow-up study of each of the participants involved in the current study that would look at achievement, math related course/career selection, and student participation/engagement in class. This would require permission from the participants to allow the researcher to obtain more data to analyze along with the results of the current study. The researcher was curious to determine whether the improved attitude related to value had any impact on increased participation or achievement in math. The researcher would like to compare attendance/extra help records, provincial exam results, grade 11 course selection, and work experience placements for both the journal writing and non-journal writing groups. What did student attendance look like during or after the completion of the study? How do student averages and provincial exam results compare? Did taking time out for journaling have any impact on achievement? The researcher also has access to records that kept track of student extra help visits for each group during the study. The impact of metacognitive journaling and improved attitude related to value of math may have had additional impacts not measured or reported in the current study. These other factors such as participation and achievement are important when looking at long term effects and contributing to a body of evidence that supports journaling.

From theory, research and experience we continue to understand the importance of positive attitudes toward math. As students develop more positive attitudes toward math, we hope to see increased motivation, enjoyment, relevance, and confidence through student attitude surveys. We hope to see avoidant/negative behaviours (skipping, excuses, incomplete work) replaced by engaged/positive behaviours (participation, questions, quality work). We hope to read student journals on coursework and attitude that display metacognition (awareness, reflection and development), inquiry, and self-assessment. We hope to see projects that exhibit
creativity, cross curricular connections and deeper mathematical thinking. Journals could provide the catalyst to help students engage in conversations with educational partners (including themselves) and take responsibility for their choices. Students will think about, talk about and do further research on how math will impact their future. As learning and attitude improves we hope to see students choosing more math courses than are required for graduation and subsequently choosing careers that require math. Students must realize it is no longer acceptable to say “I can’t do math”. We will no longer perpetuate the negative stereotypes and phrases that haunt math, we will instead hear phrases like: “I am going to use math everywhere!”, “Math is exciting, interesting and dynamic!” Collaboration and inquiry will become the norm as sharing grows, attitude improves and learning that transforms math education for all.

Conclusion

This study began as an investigation into whether metacognitive journaling could help students improve their attitudes toward math. What resulted was an experience that provided the researcher with valuable information related to teacher and student learning. Overall, students who experienced journal writing took responsibility for their attitude and were able to develop some useful strategies that may have led to their improved attitude related to valuing of math. A greater understanding of the role of journaling, metacognition and attitudes related to math will be an integral part of the researcher’s planning and implementation of the new secondary math program. To improve student learning, thinking and attitudes toward math, the new program emphasizes the role of current research related to literacy across the curriculum, assessment for learning, career skills, personal needs, cognition and affect.

Long term societal attitudes toward math can improve when more students see relevance, are motivated, gain confidence and can enjoy math. Further research into the impacts of
metacognitive journaling on attitudes that focuses on growth through inquiry, collaboration, and professional learning responsive to student needs is required. Engaging some students in math requires peeling away years of negative feelings through communication that links current thinking (awareness) to the past (reflection) and the future (development). Journals could be a creative and versatile tool to promote positive attitudes and success for all partners in math education through meaningful learning experiences. Student course selection in British Columbia will be related to career pathways this fall, which requires students to see the importance and value in mathematics now to ensure doors are not closed prematurely. Increased participation and understanding of math is needed since our students will be expected to think mathematically as they seek evidence (data and observations), make connections and apply diverse strategies, to address challenges linked to environmental, economic, and social needs of our complex world. As teachers we are morally obligated to provide opportunities that help individuals realize that they can be successful in math and that math is an important part of everyday life.
References


http://wordnetweb.princeton.edu/perl/webwn?s=attitude


Norton.


http://www.journeytoexcellence.org/practice/assessment/glossary.phtml


Appendix A:

Journal Prompts

Instructions: Students will be encouraged to think about the definitions of math attitude
(emotion, ability, importance / value and behaviour) and metacognition
(awareness, reflection development) as they respond to each journal prompt.

Refer to Describing Attitude and Metacognition – handout kept at the front of their journal.

PROMPT A_______________________________________________________

1. To prepare for a classroom debate, provide arguments for each of the following statements. Support your arguments with specific examples, experiences and observations you have made over the years.

<table>
<thead>
<tr>
<th>“Boys are better at math.”</th>
<th>“Girls are better at math.”</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. What do you really believe? Who is better at math, boys or girls?

3. What do boys need to improve their ability and attitude in math?

4. What do girls need to improve their ability and attitude in math?

PROMPT B_______________________________________________________

1. Write your own math autobiography (discuss your attitude, confidence, achievement, ability, likes, dislikes, activities…). Ensure your story covers your math experiences both in and out of school over your entire life.

2. Extend your story to cover your math experiences as an adult (discuss the role(s) that math will play in your future).

3. Give your math attitude an extreme math makeover / overhaul. What would it look like? What parts of your math attitude need to be reduced? Re-used? Recycled?
PROMPT C

You have been asked to provide feedback to the local college committee that is responsible for creating programs to train future math teachers. (Please do not include any names in your descriptions)

1. Briefly describe what you feel are the characteristics (personality, classroom strategies and activities) of a “good” math teacher.

2. Briefly describe what you feel are the characteristics (personality, classroom strategies and activities) of a “bad” math teacher.

3. Create 3 interview questions that you would like your principal to ask when hiring a new math teacher. Provide detailed responses you would expect to hear from the “perfect” math teacher.

4. Besides the teacher, what other resources have you or could you use to help you when you are struggling in math.

PROMPT D

You are asked to design a poster to promote the movie “High School Math-ical?”

1. Your poster should include examples of positive and negative images (pictures), phrases and stereotypes related to math.

   (note: ensure the poster has a balance of both negative and positive)

2. Choose one negative image or phrase that relates directly to your life and describe how you plan to look at it more positively in the future.
PROMPT E

1. List 5 jobs that you are interested in pursuing. For each job
   a) Explain why you are interested in this job.
   b) Describe how math is used in this job.

2. List 5 jobs that use a lot of math (do not include any jobs listed in #1) and have a significant impact on your everyday life.
   For each job
   a) Explain how this job impacts your everyday life.
   b) Describe how math is used in this job.

3. What training (courses, experiences, skills, grade levels, grade…) related to math do you plan on getting to ensure you are qualified to do each of the jobs you listed in #1.

PROMPT F

1. How do you feel about your ability in math?

2. Are you happy with your current grade in math? Why or why not? Reflect on your work habits and strategies you’ve used.

3. a) If you are happy with your current grade, in what ways do you feel you earned this grade? (List at least 3 ways)

   b) If you are unhappy, how can you reach the grade you would like to see? (List at least 3 goals to help you improve)

PROMPT G

Complete each sentence.

1. I enjoy math the most … (create a top 3 list)

2. I would enjoy math even more if… (create a top 3 list)

3. I don’t enjoy math … (create a top 3 list)

4. Math would be more interesting if… (create a top 3 list)

5. Create a brief lesson plan (activity? Game? Project?) that would make learning measurement (Ch. 1: perimeter, area, surface area, and volume) more fun (enjoyable)…
PROMPT H

Imagine you are interviewing your parents regarding their attitudes toward math.

1. Create 5 questions you would ask your parents / guardians about their attitudes toward math (relevance, motivation, interest, abilities, importance, …)
2. Answer each of the 5 questions you created in #1 above as you think your parents / guardians would.
4. How could your parents / guardians help you to further improve your math attitude.

PROMPT I

You are the math doctor!

1. Describe some of the main causes of math anxiety in students.
2. Describe some of the symptoms of math anxiety in students.
3. Prescribe some treatments you would recommend to students to deal with their math anxiety.
4. Have you ever experienced math anxiety? How did you deal with it? (or How would you deal with it?)
PROMPT J

Please see below for some strategies used in the classroom. Please feel free to add / include any strategies that are not in the list.

1. Choose 3 strategies that WOULD motivate you to do math? Explain.

2. Choose 3 strategies that WOULD NOT motivate you to do math? Explain.

3. Choose 3 strategies that WOULD help you learn math concepts. Explain.

4. Choose 3 strategies that WOULD NOT help you to learn math concepts. Explain

Classroom Strategies to Consider:

a) play games or activities
b) introduce math magic, number tricks and math trivia
c) include math trivia
d) text questions / worksheets
e) work in groups (discuss with classmates)
f) write in mathematics (journals, explaining your thinking)
g) do projects
h) use technology
i) math language and terminology focus
j) locating and explaining errors in “solutions”
k) teacher going over examples on board
I) use drawing or diagrams to explain concepts
m) memorize facts and rules
n) use hands on manipulatives (algebra tiles, blocks, compass…)
o) writing quizzes and tests
p) creating study tools (cheat sheets, webs, study cards…)
q) research in math (careers, history, individuals…)
PROMPT K

Please see below for some topics in a typical math class
When answering the questions below be sure to discuss your math strengths and weaknesses.

1. Choose one of the following topics in math that you found hard.
   Why was it hard? Write about a specific time when you were really confused in math class. What did you do? Who did you get help from?

2. Choose one of the following topics in math that you found easy.
   Why was it easy?

Topics in a typical math class:

- Fractions
- Problem Solving
- Trigonometry
- Measurement
- Probability
- Graphing
- Integers
- Factoring
- Algebra
- Geometry
- Tables

PROMPT L

“Chicken soup for the math soul”

1. Using your own personal experiences and observations, create a dialogue / play between 2 friends who are discussing confidence in math. One student, “Connie”, is math confident and the other student, “Les”, is not math confident. Your dialogue should include 10 statements (5 for Connie and 5 for Les) that clearly identify each student’s confidence in math (Include statements about attitude, content, work habits, abilities, achievement, effort, successes, failures, strategies for both students.) The dialogue should demonstrate how Connie tries to support and help build Les’ math confidence.

   For example:

   Les: “I will never be good at math no matter how hard I try!”

   Connie: “I used to believe that but since I started asking more question’s in class, I find that I understand math better.”

2. Which student do you feel most resembles your level of confidence. Why?

3. Pick two of Connies statements that you feel would be most effective to improve your confidence. Explain your choices.
PROMPT M

1. Do you think metacognitive journal writing has helped to improve your attitude toward math? Explain why or why not.

2. What were the benefits to metacognitive journal writing in math?

3. How could metacognitive journal writing be changed to be more effective in math?

4. Create 2 journal prompts that you would like to respond to.

5. Briefly respond to the 2 journal prompts you created in #4.
Appendix B:

DESCRIPTING ATTITUDE AND METACOGNITION

DEFINING A MATH ATTITUDE?

Emotion:  
\[ \text{I dislike math} \quad \text{to} \quad \text{I like math.} \]

Belief:  
\[ \text{I can’t do math} \quad \text{to} \quad \text{I can do math.} \]  (ability focus)
\[ \text{Math is not important} \quad \text{to} \quad \text{Math is important.} \]  (value / importance focus)

Behavior:  
\[ \text{I avoid (am not motivated) to do math} \quad \text{to} \quad \text{I engage (am motivated) to do math.} \]

THINKING / WRITING METACOGNITIVELY - GUIDING QUESTIONS

Metacognitive journaling will be introduced to the students as a series of questions they need to consider. Have students consider the following questions when forming their journal response.

Awareness:  
1) Why do you think (or behave) this way?
2) When did you start thinking (or behaving) this way?
3) What prior experiences led to this way of thinking (or behaving)?
4) Who were the individuals that influenced this way of thinking (or behaving)?
5) Where did this thinking (or behaving) come from?

Reflection:  
6) How has this way of thinking (or behaving) affected you now?
7) What strategies have you used in the past that were
   a) successful? \quad b) unsuccessful?
8) What strategies have you observed that others have used that were
   a) successful? \quad b) unsuccessful?

Development  
9) What ways could you modify or adapt this way of thinking (or behaviour) so you can improve your attitude towards math?
10) What experiences could you draw from the past or the present that could help you improve your attitude towards math?
11) How likely do you think you will be to try your new strategies in the future?
12) How successful do you think these new strategies will be in improving your attitude toward math?
Appendix C:

Metacognition Rubric

Refer to “Describing Attitude and Metacognition” handout for further descriptions

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>EXPECTATIONS</th>
<th>AWARENESS</th>
<th>REFLECTION</th>
<th>DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No evidence of meeting</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is missing.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is missing.</td>
<td>Development of a future plan to improve math attitude is missing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are not described.</td>
<td>Affects of these strategies are not explained.</td>
<td>Likelihood of implementation and predicted success of this plan is not discussed.</td>
</tr>
<tr>
<td>1</td>
<td>Not yet Meeting</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is vague.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is vague.</td>
<td>Development of a future plan to improve math attitude is vague and / or unrealistic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are not connected to attitude description.</td>
<td>Affects of these strategies are not clearly explained nor supported with specific examples.</td>
<td>Likelihood of implementation and predicted success of this plan is not clearly discussed.</td>
</tr>
<tr>
<td>2</td>
<td>Minimally Meeting</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is acceptable.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is acceptable</td>
<td>Development of a future plan to improve math attitude is acceptable and /or realistic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are weakly connected to attitude description.</td>
<td>Affects of these strategies are briefly explained and weakly supported with specific examples.</td>
<td>Likelihood of implementation and predicted success of this plan is briefly discussed.</td>
</tr>
<tr>
<td>LEVEL</td>
<td>EXPECTATIONS</td>
<td>AWARENESS</td>
<td>REFLECTION</td>
<td>DEVELOPMENT</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>3</td>
<td>Meeting</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is evident.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is evident.</td>
<td>Development of a future plan to improve math attitude is evident and realistic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are connected to attitude description.</td>
<td>Affects of these strategies are explained and supported with specific examples.</td>
<td>Likelihood of implementation and predicted success of this plan is discussed.</td>
</tr>
<tr>
<td>4</td>
<td>Exceeding</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is detailed.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is detailed.</td>
<td>Development of a future plan to improve math attitude is detailed and realistic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are strongly connected to attitude description.</td>
<td>Affects of these strategies are clearly explained and strongly supported with specific examples.</td>
<td>Likelihood of implementation and predicted success of this plan is clearly discussed.</td>
</tr>
<tr>
<td>5</td>
<td>Extensively Exceeding</td>
<td>Awareness of current math attitude (emotions, beliefs, and behaviour) is comprehensive and beyond expectations.</td>
<td>Reflection on past strategies (successful and unsuccessful) used or observed in math is comprehensive and beyond expectations.</td>
<td>Development of a future plan to improve math attitude is comprehensive, realistic and beyond expectations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influences and prior experiences are deeply connected to attitude description.</td>
<td>Affects of these strategies are clearly explained and strongly supported with specific examples. Deeper understanding is evident.</td>
<td>Likelihood of implementation and predicted success of this plan is clearly discussed. Real commitment is evident.</td>
</tr>
</tbody>
</table>

LEVEL OF METACOGNITION SCORE: ______  (MINIMUM - 0 to Maximum - 15)
**Appendix D:**

**ATTITUDES TOWARD MATHEMATICS INVENTORY (ATMI) © Martha Tapia 1996**

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the response that most closely corresponds to how the statements best describes your feelings.

<table>
<thead>
<tr>
<th>1</th>
<th>Mathematics is a very worthwhile and necessary subject.</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>I want to develop my mathematical skills.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>3</td>
<td>I get a great deal of satisfaction out of solving a mathematics problem.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>4</td>
<td>Mathematics helps develop the mind and teaches a person to think.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>5</td>
<td>Mathematics is important in everyday life.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>6</td>
<td>Mathematics is one of the most important subjects for people to study.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>7</td>
<td>High school math courses would be very helpful no matter what I decide to study.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>8</td>
<td>I can think of many ways that I use math outside of school.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>9</td>
<td>Mathematics is one of my most dreaded subjects.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>10</td>
<td>My mind goes blank and I am unable to think clearly when working with mathematics.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>11</td>
<td>Studying mathematics makes me feel nervous.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>12</td>
<td>Mathematics makes me feel uncomfortable.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Item</td>
<td>Statement</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>------</td>
<td>--------------------------------------------------------------------------</td>
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<td>---------</td>
<td>-------</td>
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</tr>
<tr>
<td>13</td>
<td>I am always under a terrible strain in a math class.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>14</td>
<td>When I hear the word mathematics, I have a feeling of dislike.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>15</td>
<td>It makes me nervous to even think about having to do a mathematics problem.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>16</td>
<td>Mathematics does not scare me at all.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>17</td>
<td>I have a lot of self-confidence when it comes to mathematics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>18</td>
<td>I am able to solve mathematics problems without too much difficulty.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>I expect to do fairly well in any math class I take.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>20</td>
<td>I am always confused in my mathematics class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>I feel a sense of insecurity when attempting mathematics.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>22</td>
<td>I learn mathematics easily.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>I am confident that I could learn advanced mathematics.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>24</td>
<td>I have usually enjoyed studying mathematics in school.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>25</td>
<td>Mathematics is dull and boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>26</td>
<td>I like to solve new problems in mathematics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Statement</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
<td>Agree</td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>27</td>
<td>I would prefer to do an assignment in math than to write an essay.</td>
<td></td>
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</tr>
<tr>
<td>28</td>
<td>I would like to avoid using mathematics in college.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>29</td>
<td>I really like mathematics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>I am happier in a math class than in any other class.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>31</td>
<td>Mathematics is a very interesting subject.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>32</td>
<td>I am willing to take more than the required amount of mathematics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>I plan to take as much mathematics as I can during my education.</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>34</td>
<td>The challenge of math appeals to me.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>35</td>
<td>I think studying advanced mathematics is useful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>I believe studying math helps me with problem solving in other areas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>I am comfortable answering questions in math class.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>A strong math background could help me in my professional life.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>I believe I am good at solving math problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note: Permission to use the ATTITUDE TOWARD MATHEMATICS INVENTORY (ATMI), was obtained from its author, Martha Tapia, by email on February 23, 2009

Subject: RE: obtaining permission to use ATMI?
From: "Tapia, Martha" <mtapia@berry.edu>
Date: Monday, February 23, 2009 3:09 pm
To: KIM MURCHESON <murcheson@shaw.ca>

Dear Kim,

I am attaching the file of the Attitudes Toward Mathematics Inventory (ATMI). Hope you find it useful. If you decide to use it, please let me know. If you have any questions, do not hesitate to ask me.

Sincerely,

Martha Tapia

Martha Tapia, Ph.D.
Associate Professor
Department of Mathematics and Computer Science
Berry College
P.O. Box 495014
Mount. Berry, Georgia 30149-5014
Appendix E:

TEACHER JOURNAL - OBSERVATIONS PAGE

Each day a journal prompt is given to students the teacher will record the following observations. All journal writing occurred in a computer lab.

METACOGNITIVE JOURNALING: WEEK #: ____ DATE: _______ LAB: ____

ALLOTED CLASS TIME: START: _______ END: ______

ABSENT STUDENT(S):    DATE PROMPT ACTUALLY WRITTEN:

__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________
__________________________________  ____________________________________

TEACHER INSTRUCTIONS:

• Recommend students use the computer to complete their response.
• Write your student number (not your name) on your journal response.
• Writing format in journals entries is very flexible and can include: sentences, point form, diagrams, tables, comments, questions, quotes, stories,…
• While clear communication of your level of metacognition is emphasized, your grammar and sentence structure is not emphasized.
• Encourage students to refer to Defining Attitudes and Metacognition handout and the metacognitive journal rubric at the front of their journal.
• In consideration of others please do not include specific names of individuals.
Teacher provided students the journal prompt on paper, and then read it out loud:

```

```

- Contributing Factor to Attitude addressed in this prompt: ___________________
  * Students were not told which factor was specifically being addressed.

- Students were permitted time to ask the teacher for clarification.

- Student comments / questions and teacher answers / responses were recorded below.

<table>
<thead>
<tr>
<th>STUDENT COMMENT / QUESTION</th>
<th>TEACHER RESPONSE / ANSWER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

- Hand in journal page (reminder: include student number not name on response)
- Put journal page in journal after level of metacognition has been assessed by teacher
Appendix F:

DEMOGRAPHIC SURVEY

- Please do not identify yourself. The information on this survey is only used to look at the overall class, not the individual.

Course: **Math 10 Applied**

Please CIRCLE the choice that applies to you:

<table>
<thead>
<tr>
<th>1) Blocks:</th>
<th>_<em><strong>/</strong></em></th>
<th>_<em><strong>/</strong></em></th>
</tr>
</thead>
<tbody>
<tr>
<td>2) Gender:</td>
<td>FEMALE</td>
<td>MALE</td>
</tr>
<tr>
<td>3) Current Age</td>
<td>Year:</td>
<td>Months:</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>0 1</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>2 3</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>4 5</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>6 7</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>8 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 11</td>
</tr>
<tr>
<td>4) What was your grade in Math 9?</td>
<td>A  B  C+</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C  C- F</td>
<td></td>
</tr>
<tr>
<td>5) Have you taken Math 10 Essentials before taking this class?</td>
<td>YES  NO</td>
<td></td>
</tr>
<tr>
<td>6) Have you taken Math 10 Applied before taking this class?</td>
<td>YES  NO</td>
<td></td>
</tr>
<tr>
<td>7) Have you taken Math 10 Principles before taking this class?</td>
<td>YES  NO</td>
<td></td>
</tr>
<tr>
<td>8) Have you worked with Learning Assistance on Math 10 Applied at all this term?</td>
<td>YES  NO</td>
<td></td>
</tr>
<tr>
<td>9) Have you worked with Opportunities on Math 10 Applied at all this term?</td>
<td>YES  NO</td>
<td></td>
</tr>
</tbody>
</table>
Appendix G:

EDUCATIONAL RESEARCH CONSENT FORM

"IMPACT OF METACOGNITIVE JOURNAL WRITING ON STUDENT ATTITUDE TOWARDS MATHEMATICS"

September, 2009

Kim Murcheson, Researcher
Masters of Educational Leadership Student
Vancouver Island University
(250) 334-2428
Kim.Murcheson@sd71.bc.ca

Harry Janzen, Ph.D., Supervisor
Department of Education
Vancouver Island University
(250) 740-6220
Harry.Janzen@viu.ca

I am a Masters of Educational Leadership student at Vancouver Island University (VIU) and Math teacher at Mark R. Isfeld Secondary School. Under the supervision of Dr. Janzen, Dean of the Department of Education at VIU, I am studying the affects of journal writing on student attitudes toward mathematics.

This study includes students in both Applications of Math 10 classes that I teach. At the beginning of the course, you will complete an “attitude towards math” survey. Over the next 10 weeks, one class will write in journals and the other class will not. I will ask students in the journal writing class to respond to a question or comment related to their math attitude. Each journal entry should take 20 to 30 minutes each week. Both classes will cover the same material and will be graded the same way. At the end of the ten weeks you will complete the math attitude survey again, and a survey that will provide information related to gender, student support, past grades, and age.

A possible harm related to participating in this study is the negative feelings or experiences you may have when journal writing about your math attitude. If you are struggling with any of your journal entries I encourage you to talk with someone you trust. I will also provide contact information for student services offered at Mark Isfeld Secondary School. A possible benefit of writing in journals is that you may better understand and develop ways to improve your attitude toward math. Information gained from this research may also help me better understand your attitude toward math, develop better ways to help you learn math, and create a more supportive classroom for you in the future.

All records of participation will be kept strictly confidential, only the supervisor and I will have access to the information. I will make the final results from this study available to you and your parents upon its completion (July 2010). I will shred or electronically erase all data collected during the study, two years after its completion (July 2012).
Your participation is completely voluntary. You may decide to withdraw your participation at any time and it will not affect your present or future status at Mark R. Isfeld Secondary School. If you choose not to participate in the study you will continue to complete the surveys and journal writing as a regular part of math class, but you will not have any of your data included in my final report.

I will share the results from this study in a written report and at a public presentation as required by Vancouver Island University (July 2010). I may also share the findings with other interested parties which could include teachers, parents, administrators and ministry of education staff, in the province of British Columbia. Information about the project that is made public will not identify you in any way.

**STUDENT CONSENT**

I have read the above form, understand the information read, understand that I can ask questions or withdraw my participation at any time. I have also been given a copy of this consent form.

__________________ would like to participate in this educational research study. If you would like to reach me at any point during the study, I prefer to be contacted by email at Kim.Murcheson@sd71.bc.ca

<table>
<thead>
<tr>
<th>Student / Participant signature</th>
<th>Date</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Teacher / Researcher signature</th>
<th>Date</th>
</tr>
</thead>
</table>
EDUCATIONAL DEBRIEFING FORM

“IMPACT OF METACOGNITIVE JOURNAL WRITING ON STUDENT ATTITUDE TOWARDS MATHEMATICS”

September, 2009

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During this study, students in two Applications of Math 10 classes taught by the researcher completed the same survey at the beginning and again at the end of the 10 week study to assess their individual change in attitude (self-confidence, motivation, value and enjoyment) toward math. Students also completed a demographic survey. In addition to the surveys, one of the classes participated in weekly metacognitive (awareness, reflection, development) journal writing during the 10 week study. Students were asked to respond to journal prompts related to factors that may influence their attitude towards math. These factors included self-confidence, anxiety, value (relevance), enjoyment, nature of mathematics, parent influence, teacher influence, motivation, gender bias, and achievement (Wiggan & Toronto Board of Education Mathematics Dept., 1981). The purpose of this study was to determine whether metacognitive journaling had any effect on improving secondary student attitudes toward mathematics, if an affect was found was the change in attitude related to writing metacognitively? It was hypothesized that, if found effective, the implementation of journal writing to promote metacognitive thinking would be recommended for regular use in secondary school classrooms to help students understand and develop more positive attitudes toward math.

In a recent study by Ma (2006) attitude toward math had the greatest impact on student's participation in advanced math courses and careers. Ma also suggested that if students perceive math to be important they may not avoid it in the future, despite prior achievement. Students with positive attitudes consistently show improved math performance, and exhibit less math avoidance behaviours (Hembree, 1990; Wiggan et al., 1981). Math avoidance behaviors include asking fewer questions in class, paying less attention in class, spending less time on homework and trading accuracy for speed (Berch & Mazocco, 2007).

Students who are encouraged, through writing, to activate prior knowledge and put situations in context are more motivated to learn (Winstead, 2004). They also have increased ability to process, learn and store new information. A study by Borasi and Rose (1989) found that "As the students write in the journals, they can be encouraged to express and reflect upon their feelings, knowledge, processes and beliefs about mathematics, and consequently grow along each of these dimensions." (p. 347). Students may feel empowered to deal with their emotional stress related to mathematics in a more effective way in the future. The same study by Borasi and Rose also
suggested that the process of journal writing helped teachers develop a more understanding, supportive relationship with their students through communication that extended beyond course content to how students were thinking and feeling about math.

If you would like more information on the issues related to this study, please see the attached list of references. Articles can be found through an online search using google.ca, at Vancouver Island University Library (Nanaimo) or from the researcher upon request ((250) 334-2428 or Kim.Murcheson@sd71.bc.ca). Books can be purchased online from Amazon.com or can be found at Vancouver Island University Library (Nanaimo).

If you are interested in the results of this study, you may contact Dr. Harry Janzen ((250) 740-6220 or Harry.Janzen@viu.ca) or Kim Murcheson ((250) 334-2428 or Kim.Murcheson@sd71.bc.ca) at the completion of this study (July 2010). Please note that only overall (group) results, not individual results will be shared. Information about the research study that is made public will not in any way identify any of the individual student participants.

If you have any questions, concerns or comments about this study please contact Dr. Harry Janzen ((250) 740-6220 or Harry.Janzen@viu.ca) or Kim Murcheson ((250) 334-2428 or Kim.Murcheson@sd71.bc.ca).

Thank you for your participation.
Respectfully yours,

Kim Murcheson