University of Nebraska - Lincoln

DigitalCommons@University of Nebraska - Lincoln

Summative Projects for MA Degree

Math in the Middle Institute Partnership

7-2006

Factors that Influence Mathematics Attitudes

Natalie Jenkins
Gering, Nebraska

Factors that Influence Mathematics Attitudes

Natalie Jenkins
Gering, Nebraska

A report on an action research project submitted in partial fulfillment of the requirements for Master of Arts in the Department of Teaching, Learning and Teacher Education, University of Nebraska-Lincoln.

Ruth Heaton, Advisor

July 2006

Factors that Influence Mathematics Attitudes

ABSTRACT

In this action research study conducted within my sixth grade High Ability Learner (HAL) classroom, I investigated the current mathematics attitudes of my students and how these attitudes correlated to personal mathematics achievement and identified intelligence domains. I discovered that most of my nineteen students held a negative attitude toward the subject of mathematics. Consistent low ratings were also found in the logical/mathematical domain of most of my students' ALPS Multiple Intelligence Profiles. Regardless of this dominant affective data (indicating little mathematics interest or potential from student perspectives) surprisingly, most of my sixth grade HAL students scored above the 90th percentile on the mathematics portion of their most recent Terra Nova nationalized testing report. As a result of this action research, I clearly see the need for gifted students to be shown important connections between mathematics and its utility outside the context of school academia. By supplementing our school's gifted education curriculum with activities that actively engage students in mathematical interpretation and creative problem solving, I hope to nurture an intrinsic interest in mathematics as a vital part of my students' overall development.

It can be a daunting task attempting to motivate students who have attained high levels of academic success without having to exert a great deal of personal effort to achieve it. I am referring to the art of teaching our gifted population, those brilliant few who have been blessed with intellectual abilities exceeding the norm. Having been the High Ability Learning Coordinator for my school district for five years, I have faced this challenge on a daily basis. Continually, I have been amazed by the incredible potential lying within my students' thought patterns, but at the same time have been puzzled by their negative attitudes and lack of desire, especially with regard to the subject of mathematics. The purpose of this action research study performed within my High Ability Learner (HAL) classroom was to investigate the current mathematics attitudes of my nineteen sixth grade HAL students and how these attitudes correlate with personal mathematics achievement and identified intelligence domains. It was my aim as an action researcher to better understand why my students might feel the way they do about mathematics and help them begin to enjoy mathematics as a relevant and important part of their daily lives.

Problem of Practice

Many of my sixth grade HAL students outwardly expressed a dislike for mathematics. Many also attained a lower level of achievement in Terra Nova mathematics scores as compared to their respective overall composite scores. During HAL sessions in my classroom, students generally did not perform mathematical skills at the high level they performed in other areas of the curriculum such as language, science, and technology. Ideally, I wanted my HAL students to like mathematics the way I did, and claim it as a personal area of strength. Furthermore, I wanted to see the Terra Nova mathematics scores of my HAL students consistently equal to or higher than their respective Terra Nova composite scores. Therefore, my action research study was an inquiry into the mathematics attitudes of my students including a better understanding of how and why these attitudes may have been formed. Through my action research, I strove to find possible connections between mathematics attitudes and such things as student-teacher relationships, teaching methods, educational values held by the family and community, home environment, presence (or lack of) a positive role model, selective interest in other areas of the curriculum, a student's innate character, and/or his or her identified intelligence domains.

Through the use of student attitude scales, journal entries, and personal interviews, I hoped to draw conclusions as to what factors may have formed the current mathematics attitudes of my HAL students. These factors were worth knowing for several reasons. First of all, they were valuable to know for my own teaching so that I could implement effective methods for fostering positive mathematics attitudes, rather than negative ones. They were also important to identify so that I could inform and counsel parents as to effective ways of building mathematical awareness within the home environment. Most importantly, the results of my action research were important to identify so that other teachers in my district, state, and nation could adapt and improve their current teaching pedagogies accordingly.

Literature Review

At the core of my teaching philosophy was the belief that genuine learning was a personalized phenomenon as unique as an individual's intrinsic character. Every learner, I believed, must engage his or her distinctive cognitive preferences in order to draw meaning from new information. Authentic learning experiences of this type manifested themselves in various forms according to each learner's mental and psychological aptitudes. Author Howard Gardner of Harvard University supported this viewpoint in the second edition of his book entitled Frames of Mind: The Theory of Multiple Intelligences. Gardner's work, focusing on what he termed as "multiple intelligences," had had a profound impact on educational practices, particularly in the United States. The basis of his personal educational philosophy was this:

> *I want my children to understand the world, but not just because the world is fascinating and the human mind is curious. I want them to understand it so that they will be positioned to make it a better place. Knowledge is not the same as morality, but we need to understand if we are to avoid past mistakes and move in productive directions. An important part of that understanding is knowing who we are and what we can do. Ultimately, we must synthesize our understandings for ourselves. The performance of understanding that truly matters are the ones we carry out as human beings in an imperfect world which we can affect for good or for ill* (1993, p. 180-181).

Before Gardner's research, many people believed intelligence was a single inherited entity. Furthermore, it was thought that human beings were born with a blank slate and could be trained to learn anything, provided it was presented in an appropriate way. Now, however, researchers are more convinced that the complex capabilities of the brain cannot be measured accurately by traditional IQ tests. In fact, Gardner's theory described a total of eight distinct intelligences that were quite independent of each other and possessed their own strengths and constraints. He also suggested that the human mind was far from unencumbered at birth and would experience difficulty if attempting to learn concepts outside personal areas of intelligence, which he referred to as "intelligence domains" (Gardner, 1993).

Howard Gardner's eight multiple intelligence domains are described below. The first two have been typically valued in schools, the latter being the logical/mathematical intelligence category that directly relates to the major focus of this action research. The next three are commonly associated with the arts; the next two are what Gardner termed "personal intelligences"; and the final category refers to nature awareness (Gardner, 1993).

> ***(1) Verbal/linguistic intelligence*** *involves sensitivity to spoken and written language, the ability to learn languages, and the capacity to use language to accomplish certain goals. This intelligence includes the ability to effectively use language to express oneself; and language as a means to remember information. Writers, poets, lawyers, and speakers are*

among those that Howard Gardner sees as having high linguistic intelligence (1993, p. 41-43).

(2) Logical/mathematical intelligence *consists of the capacity to analyze problems logically, carry out mathematical operations, and investigate issues scientifically. In Howard Gardner's words, it entails the ability to detect patterns, reason deductively, and think logically. This intelligence is most often associated with scientific and mathematical thinking* (1993, p. 41-43).

(3) Musical/rhythmic intelligence *involves skill in the performance, composition, and appreciation of musical patterns. It encompasses the capacity to recognize and compose musical pitches, tones, and rhythms. According to Howard Gardner, musical intelligence runs in an almost structural parallel to linguistic intelligence* (1993, p. 41-43).

(4) Bodily/kinesthetic intelligence *entails the potential of using one's whole body or parts of the body to solve problems. It is the ability to use mental abilities to coordinate bodily movements. Howard Gardner sees mental and physical activity as related* (1993, p. 41-43).

(5) Visual/spatial intelligence *involves the potential to recognize and use the patterns of wide space and more confined areas* (1993, p. 41-43).

(6) Interpersonal intelligence *is concerned with the capacity to understand the intentions, motivations, and desires of other people. It allows people to work effectively with others. Educators, salespeople, religious and political leaders, and counselors all need a well-developed interpersonal intelligence* (1993, p. 41-43).

(7) Intrapersonal intelligence *entails the capacity to understand oneself, to appreciate one's feelings, fears, and motivations. In Howard Gardner's view, it involves having an effective working model of ourselves, and to be able to use such information to regulate our lives* (1993, p. 41-43).

(8) Naturalist intelligence *enables human beings to recognize, categorize, and draw upon certain features of the environment* (1993, p. 41-43).

Multiple intelligence teaching strategies in mathematics, for example, aim to personalize learning specifically to the logical/mathematical domain and link new concepts to the learner's personal experiences outside of school. This method was supported by the findings of an action research project entitled Improving Student Motivation and Achievement in Mathematics through Teaching to the Multiple Intelligences (Bednar, Coughlin, Evans & Sievers, 2002).

Conclusions drawn from the study of elementary students in this project led to the following statement:

> *Research indicates that students have an inability to transfer math concepts into real life situations. It seems students learn the process of doing mathematics at school and tend to leave it in that context. As a result, they do not develop a keen sense of the mathematics in the world around them when they complete daily activities such as shopping, watching a football game, or questioning the day's temperature. The need for nontraditional teaching strategies via individual learning styles is evident. A stronger emphasis on connecting mathematics to other disciplines is necessary for students to realize how the world relies on mathematics. Literature suggests that instruction needs to be real life, personalized, engaging, interdisciplinary, and multiple intelligences based* (2002, p. 3).

According to Dr. Howard Gardner's Theory of Multiple Intelligences, each of the eight distinct intelligences had the possibility of emerging during normal childhood development and had a peak end-state performance. The logical/mathematical intelligence, for example, peaked in adolescence and early adulthood if developed during childhood. As Lazear (1999) quotes Gardner,

> *This intelligence is formed in the confrontation with the world of objects. Through the manipulation of objects, in ordering and reordering them, and in assessing their quantity, the young child gains his or her initial and most fundamental knowledge about the logical/mathematical realm. From this preliminary point, logical/mathematical intelligence rapidly becomes remote from the world of material objects and over the course of development, one proceeds ultimately to the heights of abstract logic and science* (1999, p. 39-40).

Social scientists, physicists, chemists, and mathematicians are all examples of people with a highly developed logical/mathematical intelligence which likely had its beginning in early childhood. Gardner also compared this particular intelligence, often called scientific thinking, to a computer needing a set of operations in order to function, such as the DOS operating system. He also suggested that each of the intelligences would one day be able to manifest itself in computer form because we can specify the steps necessary to do what each intelligence domain enables us to do (Lazear, 1999).

Teachers were generally well aware that student attitudes were more positive and motivation was higher when student interests or backgrounds were incorporated into the mathematical content area. In addition, researchers found "the more innately familiar students are with the content of a problem, the more likely they are to have success in solving it due to reduction in cognitive load" (Ku & Sullivan, 2001). The cognitive load theory viewed the limitations of the working memory to be the primary impediment to learning. Reducing cognitive load imposed by a body of to-be-learned information increased the portion of working memory, which was then available to attend to the learning process itself. The theory suggested that reduction in cognitive load might only be achieved through non-traditional teaching methods (Cooper, 1998). In fact, standard teaching practices were often polar opposites of those suggested by the cognitive load theory. See Appendix A. In summary, the theory stated there would always be the need to reduce cognitive load in order to maximize the mental resources required in the learning process. If, for some reason, cognitive load increased rather than decreased, learning would be inhibited. Furthermore, an increased natural interest factor coupled with a decreased cognitive load seems to work quite compatibly in the area of mathematics" (2001, p. 85).

Another research finding suggested teachers and students often have very different perceptions of how a mathematics class should be conducted (Diamond, 2001). Teachers often followed a textbook to fill the allotted time for mathematical computation via pencil and paper practice alone. This process tended to leave little opportunity for creative problem solving and mathematical interpretation. The mathematics taught in many schools, therefore, appeared to students as only a creation of teachers and textbook writers as opposed to essential life skills (Diamond, 2001). Unfortunately, students who objected to the format or goal of a mathematics class could either argue convincingly for a different approach or simply trust the teacher and wait for results (Diamond, 2001).

Without a doubt, the teacher maintained a potent force in the classroom. It was found that a teacher's enthusiasm toward the subject matter had a greater impact on student attitude than instructional variables. A teacher who showed excitement toward mathematics, for example, tended to produce similar enthusiasm in his or her students. Furthermore, a teacher who disliked and feared mathematics also passed on a lasting negative attitude to students (Burton, 1999). In addition to these factors, research indicated that parental influence can also affect the mathematics attitudes and performance of children in the following three ways: parental expectations of a child's achievement, parental encouragement, and a parent's own mathematics attitudes. Findings about student attitudes toward mathematics were positively related to how they rated their parent's attitudes toward mathematics. The attitude of students was also positively correlated with the amount of mathematics education desired by the parents for their children (Aiken, 1999).

Throughout my literature review, a reoccurring proposal on the topic of mathematics attitudes seemed to emerge. Since researchers were confident a student's self-perceived ability in mathematics was critical to success and a predictor of personal mathematics achievement (Tapia & Marsh, 2000), a focus on the formation of mathematics attitudes needed to be amplified. Further identification of the specific factors that influence the formation of mathematics attitudes was crucial. In addition, we needed to know how mathematics attitudes are altered and the best techniques for intervention and stimulation of positive self-efficacy. "If the feelings our students have toward mathematics are to be fully understood, continued research was absolutely essential" (Tapia & Marsh, 2000). This made me feel that my action research was of great value to the mathematical community as a whole. However, I wanted my research to also include information about the mathematics attitudes of gifted students in particular, as that was my current area of teaching.

I was fortunate to find an article written by Ed Zaccaro (2006) that outlined seven guidelines to consider in designing a program to help gifted students experience challenge and enjoyment in mathematics. His guidelines included the following:

> ***(1) Challenge and frustration are a part of learning and life. They should both be viewed as a normal part of the learning process.*** *For example, teachers of gifted students should share experiences where adults have made mistakes. They must also encourage students to take intellectual risks within the safety net of their open acceptance* (2006, p. 3-4).
>
> ***(2) Math is often taught as all scales and no music. Children must have the opportunity to see the exciting and interesting parts of mathematics.*** *The goal of a good gifted program should not be to move students through the curriculum as quickly as possible. This approach can lead to a loss of interest in mathematics because it does not nurture a child's passion for mathematics. An alternative approach is to keep gifted children with their same age peers, but give them an opportunity to experience the parts of mathematics that are not only challenging, but also very interesting. When children first see the wonders of math and science, it is as if they stepped into a room that they didn't know existed. Such as:*
>
> - *Using simple geometry to see how the circumference of the earth was determined for the first time almost 2500 years ago,*
> - *Using their knowledge of the speed of light to realize that looking at stars is looking back in time a hundred, a thousand, or even a million years,*
> - *Finding the distance a ship is from shore through the use of trigonometry, and*
> - *Finding the height of a tree by measuring its shadow and then using ratios.*
>
> *If musicians were not given the opportunity to perform or play music that stirred their hearts, it is unlikely they would develop a passion for their field. The same holds true for children and mathematics. Children who are talented in mathematics must be exposed to material that lights a fire and nurtures their gift* (2006, p. 3-4).
>
> ***(3) It is important for children to be shown the fascinating connections between mathematics and the real world.*** *Because mathematics instruction is often dominated by*

facts and calculation, children are rarely exposed to important concepts that connect math and science to the real world. For example:

- *The Challenger disaster occurred because the recommendation not to launch made by mathematicians and engineers was overruled by management.*
- *The popular singer Aaliya was killed in a plane crash because the pilot and others ignored what mathematics told them.*
- *Racial bias in jury selection was proven by a mathematician (he said there was approximately l in 1,000,000,000,000,000 chances that the jury was fairly picked.)*
- *About 2500 years ago, mathematicians changed the study of space from one of fantasy and guesswork into a real science* (2006, p. 3-4).

(4) Children who are gifted in mathematics must learn to appreciate their gift. *Imagine what a young athlete feels like to have hundreds of people cheering for him, plus trophies, medals and awards. It is unlikely that this kind of motivating environment will ever become routine for those students who excel in math and science. It is important that teachers of the gifted make students feel that their gifts are something to be treasured* (2006, p. 3-4).

(5) Parents and educators must understand that a child's interests and passions do not necessarily correspond with their areas of giftedness. *We must encourage gifted children to follow their passions, even if they are not within their area of giftedness* (2006, p. 3-4).

(6) Mathematically gifted children must be given material that truly challenges them and appropriately challenges them (2006, p. 3-4).

(7) Highly able children must have the opportunity to work with children within similar abilities. *The importance of like-mindedness cannot be overstated because the value of this kind of interaction is not limited to the intellectual growth that it can foster. The social and emotional development that can occur as a result of healthy disagreement, discussion, and debate can have a profound impact on mathematically gifted children. An additional benefit is a reduction in the social isolation that these children sometimes experience* (2006, p. 3-4).

To me, Zaccaro's second guideline listed above represented the most profound literature review concept of my action research. It precisely revealed the core factor I originally predicted might produce positive mathematics attitudes in the lives of my students. The data immediately seemed clear to me. Simply put, my HAL students needed opportunities to experience the exciting wonders of mathematics. The author had made an extremely meaningful comparison by contrasting the study of mathematics to the study of music. Having been a pianist and vocal soloist, as well as a private piano instructor, I easily envisioned learning music without the opportunity to perform. It unquestionably reaffirmed the notion that this method of learning would never help a musician build a passion for song. Using pedagogy alone, without the joy of expressing oneself through musical interpretation, would indeed leave the study of music dull and boring. Similarly, it was also doubtful a passion for mathematics could be acquired through the isolated act of drill and practice. What my students were lacking were the opportunities to actively experience the parts of mathematics that interestingly connected it to real issues they and others faced in the world around them. In other words, students who were talented in mathematics needed exposure to material that lit a fire within them and nurtured their gift (Zaccaro, 2001). Since gifted education was all about individual passion areas, this idea really hit home for me.

The purpose for my action research study was strengthened by the lack of comprehensive data available in literature reviews on the topic of mathematics attitudes. For example, although existing literature unanimously supported the importance of a positive learning attitude, it did not explicitly describe the underlying factors that enhance or obstruct a positive attitude toward mathematics. There was also little research regarding how mathematics was viewed from a student's perspective. Being the HAL coordinator, in contrast to one of the six classroom teachers in our district who taught sixth grade mathematics, helped create an open channel of communication between my students and me. All of us could approach mathematics topics without fear of affecting a mathematics grade or our student-teacher relationships. On a regular basis, HAL sessions often included informal open discussions initiated by the students themselves about happenings in their regular classrooms, after school and at home. Through the discussions, students learned the emotional safety of my classroom and the fact they could be candid and confide in me. Because of the stability of the relationships I had built with my students, I felt confident I received honesty and sincerity throughout the data gathering process.

Purpose Statement/Research Questions

The purpose of this study was to investigate the current mathematics attitudes of my sixth grade High Ability Learners and how these attitudes might correlate to personal mathematics achievement and identified intelligence domains. Data collection took place during the spring semester of 2006 in my HAL classroom. This study attempted to answer the following research questions:

1. ***What are the Terra Nova standardized composite and mathematics scores of my HAL students?***
2. ***What are the identified intelligence domains of my HAL students?***
3. ***How do my HAL students use their own words to describe personal feelings about math?***
4. ***What sources formed the current math attitudes of my HAL students?***
5. ***How do family values and backgrounds correlate to math attitudes?***

Method

During the first week of February 2006, my timeline indicated I gather the data needed for research question ***(1) What are the Terra Nova standardized composite and mathematics scores of my HAL students?*** Since I did not receive formal IRB approval until the first of March, this process was delayed several weeks. My principal granted written permission for use of these scores in my research study, although as HAL coordinator I have access to the test scores for all students in our K-12 district. These scores were utilized as part of the district-wide HAL identification matrix I complete each school year and send to Lincoln for Nebraska Department of Education HAL grants and budget reporting. I gathered and organized the most current Terra Nova composite and mathematics scores for my nineteen sixth grade HAL students onto an Excel Correlation Matrix so that these scores could be aligned with one another and compared to the Autonomous Learner Publishing Services (ALPS) Multiple Intelligence Profiles soon to be completed by each student. This test data was reported only in aggregated form.

During the third week of February, each of my HAL students completed an ALPS Multiple Intelligence Profile to serve as the data source for research question ***(2) What are the identified intelligence domains of my HAL students?*** See Appendix B, C, D and E. Two worksheets were given to each student to use in rating themselves on a scale from 1 (least like me) to 5 (most like me) on eight "ways of knowing" characteristics listed under each of the multiple intelligence domains. See Appendix C and D.

- *Box #1 identified verbal/linguistic intelligence characteristics*
- *Box #2 identified logical/mathematical intelligence characteristics*
- *Box #3 identified visual/spatial intelligence characteristics*
- *Box #4 identified bodily/kinesthetic intelligence characteristics*
- *Box #5 identified musical/rhythmic intelligence characteristics*
- *Box #6 identified interpersonal intelligence characteristics*
- *Box #7 identified intrapersonal intelligence characteristics*
- *Box #8 identified naturalist intelligence characteristics*

I compiled this data onto the ALPS Multiple Intelligence Profile Summary Sheet for each student. See Appendix E. Next, I transposed the 1-to-40-point ranking from the logical/mathematical domain into a percentile and placed it on my Excel Correlation Matrix alongside the Terra Nova scores in order to draw desired mathematical comparisons. Dominant affective data emerged within the logical/mathematical domain, as students consistently gave themselves low ratings indicating they saw themselves as having little mathematics interest or potential in mathematics. The logical/mathematical characteristics included the following list shown in Box #2 of Appendix C:

- *Loves playing with numbers*
- *Likes addition, subtraction, multiplication, division and other operations with numbers*
- *Loves math and science*
- *Loves playing games or solving brainteasers that require logical thinking*
- *Looks for patterns, regularities or logical sequences in things*
- *Likes to measure or categorize things*
- *Likes logical argumentation*
- *Likes to collect things and develops orderly systems*

Starting the first week in March, my HAL students began composing a series of journal entries. Each student completed one journal per week for three consecutive weeks. Each journal entry was one page in length and had a specific writing probe listed at the top. See Appendix F, G and H. These entries became the data source in answering research question ***(3) How do my HAL students use their own words to describe their personal feelings about math?*** After I assured my students their compositions would be held in strict confidence, they readily opened up to me through their writings. In fact, some of them filled in both the front and back of an entire page. I was not at all surprised by my students' opinionated comments, as I often find gifted students have intense opinions about many topics. Authors of When Gifted Kids Don't Have All the Answers state that:

> *Gifted children can be extraordinarily sensitive. They often feel more than other kids their age. They tend to develop empathy earlier than other children do. They have a social conscience and an intense awareness of the world's problems. They worry about the world, the environment, wars and conflicts, hunger and homelessness. Their emotions are intense and close to the surface* (2002, p. 7).

I found a common theme in my student journal entries that seemed to focus on the fact that many of my HAL students held negative feelings toward the subject of mathematics.

My students started to complain when they saw a fourth journal entry awaiting them when they arrived in my classroom the last week of March. They were preoccupied with their Career Discovery Lab projects, our study of Leonardo Da Vinci, and our upcoming Culinary

Entrepreneurship Fair. At this same time, I became very stressed and felt my research study was interrupting what should be happening in my classroom. Because I was pleased with the thorough and explicit explanations given by my students in their first three journal entries, I felt confident this portion of my action research had been sufficiently investigated.

Later that week, it was time to have my students complete the Attitude Scale which attempted to answer the research question ***(4) What sources formed the current math attitudes of my HAL students?*** Only seventeen students were present during the administration of the Attitude Scale which consisted of fifteen questions students responded to by marking an “A” for always, an “S” for sometimes or an “N” for never for each question. See Appendix I.

During the second and third weeks of April, I randomly selected five of my sixth grade HAL students to formally interview during class time. I chose those who were furthest along with their Culinary Entrepreneurship Fair PowerPoint presentations so the other students would not lose limited class time available before our Culinary Fair took place in May. The twelve interview questions began with school-related issues and gradually led to individual family values and circumstances. See Appendix J. The statistics gathered from these audiotaped interviews answered my fifth and final research question ***(5) How do family values and backgrounds correlate to math attitudes?***

Analysis

As I looked back on all the research data I had collected, the central assertion I confidently made was that most of my students said they did not like sixth grade mathematics. A prominent reason my students complained about doing sixth grade mathematics was because it was often routine practice on concepts they already mastered. One HAL student noted, “In math we spend most of our time reviewing. It’s a waste of time.” Another added, “I absolutely hate math because it's boring." A third concurred, "I don't like math because all we do is repeat things we already know." According to Delisle and Galbraith (2002),

> *Although gifted students grasp mathematical concepts readily, they often have little or no patience for regular math lessons or homework. They can solve problems quickly and easily but will immediately want to move onto more challenging problems, despite what the rest of the class is doing. They hate to 'wait for the group' and tend to get bored with the regular curriculum. They resist assignments that don't present opportunities for new learning and dislike drill, practice and routine so much that they will start to do inaccurate and/or sloppy work. Because gifted students show superior reasoning powers, they grow impatient and may seem stuck-up or arrogant to others. They often challenge authority and have difficulty getting along with less able peers* (2002, p. 8-10).

The individual viewpoints described in student journal entries were vividly revealing. On the positive side, fourteen journal entries reflected that my students felt successful at mathematics based on the fact they (almost) always received an A in mathematics on their report card. One student said geometry was very enjoyable and another student indicated mathematics used to be her favorite subject. Another student mentioned he wanted to be a mathematics teacher because he excelled at mathematics. Six students remembered liking fourth grade mathematics in particular because their fourth grade teacher played music while they completed mathematics assignments. This same teacher also had students explain mathematics problems to each other, used mathematics rewards, and let them play computer games such as Accelerated Math. Approximately 90% of my HAL students felt mathematics was important to their futures, especially with regard to earning money, shopping and paying bills. One student predicted, "I will definitely need to know some math for when I grow up because I plan to make a lot of money and spend it."

In other journal entries, almost all students had suggestions about how they wished mathematics class could be. Generally speaking, they wanted more kinesthetic learning activities and lessons they could do together, rather than solo practice and repetitive worksheets.

One student said it like this, “It would be cool to play math games or do puzzles together instead of the boring assignments we do every day.” Many students also felt strongly there should not be mathematics homework. For example, several students remarked, “I think teachers should stop wasting our time with math homework. We need longer weekends and shorter school days.”

Based on the results of the Attitude Scale shown below, data confirmed my prior assumption that most of my students did indeed carry a negative attitude toward mathematics because all of my students reported a preference for working on any other subject than mathematics, as shown in #2 below. Results also indicated all of my students usually worked on mathematics assignments alone instead of in cooperative learning groups, as shown in #3 below. Ten students had noticeable mathematics anxiety and fifteen students regarded mathematics as something not everyone could understand, as shown in #10 and #15 respectively. It was particularly interesting to me to find that fourteen of my students did not necessarily regard being good at mathematics as a sign of intelligence, as revealed in #12 below. My students were aware that high mathematics Terra Nova scores played a major role in personal identification as a High Ability Learner and inclusion in HAL programming.

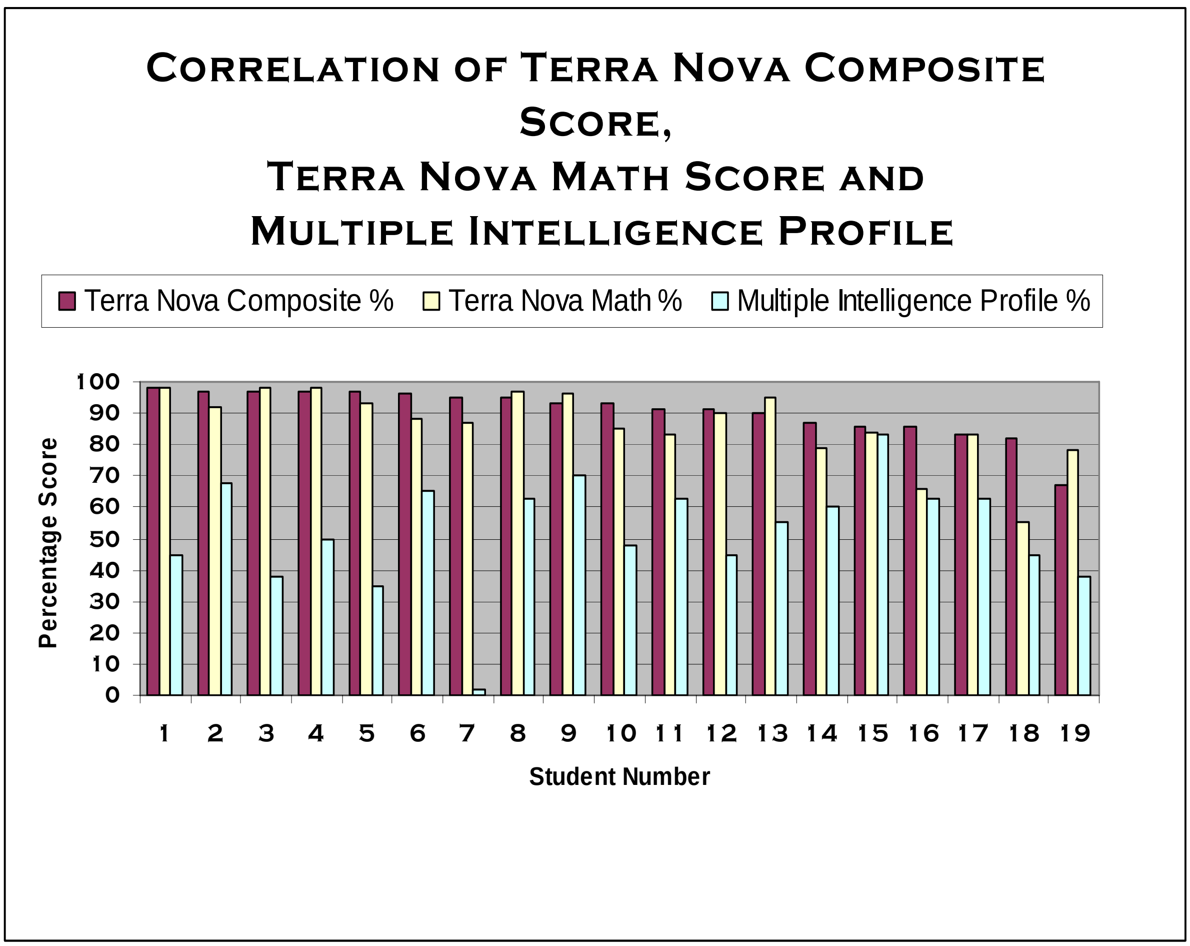
ATTITUDE SCALE

Check One: A = Always
S = Sometimes
N = Never

	A	S	N
1. I look forward to math class.	1	9	7
2. I would rather work on any other subject than math.	8	9	0
3. We do math assignments by ourselves.	6	11	0
4. I get good grades in math.	12	4	1

5. I think boys do better in math than girls.	1	7	9
6. I think math is something I don't need to understand.	1	5	11
7. I admire other students who are good at math.	3	9	5
8. I like it when math problems make me think "outside the box."	4	8	5
9. I think I'm good at many things, but I'm not good at math.	2	8	7
10. I feel sick when I have to take a math test.	4	6	7
11. If my teacher likes math, it makes me like math too.	1	8	8
12. HAL students should be good at math.	2	14	1
13. I have a hard time sitting down to do my math homework.	2	7	8
14. I'm not sure of my math answers, even on simple problems.	2	7	8
15. I think math is something not everyone can understand.	8	7	2

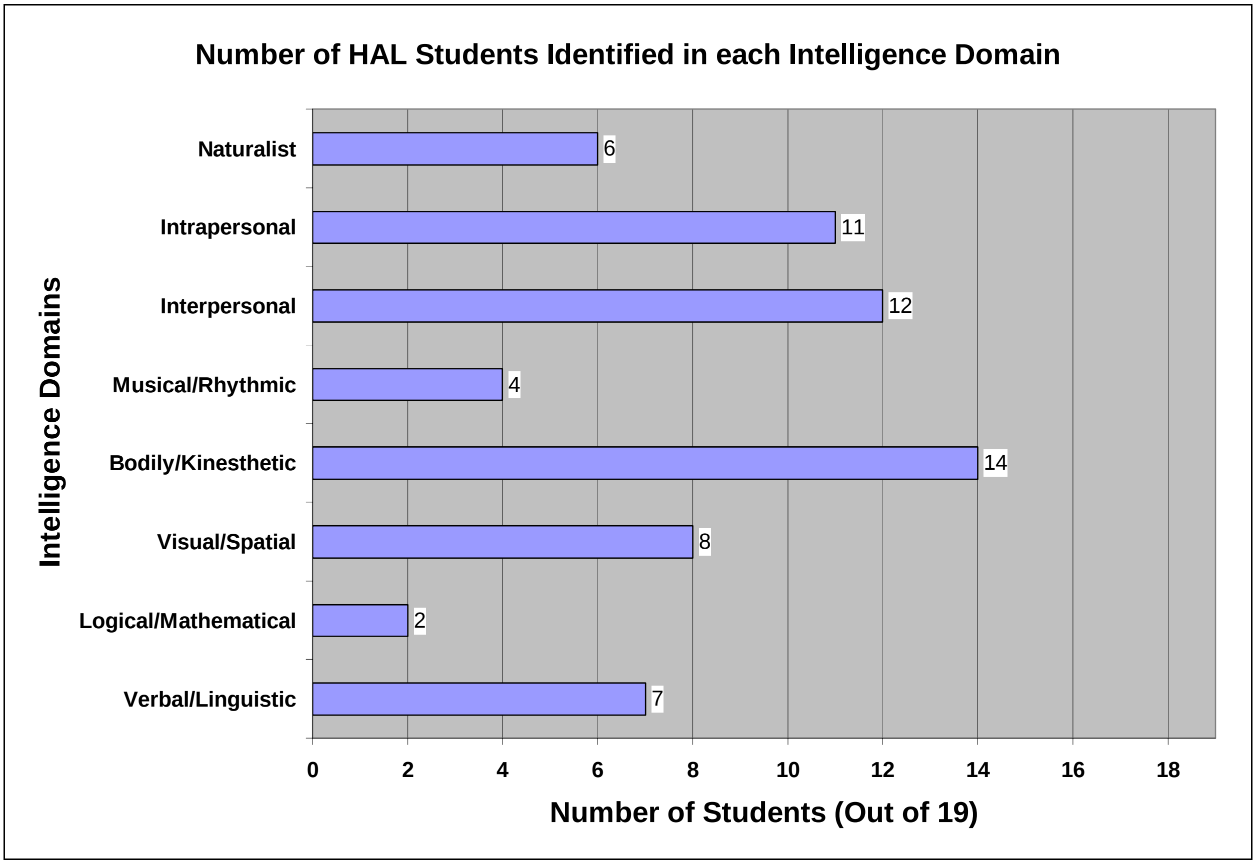
Next, I made assertions about the data compiled on the Excel Correlation Matrix, which aligned all Terra Nova composite and mathematics scores with one another and compared them to the results of the ALPS Multiple Intelligence Profiles shown here:



The majority of my HAL students had earned high Terra Nova mathematics scores even though they had given themselves low ratings in the logical/mathematical intelligence domain. The Matrix showed student #3, for example, with a rating of less than 39% mathematics interest or potential mathematics IQ on the Multiple Intelligence Profile, yet at the same time, he or she also achieved an outstanding 99% on the Terra Nova mathematics test. This placed merit on my previous notion that making students feel successful at mathematics may be more important than their actual academic ability.

Because the Excel Correlation Matrix revealed seventeen out of nineteen HAL students did not see themselves as mathematically gifted (even though they excelled in it academically), it seemed my students could certainly “do the mathematics,” but they were not “enjoying the mathematics.” Originally, I was confident those who were gifted mathematicians (as revealed by their high Terra Nova scores) would also award themselves high IQ ratings in the logical/mathematical intelligence domain. This scenario seemed to directly link my research findings to the article in my literature review that compared the study of music to the study of mathematics (Zaccaro, 2006). It stated if students cannot investigate the exciting and relevant components of a subject, they are simply not going to develop a passion for it.

In order to fully compare and contrast all the data complied from the ALPS Multiple Intelligence Profiles; I then created a second graph shown below:



This graph totaled the amount of HAL students within each of the eight intelligence domains. Some of my students were gifted in more than one category; others had only one identified intelligence domain. Most noteworthy was the fact that this particular group of nineteen HAL students had only two students identified in the logical/mathematical intelligence domain. Perhaps this was another reason for the high percentage of students within this group who had negative mathematics attitudes. Overall, the three prime areas of identified intelligence in this group were bodily/kinesthetic, interpersonal and intrapersonal domains with logical/mathematical and musical/rhythmic domains sparsely represented within the group.

In the concluding audio taped student interviews, many of my students described mathematics as boring. One of my sixth graders told me, “The word boring to us means not interesting, repetitive, tiresome and unexciting.” I suspected my students felt this way because they basically did the same type of mathematics assignments everyday and rarely had the opportunity to be challenged. Several of my students told me they liked mathematics, have always excelled at it, and even enjoyed teaching mathematics to their younger siblings. At this point, I would have liked to have stopped and gathered more personal data about the home lifestyles and backgrounds of my students because I suspected these kinds of factors also played an enormous role in their attitudes toward education in general. Delisle and Galbraith support this suggestion by stating that definitions of giftedness are influenced by social, political, economic, and cultural factors (2002, p. 17). However, demographic data including family income, race, religion, politics and ethics were areas my research professor recommended I avoid because they often carried moral and ethical implications for students, parents and school districts.

When I replayed the audiotapes, it seemed most of the students I interviewed highly valued mathematics especially with regard to their future careers and lives as adults. Most of them said their parents wanted them to earn good grades, which in this case meant their parents expected them to do well on their mathematics assignments. The bottom line here was a common scenario in schools called “getting the grade.” If parents saw that their child received a good grade on his or her report card, they naturally assumed the child was mastering the content and feeling good about the mathematics. Unfortunately, that is not always the case.

Most of the students I interviewed had a mathematics mentor (someone in their life they felt was good at mathematics) and also had other individuals around them who were good at science, English or other specific areas of the curriculum. The top three family free time activities included watching movies, reading, or visiting relatives. One hundred percent of the students I interviewed said their parents had high expectations for their futures, several noting their parents encouraged them to make their own decisions regarding options of higher education and careers. One hundred percent of the students I interviewed also said they often spoke about what they did at school with their parents at home. Because I consistently received a great deal of parental support from HAL parents, all of these findings seemed valid to me. Most of my HAL students were definitely blessed with nurturing and caring parents, so perhaps strong parental involvement was another major component in student success at school.

I was pleased to hear several interviewees say they felt naturally "good at math" for as long as they can remember. A few still liked mathematics, but most indicated a strong dislike for it. Throughout the interview process, students repeated many of the comments they had written about previously in their journal entries. They spoke about how their math teachers were boring, said the same thing over and over again and then assigned the same kind of mathematics work every day. They said they wished mathematics lessons could be more active and include playing games or doing cooperative mathematics projects. One student told me she thought math was irrelevant, while another said only her dad liked math, but none of the girls in her family liked it.

Interpretation

My research findings were a mixture of quantitative and qualitative data. Data collection instruments were designed to lead students to a combination of both numerical and subjective responses. Many of my sixth grade HAL students scored at or above the 90th percentile in their Terra Nova composite scores. However, the majority also scored at a lower percentile in their Terra Nova mathematics score alone as compared to their overall composite score. This may have been partially due to the identified intelligence domains of the particular students surveyed. Only two students demonstrated intelligence domains highly correlated to their mathematics ability. As the literature review suggested, this may have been due to the fact that this particular group of gifted students simply had their high abilities focused in other areas. Corresponding to Gardner's views concerning multiple intelligences, it was understandable that the subgroup of the population I studied demonstrated high ability in one or two specific domains, rather than very high ability in all academic areas. For some gifted students, this area may be mathematics, but for others, it may not.

One must also remember that much of the data collected was relying upon the subjective responses of students in sixth grade who were approximately eleven years of age. Although their thoughts and concerns were ultimately focused on their mathematics attitudes, it must be remembered that gifted students this age may report that any school subject was not necessarily fun or relevant to daily life because it was either lacking intellectual challenge and/or the gifted students were looking for ways to gain social approval or acceptance (Delisle and Galbraith, 2002). Gifted children in particular may also report a setting that is stimulating to children with normal intelligence levels to be boring or not interactive (Delisle and Galbraith, 2002).

Overall, my research findings suggest that my HAL students' current attitudes toward mathematics were not being shaped in a positive way. Not only were these intelligent children left with self-concepts that they did not excel in mathematics, but they also struggled to relate its importance to their everyday lives. In order to foster positive student attitudes toward mathematics, parents and teachers must work together. Within the family atmosphere, parents should demonstrate the utility of mathematics in everyday happenings, whether attending a sporting event, shopping or working in the kitchen or garage. Parents need to make conscious efforts to communicate mathematical thinking through natural conversations with their children and therewith, become mathematics role models for them. At school, students must view their time in the mathematics classroom with positive self-efficacy. Teachers can help promote optimistic student attitudes by reducing cognitive load and using mathematics content that is innately familiar to the students. Teachers must also engage students in assignments that require genuine mathematical interpretation in contrast to traditional computation and skill practice alone. Creative problem solving activities that mimic scenarios outside the context of school academia are essential in encouraging intrinsic enjoyment and future interest in mathematics.

For gifted students, my action research concurs that meaningful high-level thinking opportunities in mathematics and content tailored for individual intelligence domains are particularly critical. The implementation of lengthy project-based or inquiry-based units of study in which students become deeply involved in useful work leads to broad implications toward this desired pedagogy. Literature I reviewed after the conclusion of my action research supported this approach for struggling students as well (Darling-Hammond & Ifill-Lynch, 2006). With this method, highly engaged students talked willingly about experiences in which they truly learned something and took pleasure in sharing and analyzing their successes. I, in fact, witnessed the effectiveness of this approach by incorporating several long-term projects in my HAL classroom. One such theme was an “Invention Convention” in which students applied a wide range of mathematical thinking in order to develop an original invention of their own design. Many students chose to invent interactive board games involving geometry and discrete mathematics. A second overarching project theme called “Images of Greatness” approached mathematics from a historic perspective through the study of famous people including mathematic legendaries Albert Einstein and Sir Isaac Newton. After extensive Internet research on the life of an eminent person of personal interest to them, each HAL student authored a biography including a full-color picture gallery. As a culminating activity, each student dressed in costume to present a speech on stage through which they portrayed their famous person's unique attributes to the community.

In conjunction with my ongoing action research this past school year, I created another thematic HAL unit of study entitled "Culinary Entrepreneurship Fair." My students did not sit in the HAL classroom looking at a mathematics textbook for this assignment. Rather, they formed food business partnerships, went physically to the grocery store, developed recipes, calculated ingredients and budgets, sold their products for profit or loss to the community, and interpreted overall business plan successes. In completing this extensive project, I had the ultimate pleasure of seeing the implications of my action research become an exciting reality. Before me were my students, actively immersed in authentic mathematical problem solving and enjoying mathematics because it was relevant and important to the happenings in their lives.

APPENDIX A

STANDARD TEACHING PRACTICE
vs.
COGNITIVE LOAD THEORY

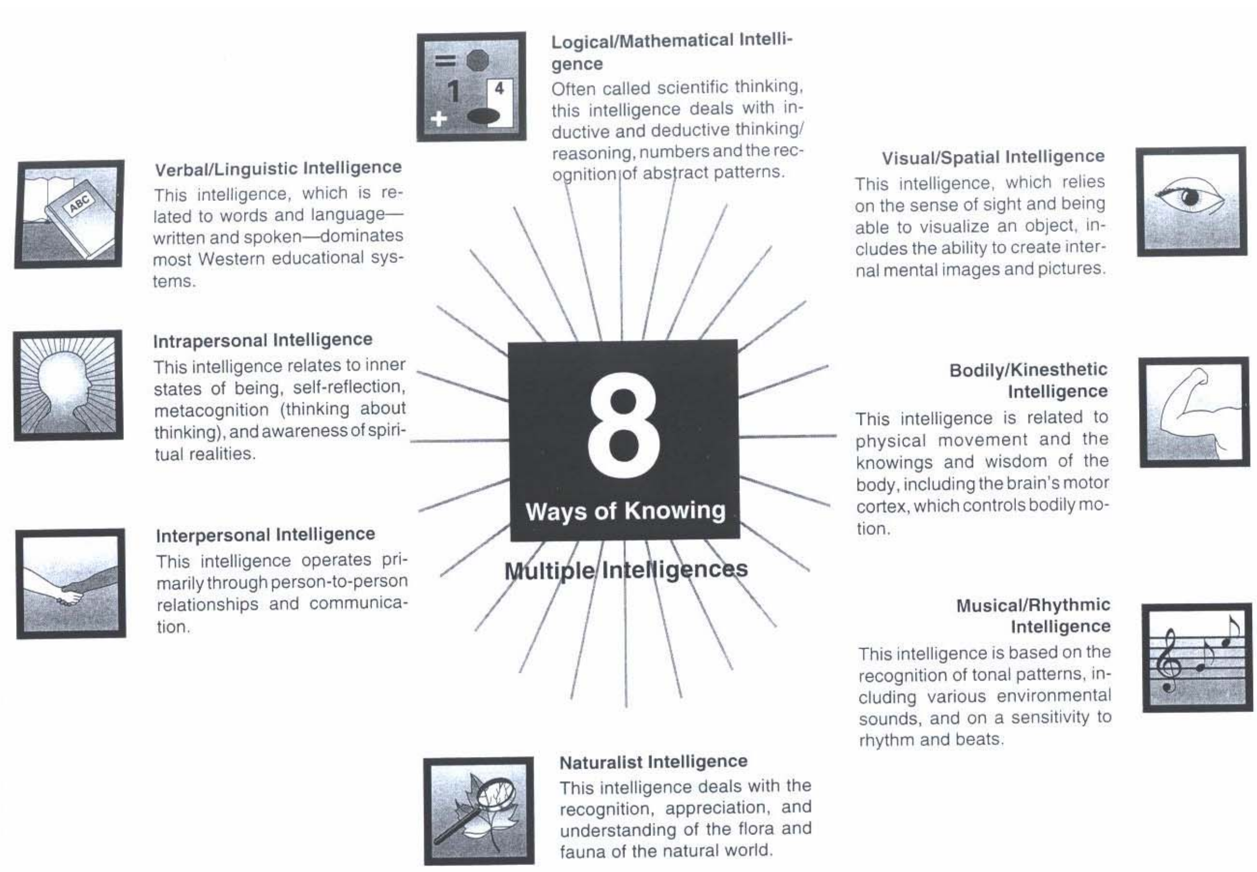
Standard practice	Cognitive load generated effect
1 Use conventional problems which specify the goal so that students 'know what they have to find'.	The goal free effect Use goal free problems
2 Students need to solve many problems to learn because 'practice makes perfect'.	The worked example effect Students learn by studying worked examples. Problem solving is used to test if learning has been effective.
3 Instructional materials which require both textual and graphical sources of instruction should be presented in a 'neat and tidy' fashion where the text and graphics are located separately.	The split attention effect Instructional materials which require both textual and graphical sources of instruction should integrate the text into the graphic in such a way that the relationships between textual components and graphical components are clearly indicated.
4 The same information should be presented in several different ways at the same time.	The redundancy effect Simultaneous presentations of similar (redundant) content must be avoided.
5 Similar to-be-learned information should be presented using an identical media format to ensure consistency in the instructional presentation.	The modality effect Mix media, so that some to-be-learned information is presented visually, while the remainder is presented auditorily.

APPENDIX B

ALPS
MULTIPLE INTELLIGENCE PROFILE DOMAINS

R E S E A R C H   Q U E S T I O N

What are the identified intelligence domains of my HAL students?



APPENDIX C

ALPS
MULTIPLE INTELLIGENCE PROFILE
WORKSHEET #1

R E S E A R C H   Q U E S T I O N

What are the identified intelligence domains of my HAL students?

Rate yourself on a scale from l (lease like me) to 5 (most like me) in each category.

1

___ Likes to talk, talk, talk
___ Likes to read
___ Likes to write stories, poems, ...
___ Likes to learn new words and how to use them
___ Wants to know the meaning of different words
___ Enjoys Scrabble, Password and other word games
___ Likes tongue twisters, nonsense rhymes or puns
___ Loves English, Social Studies & History

___ **Total**

3

___ Manipulates images visually
___ Reads maps, charts and diagrams
___ Daydreams more than others
___ Draws figures which are advanced for age group
___ Loves movies, videos, slides, visuals
___ Enjoys puzzles and mazes
___ Likes pictures more than words
___ Doodles on books and papers

___ **Total**

2

___ Loves playing with numbers
___ Likes addition, subtraction, multiplication, division and other operations with numbers
___ Loves Math and Science
___ Loves playing games or solving brainteasers that require logical thinking
___ Looks for patterns, regularities or logical sequences in things
___ Likes to measure or categorize things
___ Likes logical argumentation
___ Likes to collect things and develops orderly systems

___ **Total**

4

___ Learns and expresses self through movement
___ Likes to build things
___ Excels in one or more sports
___ Moves, twitches, taps or fidgets
___ Can mimic other people's gestures
___ Enjoys movement - dancing, running, exercising
___ Has excellent manual dexterity
___ Likes to "clown around"

___ **Total**

APPENDIX D

ALPS
MULTIPLE INTELLIGENCE PROFILE
WORKSHEET #2

R E S E A R C H   Q U E S T I O N

What are the identified intelligence domains of my HAL students?

Rate yourself on a scale from l (lease like me) to 5 (most like me) in each category.

5

___ Enjoys listening to different types of music
___ Expresses music through body movement, humming, whistling and singing
___ Sensitivity to rhythm, beat, pitch and sound
___ Has a good singing voice
___ Plays a musical instrument
___ Sensitive to environmental sounds
___ Composes music or rhythms
___ Enjoys performing music

___ **Total**

6

___ Enjoys people
___ Interacts effectively with others
___ Shows natural leadership
___ Communicates effectively
___ Solves conflicts with others
___ Likes to play games involving others
___ Has empathy toward others
___ Knows how to respond to others

___ **Total**

7

___ Shows independence and strong will
___ Understands self - strengths and weaknesses, inner feelings and ideas
___ Loves to keep a journal
___ Shows autonomy in some actions
___ Knows own needs and how to meet them
___ Marches to the beat of a different drummer
___ Prefers working alone most of the time
___ Learns from successes and failures

___ **Total**

8

___ Shows knowledge of the living world
___ Experiences a "oneness" with nature
___ Shows concern about the environment and animals
___ Studies plants and animals and their classifications
___ Enjoys roles related to nature
___ Loves to have many pets
___ Loves the outdoors
___ Shows concern about environmental issues

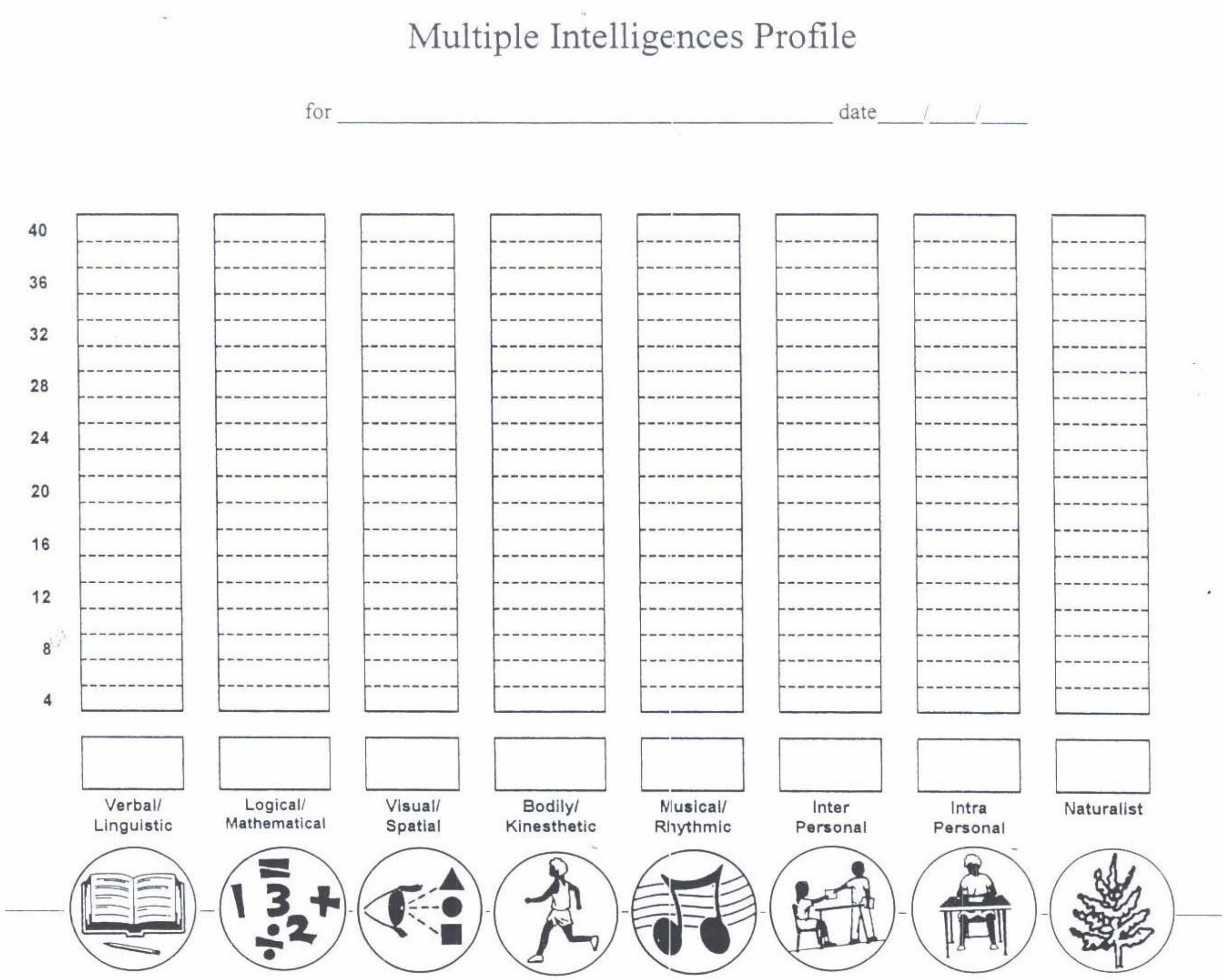
___ **Total**

APPENDIX E

ALPS
MULTIPLE INTELLIGENCE PROFILE
SUMMARY SHEET

R E S E A R C H   Q U E S T I O N

What are the identified intelligence domains of my HAL students?



APPENDIX F

JOURNAL ENTRY #1

R E S E A R C H Q U E S T I O N

How do my HAL students use their own words to describe their personal feelings about math?

Journal Probe #1:
How successful are you at sixth grade math? Have you ever felt differently about math than you do now? If so, when and why?

APPENDIX G

JOURNAL ENTRY #2

RESEARCH QUESTION

How do my HAL students use their own words to describe their personal feelings about math?

Journal Probe #2:
Have your math classes at school been interesting to you so far? Why or why not? How do you wish math class could be?

APPENDIX H

JOURNAL ENTRY #3

R E S E A R C H   Q U E S T I O N

How do my HAL students use their own words to describe their personal feelings about math?

Journal Probe #3:
How do you see math as being important to your future, especially as it relates to your career someday or your role as a future parent?

APPENDIX I

ATTITUDE SCALE

RESEARCH QUESTION

What sources formed the current math attitudes of my HAL students?

Check One: A = Always
S = Sometimes
N = Never

	A	S	N
1. I look forward to math class.			
2. I would rather work on any other subject than math.			
3. We do math assignments by ourselves.			
4. I get good grades in math.			
5. I think boys do better in math than girls.			
6. I think math is something I don’t need to understand.			
7. I admire other students who are good at math.			
8. I like it when math problems make me think “outside the box.”			
9. I think I’m good at many things, but I’m not good at math.			
10. I feel sick when I have to take a math test.			
11. If my teacher likes math, it makes me like math too.			
12. HAL students should be good at math.			
13. I have a hard time sitting down to do my math homework.			
14. I’m not sure of my math answers, even on simple problems.			
15. I think math is something not everyone can understand.			

APPENDIX J

FORMAL INTERVIEW

RESEARCH QUESTION

How do family values and backgrounds correlate to math attitudes?

1. How do you feel about school this year? Have you always felt this way?
2. Did you ever have a teacher who liked what he or she was teaching?
   How did you know?
3. Did you ever have a teacher who <u>dis</u>liked what he or she was teaching?
   How did you know?
4. Can you describe to me what a good teacher is like?
5. What makes one teacher better than another one for you?
6. Have you ever known someone who loves math? How did you know?
7. Do you think anyone in your family enjoys math? How do you know?
8. Do you think anyone in your family enjoys other school subjects?
   Tell me about them.
9. How often do you discuss at home what you do at school?
10. Who are the adults who live in your house? Describe your family.
11. How do you like to spend free time with your family?
12. What goals do you have for your life?
    What goals does your family have for your life?

REFERENCES

Aiken, L. (1999). Attitudes toward mathematics. *Review of educational research*, 40(4), 551-596. Retrieved on November 7, 2005, from http://www.jstor.org

Bednar, J., Coughlin, J., Evans, E. & Sievers, T. (2002). *Improving student motivation and achievement in mathematics through teaching to the multiple intelligences.* (ERIC Document Reproduction Service No. ED 466 408).

Burton, G. (1999). Getting comfortable with mathematics. *The Elementary School Journal,* (79)3, 129-135. Retrieved on November 7, 2005, from http://www.jstor.org

Cooper, G. (1998). Research into cognitive load theory and instructional design at UNSW. *School of Education Studies*, 6. Retrieved on July 16, 2006, from http://education.arts.unsw.edu.au/CLT_NET_Aug_97.HTML

Darling-Hammond, L. & Ifill-Lynch, O. (2006). If they'd only do their work. *Educational Leadership*, (63)5, 8-13.

Delisle, J. & Galbraith, J. (2002). *When gifted kids don't have all the answers.* Minneapolis: Free Spirit Publishing Inc.

Diamond, J. (2001). *Math is in the eye of the beholder.* (ERIC Document Reproduction Service No. ED 478 896).

Gardner, H. (1993). *Frames of mind: the theory of multiple intelligences, 2nd Ed.* Britain: Fontana Press.

Ku, H. & Sullivan, H. (2001). *Effects of personalized instruction on mathematics word problems in Taiwan.* (ERIC Document Reproduction Service No. ED 470 135).

Lazear, D. (1999). *Eight ways of knowing: teaching for multiple intelligences.* Arlington Heights: SkyLight Training and Publishing Inc.

Tapia, M. & Marsh, G. (2000*). Effect of gender, achievement in mathematics, and ethnicity on attitudes toward mathematics.* (ERIC Document Reproduction Service No. ED 449 044).

Zaccaro, E. (2006). The seven components of successful programs for mathematically gifted children. *National Association for Gifted Children Compass Points*, (Winter) 3-4.