Factors that Affect College Students' Attitudes toward Mathematics

Dr. Erin Goodykoontz
West Virginia University
eniemiec@math.wvu.edu

Most people have heard the age-old saying, "attitude is the key to success". Various quotes can be retrieved that subscribe to this philosophy. In education, research suggests that student attitudes toward a subject lead to academic success (Popham, 2005; Royster, Harris, & Schoeps, 1999). Generally speaking, mathematics is a subject that is often disliked, begging researchers to investigate how mathematics attitude affects mathematics learning. Further, I believe that student attitudes and achievement hold some implications concerning the types of mathematics courses offered and which department ultimately provides them for the students. Business and engineering majors are required to complete at least one semester of calculus at most universities. Currently, mathematics departments offer mathematics classes focusing on applications in specific areas and majors, such as business and engineering. If every other department wants a mathematics course that focuses on specific applications for their degrees, they may start offering their own mathematics courses. This, of course, could be detrimental to mathematics departments.

This study investigates college students' attitudes toward mathematics. While some of the student attitudes are positive or neutral, as an instructor of introductory mathematics courses in higher education, I have become increasingly concerned about the large number of unenthusiastic and/or poor attitudes that I have observed in many students.

It was mostly due to these firsthand experiences that I decided to investigate these attitudes further. I am most interested in college students who are enrolled in introductory college algebra courses. These courses are taught via large lectures at the University where the study is taking place. Specifically, I want to explore how college students' attitudes have changed over time and what factors have contributed to these attitudes.

This research examined what factors affect college students' attitudes toward mathematics. From these findings, suggestions will be made concerning ways in which the decline of student attitudes toward mathematics can be reversed or prevented at the college level. This qualitative study relies on survey methods to gain background information and group participants in order to choose interviewees that have had diverse mathematical experiences and attitudes throughout their life.

In order to gain a more informed and well-rounded perspective about student attitudes, I began this process by turning to the literature. The bulk of my reading consisted of what factors were found to influence student attitudes towards mathematics in previous studies. After reading, I condensed these findings into six main factors that were found to affect student attitudes toward mathematics: teacher attitudes and beliefs (Uusimaki & Nason, 2004; Beswick, 2006; Wilkins & Brand, 2004; Swan, Bell, Phillips, & Shannon, 2000; Grouws & Cramer, 1989; Schoenfeld, 1985; Beswick, 2007), teaching style and behavior (Chesebro, 2003; Wanzer et al., 1998; Thompson & Thompson, 1989; Adams, 1989; Midgley, Feldlaufer, & Eccles, 1989; Harkness, D'Ambrosio, & Morrone, 2006; Stage, 2000; Schweinle, Meyer, & Turner, 2006), teaching techniques (Anderson, 2005; Townsend et. al., 1998; Higgins, 1997; Pearce et. al., 1999; Mitchell, 1999;

Kinney, 2001; Yusof & Tall, 1999; Elliott et. al., 2001; Raymond & Leinenbach, 2000; Whitin, 2007) achievement (Hannula 2002, Tapia & Marsh 2001, Lopez, Lent, Brown, & Gore 1997, Midgley, Feldlaufer, & Eccles 1989), assessment, and parent attitudes and beliefs.

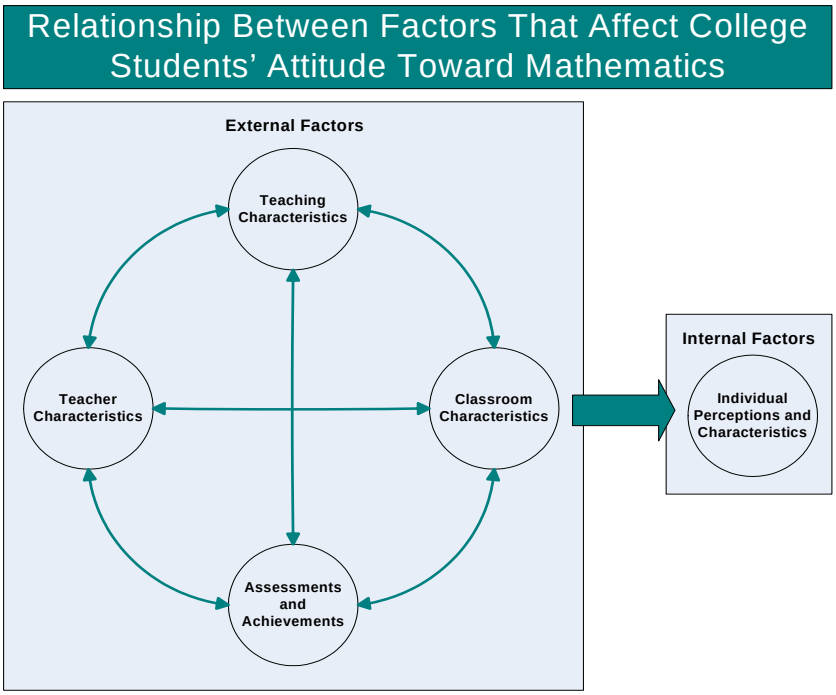
I took all of this previous information and reflected on what I wanted to come out of this study. As a teacher, I felt that there was more depth to be found concerning factors that affect student attitudes. I also knew that student's past experiences were a key influence on current attitudes. Ultimately, I wanted to know 'why'? Why do so many college students seem to dislike math? Why do some like math? And what, if anything, can teachers and the education system do to improve attitudes toward math?

Since I really wanted to know 'why', I knew I needed to talk with students. I decided to do a mixed methods study, with the qualitative component and interviews serving as the primary data source to answer my questions. I also decided to study students in an introductory large lecture mathematics course, so I used a quantitative survey to amass a larger number of numerical data and gain breadth. The quantitative study asked students questions about their attitude towards mathematics throughout their entire schooling experiences. I used the information from the surveys to group students based on grade levels where they had the most significant mathematical attitudes and also by the trend of their attitude across time.

After contacting all 99 students who completed the quantitative survey several times, I was very fortunate to have 23 students agree to speak with me. Luckily, there was a great variation in attitude trends, beliefs, and experiences, so I believe I gained a wide range of interview data.

From this process, five main themes emerged to answer my primary research question: The five themes are: 1. Teacher characteristics, 2. Teaching characteristics, 3. Classroom characteristics, 4. Assessments and achievement, and 5. Individual perceptions and characteristics. There are many relationships among these five themes. Primarily, I see these first four characteristics as external to the student, while the last one is internal and based on each student's perceptions that have been building and been influenced throughout their lives. Ultimately, I believe these four external factors can play a role in influencing each student's internal perceptions and beliefs.

Clearly there are many relationships among the five primary factors that were found to affect college students' attitude toward mathematics. There is obvious overlap and interplay among teachers, teaching, classrooms, assessments, and students. In most mathematics classrooms, the external factors affect and influence the other external factors. For example, the characteristics of a teacher usually have an effect on the teaching style and the classroom environment that the teacher creates. This varies based on the classroom, the class and the teacher. It is difficult to discuss exact relationships. But, as I went back to my original questions of 'why' do students like or dislike math and what can we do, if anything, to alter this like or dislike, I saw a key relationship emerge. This relationship sets the framework for my conclusions and implications.



The diagram above represents this relationship. On the left, we see the four external factors affecting each other, symbolized by the connecting arrows. On the right, we see the internal factor that also affects student attitudes. The arrow connecting the external factors to the internal factor represents the effect that the external factors can have on individual perceptions. These internal conditions are formed throughout life and the arrow highlights that they can be affected and changed by the external factors. I see attitudes as an internal characteristic that are most affected by individual internal perceptions. However, we, as educators, can affect the internal factors using the control we have over some of the external factors like teaching and classroom characteristics. My hope is that by focusing on altering external factors, we can affect internal perceptions and student attitudes. Ultimately, this diagram represents the relationship between external factors and the influence they have on internal perceptions and attitude.

Since this relationship is based off of the interviews, it is important to remember that this has emerged from the students' perspectives. This represents a relationship primarily from the students' point of view.

Let's consider each of these factors more closely to gain a better understanding of the student's perspective. The first external factor that emerged from the data pertained to characteristics of the teacher. I see this characteristic as one of the most important since teachers often have the power to affect other factors. When speaking with students, they often spoke of the influence a teacher's demeanor had on their attitude toward the class. These students described memories of nice teachers, funny teachers, unapproachable teachers, and devoted teachers.

Another category that emerged was the amount of interaction and type of relationships that students had with their teachers. This often led to a discussion of the amount of personal attention that students receive from teachers and the effect this has on student attitudes. One student discussed the positive impact a devoted teacher who gave plenty of personal attention can have. She said, "*I had a teacher in high school that really, really tried to do everything she could to make me understand. She met me after class. That would be the most positive thing. I knew she was doing everything she could to help me.*"

The second external factor of teaching characteristics is clearly closely related to teacher characteristics. First and foremost, students felt that the clarity of their teacher's explanation influenced their understanding of mathematics and, hence, their attitude toward mathematics. Some students also discussed the importance of seeing mathematics

and explanations from multiple points of view and multiple representations, such as graphically and algebraically.

Some also felt that the explanations and examples used in the class should highlight the usefulness of mathematics. The presence of collaborative learning also had an effect on some students' attitudes, along with the use of time and pacing during instruction. Another student thought illustrating the usefulness of mathematics can have a lasting effect on students. She said "*If you're positive and willing to take time to teach and connect with the kids and bring it into a real life scenario, I think that is going to help kids learn math better and have a better time with math in the long run.*"

Size and environment were the two primary classroom characteristics that students felt affected their attitude toward mathematics. Since this study was conducted with students enrolled in a large lecture college algebra class, size was one of the most referenced characteristics. A student summarized the way a large class makes them feel and the environment it often creates. He compared this large class to a previous college math class and said, "*It [a previous college math class] just seemed more on a personal level and it was a smaller class—there was only probably 25 kids in it and I think that really helps with math classes. When you don't feel overwhelmed by the student population as well as the concepts…and I think at the college level your classes are so huge and so you feel just swept under the rug anyway…so it's hard to kind of stay ahead of the game in that environment.*"

The fourth and final external factor is assessments and achievement. In terms of achievement, students spoke often of the value of success in mathematics courses and the role success plays in student attitudes. Specifically, students found their attitudes

improved as their success in the course improved. Simply stated a student said, *"If you do something and you do it good you're going to like it a lot better than if you're failing something. Compared to like sports. You feel like if you're good at basketball that means you like to do it. And if you're pretty terrible you don't want to go out there and play all the time.*"

In terms of assessments, the amount and type of assessments were cited by students as affecting their attitudes toward mathematics.

The final theme is the internal factor that affects student attitudes toward mathematics: individual perceptions and characteristics. In the interviews, a few students drew on early family experiences and the influence they had on their attitude toward mathematics. Individual perceptions of challenge level, frustration level, and a sense of accomplishment were believed to impact student attitudes. A student discusses the enjoyment and sense of accomplishment that comes with meeting a challenge, but also the frustration and negative feelings associated with a problem that is too challenging. Challenge and frustration are often linked with motivation. Students conveyed their need to connect to math topics in order to improve student attitudes.

Finally, the most discussed category that students felt influenced their attitude toward mathematics was the level of understanding. Most students truly felt that their attitude towards mathematics was often in direct relation to their level of understanding. When asked what would improve their attitude toward mathematics, one student said, *"…just a better understanding of it rather than just trying to remember stuff just for a test or just for a quiz. Understanding it for a long period of time"*

Now that we have considered each of these factors in more detail, what does it tell us and how can we use these ideas? I think we can consider these five themes to determine how we may be able to reverse or prevent poor attitudes towards mathematics, even at the college level.

Returning once again to the relationships among the factors, we recognize that external factors can influence each student's internal perspective. I believe a student's attitude is part of their internal perspectives and I realize that we cannot directly control each individual perspective. However, as a teacher, I know that I have some influence over these external characteristics.

After reviewing the interviews, I recognized many ideal classroom conditions that most students desire: ideal characteristics of a teacher, a classroom, a teaching style, and assessments. I believe trying to meet these ideal conditions through these external factors can ultimately influence each student's internal perception and attitude toward mathematics. Hence, considering these external factors and the ideal classroom conditions provides a framework for improving student attitudes.

All of these conditions that educators and the education system can control are external conditions belonging to one of the four factors discussed. Educators should try to affect the external conditions in the hopes of affecting each individual's internal conditions.

In terms of teacher characteristics, students want a nice, approachable devoted teacher who respects students and makes time for each student. Desired teaching characteristics include multiple classroom activities and techniques coupled with clear explanations and many examples. These examples should be challenging, interesting,

and useful in real life. The assessments would be fair and frequent; while overall the classroom would be small in size with a relaxed, interactive environment.

Seems simple and direct, right? I think many would agree with most of these ideal conditions. I would like to think I am a devoted teacher who gives clear, useful and interesting explanations. Then, why is this so difficult? Why aren't these conditions already in place? In other words, if this is so simple, why don't we do it?

Well, I believe there are many responses to this. I think for some educators, many of these conditions have been put into place. This is apparent in the positive memories that students have of mathematics.

On the other hand, the fact is that there are real world restrictions that produce obstacles to obtaining some of these conditions. Financial costs, coordinated courses, and teacher tenure are merely a few examples.

Also, while I believe most educators would agree that student attitudes toward mathematics often decline, I am not sure that everyone has considered the student point of view and the similarities it seems to have with many teacher's point of view. In other words, I do not feel that many have taken the time to truly understand where the students are coming from and the fact that teacher and students desire many of the same classroom characteristics.

The results of this study indicate five factors that influence student attitudes toward mathematics with the four external factors impacting the student's individual perceptions and characteristics. These factors and their relationship create implications and suggestions for schools at all levels.

I found through these interviews that most students really do want to understand mathematics. A lack of understanding seems to promote the decline of student attitudes toward mathematics. However, there can be differences in student definitions of understanding and teacher definitions of understanding. How do students gauge their level of understanding? Do they think understanding means being able to manipulate and apply algorithms or are they genuinely concerned with understanding the deeper concepts and connections? These clarification questions were not asked in the interviews, although upon reflecting on the interviews, I suspect the definition is different for different students. I believe true understanding needs to be emphasized more in every grade, rather than memorization and procedures. Students need depth more than breadth. The reality is many topics get covered so quickly and poorly that students often are forced to relearn material over and over again. If each topic were concentrated on and taught for understanding the first time, I believe we would have less students needing repeated remediation and would have more positive attitudes toward mathematics. As I said earlier, one way to accomplish this is to limit the number of concepts covered per year, as well as overhauling the methods used to teach the concepts. Also, some standardized tests now in the K – 12 school system have been undergoing changes. These changes need to continue to occur and focus on testing for understanding rather than purely skill. This is not to say that skills should not be covered. However, in my opinion, skills can serve as the foundation for higher level thinking, deeper understanding and stronger connections. One way to ensure students are able to obtain a deeper understanding is maintaining a proper balance between challenge and frustration. This also requires teachers evaluating students to ensure each student is being appropriately

challenged. Evaluation is not always about summative assessments. Teachers should constantly assess in their classroom. Personally, I find it very helpful to survey student facial expressions and body language. Often, I can get a sense if students are lost just by being aware of students' nonverbal reactions.

This leads to the importance of teacher devotion. Students that were interviewed want teachers who are invested in their learning and truly care if their students understand the material. An increase of devoted teachers whose primary purpose and reason for being in the education field is to teach students will definitely increase student understanding and attitudes. One way to evaluate a professor's teaching for undergraduate college mathematics course is to critically review student evaluations. However, as we have seen from this study, opinions and attitudes can be influenced by many factors. Hence, it is important that this is not the only method for evaluation. Informal conversations with past and present students can also help to evaluate teaching. Scheduled and unscheduled visits to classrooms should also occur to not only evaluate teaching but also to create conversations and collaborations among colleagues. Overall, extra efforts by everyone in the department will emphasize the importance of teaching in higher education.

Most of the implications and suggestions become attainable with smaller classes. Students overwhelmingly preferred smaller classes, as long as they are given more attention and, therefore, are able to understand mathematics more readily. It also prevents an overwhelming environment and reduces the occurrence of standardized testing. Once again, smaller classes do not guarantee increased individual attention; it merely becomes easier to do if teachers and the education system believe this is important

and are willing to follow through. I do recognize that financially, smaller classes are not always possible. In these cases, I believe more effort needs to be made to make a large classroom seem small. This can be accomplished by breaking the large class into smaller subsections. Graduate assistants or teacher's aides can assist in providing personal attention to all students.

Personally, I believe the results from my study have affected the way I view students and their attitudes. I see this come across in my teaching style and the way I interact with them. Ultimately, I believe all educators and the education system need to recognize these implications and devote efforts towards implementing suggestions as best possible. These implications and suggestions are simply stated, but in no means are they simple to implement. I truly believe a commitment to improving student attitudes will be linked to an improvement in student success and understanding.

References

Adams, V.M. (1989). Affective issues in teaching problem solving: a teacher's perspective. In McLeod, D. & Adams, V. (eds.) *Affect and Mathematical Problem Solving,* 193-201.

Anderson, J. (2005). The relationship between student perceptions of team dynamics and simulation game outcomes: an individual-level analysis. *Journal of Education for Business, Nov/Dec,* 85-90.

Beswick, K. (2006). Changes in pre-service teachers' attitudes and beliefs: the net impact of two mathematics education units and intervening experiences. *School Science and Mathematics, 106(1),* 36-47.

Beswick, K. (2007). Teachers' beliefs that matter in secondary mathematics classrooms. *Educational Studies in Mathematics*, *65*(1), 95.

Cheseboro, J. (2003). Effects of teacher clarity and nonverbal immediacy on student learning, receiver apprehension, and affect. *Communication Education, 52(2),* 135-147.

Elliott, B., Oty, K., McArthur, J., & Clark, B. (2001, November). The effect of an interdisciplinary algebra/science course on students' problem solving skills, critical thinking skills and attitudes toward mathematics. *International Journal of Mathematical Education in Science & Technology*, *32*(6), 811-816.

Grouws, D. & Cramer, K. (1989). Teaching practices and student affect in problem-solving lessons of select junior-high mathematics teachers. In McLeod, D. & Adams, V. (eds.) *Affect and Mathematical Problem Solving,* 149-161.

Hannula, M. (2002). Attitude toward mathematics: emotions, expectations, and values. *Educational Studies in Mathematics, 49,* 25-46.

Harkness, S., D'ambrosio, B., & Morrone, A. (2007). Preservice elementary teachers' voices describe how their teacher motivated them to do mathematics. *Educational Studies in Mathematics, 65*(2), 235.

Higgins, K. (1997). The effect of year-long instruction in mathematical problem solving on middle-school students' attitudes, beliefs, and abilities. *Journal of Experimental Education, 66(1),* 5-29.

Kinney, D. (2001). A comparison of computer-mediated and lecture classes in developmental mathematics. *Research and Teaching in Developmental Mathematics, 18(1),* 32-40.

Lopez, F., Lent, R., Brown, S., & Gore, P. (1997). Role of socio-cognitive expectations in high school students' mathematics-related interest and performance. *Journal of Counseling Psychology, 44(1),* 44-52.

Midgley, C., Feldlauder, H., & Eccles, J. (1989). Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development, 60,* 981-992.

Mitchell, T. (1999). Changing student attitudes toward mathematics. *Primary Educator, 5(4),* 2-9.

Pearce, K., Lungren, M., & Wince, A. (1999). The effects of curriculum practices on first graders' attitudes, activity preference, and achievements in mathematics. *Education, 119(1),* 82-90.

Popham, W. (2005). Students' attitudes count. *Educational Leadership, Feb.,* 84-85.

Raymond, A., & Leinenbach, M. (2000). Collaborative action research on the learning and teaching of algebra: a story of one mathematics teacher's development. *Educational Studies in Mathematics, 41*(3), 283-307.

Royster, D., Harris, M., & Schoeps, N. (1999). Dispositions of college mathematics students. *International Journal of Mathematical Education in Science and Technology, 30(3),* 317-333.

Schoenfeld, A. (1985). Students' beliefs about mathematics and their effects on mathematical performance: a questionnaire analysis. *Paper presented at the Annual Meeting of the American Educational Research Association,* 1-39.

Stage, F. K. (2000). Making a difference in the classroom. *About Campus, July/August,* 29 – 31.

Swan, M., Bell, A., Phillips, R., & Shannon, A. (2000). The purpose of mathematical activities and pupils' perceptions of them. *Research in Education, 63,* 11-20.

Tapia, M. & Marsh, G. E. (2001). Effect of gender, achievement in mathematics, and grade level on attitudes toward mathematics. *Paper presented at the Annual Meeting of the Mid-South Educational Research Association*. *Science, Mathematics, and Environmental Education,* 1-20.

Thompson, A.G., & Thompson, P.W. (1989). Affect and problem solving in an elementary school mathematics classroom. In McLeod, D. & Adams, V. (eds.) *Affect and Mathematical Problem Solving,* 162-176.

Townsend, M., Moore, D., Tuck, B., & Wilton, K. (1998). Self-concept and anxiety in university students studying social science statistics within a cooperative learning structure. *Educational Psychology, 18(1),* 1-14.

Uusimaki, L. & Nason, R. (2004). Causes underlying pre-service teachers' negative beliefs and anxieties about mathematics. *Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, 4*, 369-376.

Wanzer, M. & McCroskey, J. (1998). Teacher socio-communicative style as a correlate of student affect toward teacher and course material. *Communication Education, 47,* 43-52.

Whitin, P. (2007). The mathematics survey: a tool for assessing attitudes and dispositions. *Teaching Children Mathematics*, *13*(8), 426-432.

Wilkins, J. & Ma, X. (2003). Modeling changes in student attitude toward and beliefs about mathematics. *The Journal of Educational Research, 97(1),* 52-63.

Wilkins, J. & Brand, B. (2004). Change in preservice teachers' beliefs: an evaluation of a mathematics methods course. *School Science and Mathematics, 104(5),* 226-232.

Yusof, Y.M., & Tall, D. (1999). Changing attitudes to University mathematics through problem solving. *Educational Studies in Mathematics, 37,* 67-82.