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Lecturers' Views on Ghana's Undergraduate Mathematics Education

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Abstract

This paper synthesizes the views of 6 university lecturers on Ghana's undergraduate mathematics education. These views were expressed during a mathematics workshop sensitization program on the "contribution of undergraduate mathematics education to the Ghanaian economy." The data consisting of open-ended questions followed by semi-structured interviews were analyzed using qualitative analysis. The results of this study indicated that lecturers' teaching methods do not enable students to connect theories with practice. The topics these lecturers teach and the methods they use in the classroom seem far removed from students' everyday experiences. As a result, many students are rarely able to identify and connect their ideas with everyday realities of life. Additionally, some topics are delivered in a weird and abstract methodological mode, making it increasingly difficult for students to comprehend. The study finally concludes with suggestions that an overhaul of the curriculum is paramount with emphasis on students' comprehension for adoption by Ghanaian universities, to acquaint lecturers with modern teaching methods.

Key words: Teaching methods, Qualitative analysis, Undergraduate mathematics education

Introduction

Ghana's undergraduate mathematics education curriculum is comparable to those found in developed countries such as Britain, United States, Canada, Japan, Singapore and Finland (Trend in International Mathematics and Science Study [TIMSS], 2011). A major component of the curricula of these countries are courses ranging from calculus, geometry, algebra, differential equations, real analysis, complex analysis and topology. We have used the countries above as reference because the international community believes they provide the best undergraduate mathematics education. In most advanced countries, while lecturers who hold only master's degrees are not employed to teach undergraduate mathematics courses, Ghana still continues to rely on such lecturers because it does not have the full complement of professors and doctorate holders to conveniently cater for the seemingly large numbers of student intake in its universities. In the U.S. for example, master's degree holders are mainly employed as instructors in major universities to assist professors and doctorate degree holders' with teaching and research. A few, nonetheless, are still employed in liberal arts colleges to augment the full complement of teaching staff.

Effective teaching does not solely depend on lecturers' content knowledge, but also on their pedagogical skills. With student population becoming more and more diverse, the need for lecturers to pay attention to effective pedagogical skills has never been greater. In fact, effective classroom discourse has been suggested by many educators as the panacea to such problem (NCTM, 2008). In Ghana, students begin their undergraduate mathematics education after completing nine years of basic education and three years of secondary education. Students, generally, complete a four-year undergraduate mathematics education program. Mathematics education gives students flexibility in career choices and is a viable way to prepare students for graduate study in several fields. For example, fields such as computer science and chemistry require a great deal of mathematical skills. Mathematics is a challenging field that opens doors to many courses in physical sciences, engineering, computer science, biological and social sciences. Mathematics which is more than just numbers enables students to compute, think logically, solve problems and analyze issues. An acquisition of these qualities adequately prepares students for the workplace and therefore is highly valued by most employers (Augustine, 2007). Just by studying a few advanced-level mathematics courses can open windows of opportunities for students. Mathematics is an excellent foundation for students to excel in courses such as anthropology, sociology, law,

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business and medicine. Additionally, a solid mathematical training will enable students to better understand science and technology and their effects on our world.

Literature Review

Mathematics proficiency is a necessary ingredient for success in today's technologically savvy workforce (Missouri Department of Higher Education [MDHE], 2007). It is necessary, particularly for post-high school students who are generally trained to take up middle and higher-level jobs in the global workforce (Augustine, 2007). In spite of the need for mathematics proficiency, teachers still rely on instructional practices they inherited from their education preparatory programs (Ball, 1988). For such teachers, these methods of delivery force them to rely on teacher-centered approaches of teaching, which have negative effects on undergraduate learning and motivation (Walczyk, Ramsey & Zha, 2007). For most universities, however, restructuring their undergraduate mathematics instructional methods is a sure way of making them responsive to the challenges they face. This restructuring could help offset negative effects, including low student achievement, resulting in low levels of graduation rate among students. With the huge deficit in achieving the global demand for mathematics graduates, lack of self-efficacy significantly contributes to students' poor performance in mathematics ((Bandura, 1997; Hall & Ponton, 2005). Self-efficacy is a person's perception of his or her capabilities at performing a given task (Bandura, 1997). In fact, self-efficacy beliefs greatly influence decisions that students make concerning the choice of courses and career options (Hackett & Betz, 1989; Lent, Lopez, & Bieschke, 1991). Research indicates that mathematics self-efficacy positively correlates with mathematics performance (Cooper & Robinson, 1991; Hackett, 1985), and a linkage exists between self-efficacy and achievement (Hall & Ponton, 2005; O'Brien, Martinez-Pons, & Kopala, 1999; Siegle & McCoach, 2007). Thus, mathematics self-efficacy could influence mathematics achievement.

Studies involving self-efficacy has primarily focused on exploring the relationships among self-efficacy beliefs, related psychological constructs, motivation and achievement (Cooper & Robinson, 1991; Hackett & Betz, 1989; Hall & Ponton, 2005), and examining the linkage between self-efficacy beliefs and college major and career choices (Betz & Hackett, 1983; Hackett, 1985; Lent, Lopez, & Bieschke, 1991; Pajares, 1996). Consequently, students who report higher levels of mathematics self-efficacy also report higher levels of mathematics performance; this has universally become a mediating factor for academic outcomes, cognitive engagement and academic performance (Patrick & Hicks, 1997). The mediating effects of mathematics self-efficacy on mathematics performance have been of great interest to many researchers (Hackett, 1985; O'Brien, Martinez-Pons, & Kopala, 1999; Pajares & Miller, 1994; Randhawa, Beamer & Lundberg, 1993).

Apart from students' mathematics self-efficacy, conducive classroom climate can also directly influence student achievement (Eggen & Kauchak, 2007; Pierce, 2001). Classroom climate is the learning environment teachers create by adopting either a teacher-centered or student-centered approach to teaching. Apparently, student-centered approach has proven to be more effective than teacher-centered. While teacher-centered approach refers to instructional preference or teaching style that focuses most on the needs and well-being of students (Knowles, Holton & Swanson, 2005), learner-centered approach provides students with support and guidance, positive feedback and encouragement, empathy and mutual trust and respect (Pratt, 2002). When teachers create a classroom climate based on mutual trust and respect, students feel more secure (Pratt, 2002). This sense of safety is believed to have a positive influence on students' mathematics self-efficacy and mathematics achievement (Adelman & Taylor, 2005; Pianta, Stuhlman & Hamre, 2002; Pierce, 2001). Teachers who practice student-centered style of teaching at all levels have positive attitudes about student outcomes and are always optimistic that they will improve on their learning styles. Such teachers always establish student-teacher relationship that builds confidence and improves self-efficacy. Teachers who espouse student-centered perspective of teaching seek to empower the student; divulge a sense of personal regard for the welfare of their students; and view subject-matter content as simply a means for student self-efficacy (Pratt, 2002).

Student perceptions could account for considerable amount of variance in learning outcomes, which could improve if teachers created conducive classrooms for teaching and learning (Fraser, 1989). If teachers fail to exhibit this quality during the teaching process, it will result in low student perceptions of mathematical ability, which could create avenues for them to choose career paths with limited mathematics application. If teachers created a conducive learning environment, students become motivated to take risks and to participate freely in the learning process. It also provides students with a sense of safety and support and builds up students' enthusiasm and respect ─ students' level of academic achievement is greatly enhanced as a result (Pierce, 2001).
The goal of this paper was to synthesize lecturers' views on Ghanaian undergraduate mathematics education. The study was guided by the following research questions: (a) What steps should be taken by stakeholders to improve the learning outcomes (e.g., teaching style, mode of delivery, peer tutoring/mentoring) of Ghanaian

undergraduate mathematics education students (b) what are the factors that may be useful in informing the development of undergraduate mathematics education in Ghana? (c) Does the current undergraduate mathematics curriculum adequately prepare students for the workplace?

Method

Design

The research design for this study was grounded in a narrative inquiry framework. The claim for the use of narrative in educational research is that humans are storytelling organisms, who individually and socially, lead storied lives (Connelly & Clandinin, 1990). It is the study of the ways humans experience the world. This study was to examine the factors that may be useful in informing the development of undergraduate mathematics education in Ghana, and also to identify the steps that could be taken by stakeholders to improve the learning outcomes of Ghanaian undergraduate mathematics education.

Participants

Six lecturers: James, Ebenezer, Esther, Augustine, Zimi, and Abdulai (pseudonyms used throughout) participated in the study. James, thirty years old, has been teaching an introductory statistics course for the past five years. He has a master's degree in statistics. Ebenezer, thirty-five years old, has a doctorate degree in mathematics. He has been teaching graduate and undergraduate pure mathematics courses for the past nine years. Esther, thirty-two years old, has a doctorate degree in applied mathematics. She has been teaching graduate level applied mathematics courses for the past five years. Zimi, thirty-three years old, has been teaching introductory analysis courses for the past six years. He has a master's degree in pure mathematics. Finally, Abdulai, twenty-eight years old, has been teaching numerical methods for the past three years. He is yet to earn his doctorate degree in applied mathematics.

Data Collection

The initial source of data was a questionnaire consisting of open-ended questions, followed by an interview. The questionnaire, adapted from the results of the Mathematical Sciences HE curriculum Innovation Project on Graduate views on the Undergraduate Mathematics Curriculum (Inglis, Croft & Mathews, 2011), sought to examine factors that may be useful in informing the development of undergraduate mathematics education in Ghana, and also to identify the steps that should be taken by stakeholders to improve the learning outcomes of Ghanaian undergraduate mathematics education. The second stage of data collection was shaped by an initial analysis of data from the first stage and, as a result, the second stage included interview questions posed purposely to the lecturers to clarify the inconsistencies from the responses in the questionnaire. Each participant was interviewed for 30 minutes.

Data Analysis

The data analysis was grounded in an analytical-inductive method in which lecturers' responses were coded and then classified according to relevant themes. Coding of the data began with already generated codes such as: (1) teaching quality, and (2) teaching style, was derived from the literature of the study. The inductive approach to data coding was utilized in a case-by-case basis to identify themes in the data. By this approach, each lecturer's responses were compared and analyzed for similar themes with the others. The frequencies of similar responses among the lecturers were categorized into relevant themes. Because, the data were in two-fold, individual lecturers' responses in the open-ended questions were compared with the interview questions for consistencies and inconsistencies. On completion of the coding, a domain analysis of the data sets was conducted as a means of identifying, organizing, and understanding the relationships among the primary themes that were found through the coding process (Spradley, 1979).

Results and Discussion

This section presents the results of the study and is organized by eight themes. Although data were collected from each lecturer, in reporting the results, themes related to factors that examine lecturers' views that may be useful in informing the development of undergraduate mathematics education in Ghana; those that identify the steps that should be taken by stakeholders to improve learning outcomes of Ghanaian undergraduate

mathematics education; and, whether or not, the current undergraduate mathematics curriculum adequately prepares students for the workplace, were considered.

Teaching Quality

Ebenezer: Lecturers do their best to teach students very well in spite of the limited resources. They offer students the much needed support for them to excel in all their courses

Ebenezer's comment shows that lecturers are willing to put up their best despite the limited resources available to them. To ensure that students' fully understand the material presented in class, lecturers sometimes photocopy relevant supplementary material to augment those that are officially recommended.

James: Although lecturers are doing their best, most students still lack the conceptual understanding to effectively transition into higher-level mathematics.

Jame's comment demonstrates that the instructional methods used by mathematics teachers at the basic and high school levels may have outlived their usefulness. In fact, students' inability to smoothly transition into high-level mathematics indicates a fundamentally flawed structure in the school mathematics curriculum. Mathematics is well understood if the pedagogy teachers employ stresses on concept building and enables students to link them to other concepts. Additionally, some topics are delivered in a weird and abstract manner, making it increasingly difficult for students to comprehend.

Teaching Style

Esther: Nowadays, lecturers rarely write on the board. They resort to using PowerPoint slides as their mode of instruction.

Esther admits that there is markedly a change in the mode of mathematics instruction. This change may have been necessitated by changes in technology dependency over time. Her comments also brings to the fore how changes in technology use has affected mathematics instruction.

Abdulai: Lecturers who write on the board help students to develop their understanding by throwing valuable insight into the topics they teach.

Abdulai, by this remark, realizes that the traditional or conventional mode of instructional delivery that forces lecturers to write on the board is appropriate since students are able to follow every step a lecturer uses to arrive at a solution. Lecturers do not just write on the board, they also communicate verbally their strategies and procedures. Students who encounter problems during the process quickly ask questions to clarify their understanding. If teachers, through this process, are able to throw more light on the topics they treat, students understanding will be greatly enhanced.

Augustine: Most lecturers lecture their students, but this method of conveying the material to large groups is poor. It doesn't allow students to engage with the material.

Augustine admits that lecturers should teach their students rather than solely to lecture. He agrees that breaking students into smaller and manageable groups is the ideal method to transfer knowledge to the majority of our students. But, the high university enrollment, coupled with the limited resources makes this unachievable, especially, when government's budget earmarked for infrastructural development has been stretched thin.

The Need to Have More Real World Application

Zimi: There must be emphasis on applying the concepts students learn to problems they face in the real world.

James: Mathematics concepts are often presented in an overly abstract manner with little attempt at linking it to the real world.

The essence of any good mathematics curriculum is for students to apply the knowledge they acquire to solve problems. Zimi's remark clearly indicates that most lecturers present material in overly theoretical manner with no linkage or connection to occurrences or happenings in the real world. However, a few courses such as topology, real analysis and abstract algebra do no lend themselves to practical orientation, and therefore require

thorough understanding of the concepts at the rudimentary stages. Lecturers' teaching methods do not enable students to connect theories with practice. The topics these lecturers teach and the methods they employ in the classroom seem far removed from students' everyday experiences.

Peer Support

James: Students are sometimes put into groups to perform a task.

Augustine: I recommend group work as an enhancement to students' mathematics understanding. The drawback of this approach is that students of different ability levels are put together leaving room for a few students to dictate the learning process.

Learning is assumed to have occurred if students owned their styles and worked independently. Achieving this objective requires students at some point to learn from peers when they encounter problems. However, in supporting average students, care should be taken to ensure that high ability students do not control the learning process or intimidate the weaker students by their presence.

Esther: students should be encouraged to approach peers for help when they really need one.

Esther's comment emphasizes that no student or individual is repository of knowledge − no student or individual can boast of knowing everything. As students approach their peers for support, they feel very comfortable and are able to express their thought and action without any fear or intimidation.

The Development of Generic Skills

Zimi: Students should be provided with tasks that yield intellectual challenges for them to solve, and they should be trained to think abstractly and logically.

Abdulai: Students should be encouraged to think logically and to work independently some of the time.

Augustine: Group work that relies on oral presentational skills should be enforced among students. Time management and good research skills should also be encouraged among students.

Encouraging students to think logically and abstractly is an expected result of any good curriculum. In fact, if students are unable to act in such a manner, then society has failed them. Mathematics education is not only about solving theoretical problems. It is about using these ideas to enable students work independently and to become autonomous problem solvers. Good presentational skills and proper time management should be the hallmark of every good student.

Restructuring of Academic Programs

Zimi: Currently, the courses offered do not lend themselves to providing the potential of addressing the problems confronting our world. Courses should link students to industries to enable them solve problems.

Abdulai: Teaching methods should be revised periodically to make them responsive to the modern trends. Old method should give way to new ones.

Augustine: The government should make a conscious effort to provide lecturers with textbooks and computers to enable them conduct research.

Academic programs should help us solve the myriad of problems confronting us. Thus, Zimi's comment indicates the importance of restructuring courses to make them responsive to our needs. The ability to apply courses in industries is very relevant. The comment by Abdulai shows that the old methods of teaching have proven to be ineffective. Augustine's comment indicates that textbooks and computers are important for research.

Integrating Technology into Teaching and Learning

James admits that without technology integration, teaching falls short of yielding the desired expectation. With technology use becoming widespread in recent times, the need for lecturers to be more conversant with its use cannot be greater.

James: Integrating technology into teaching should form part of every lecturer's best practices. Technology has come to stay and all must go with the flow.

Career Advice and Leadership Training

Augustine: Career advice really motivates students; especially if they realize that what they are learning can lead them to specific career paths.

Zimi: Eventually, students may take up jobs that will enable them assume leadership roles. The need for leader qualities is therefore indispensable for them.

Augustine's comment echoes a penchant need of career advice for students. By attending career advice sessions, students are motivated if they can always see "light" at the end of the tunnel. A general inclination is that students then become creative and innovative in their efforts to change the status quo. The comment by Zimi is a clear determination of the fact that students will take up jobs, therefore society expects excellent leadership qualities from these students.

The discussion focuses on factors that may be useful in informing the development of undergraduate mathematics education in Ghana. It further discusses the steps that could be taken by stakeholders to improve the learning outcomes (e.g., teaching style, mode of delivery, peer tutoring/mentoring) of Ghana's undergraduate mathematics education, and finally examines whether or not the current undergraduate mathematics education curriculum adequately prepares students for the workplace. There will be comments in their right positions on teaching quality, teaching style, the need to have real world application, peer support, development of generic skills, restructuring of academic programs, integrating technology into teaching and learning and career advice.

Teaching quality influences Ghana's undergraduate mathematics education. Lecturers are often constrained by limited resources including poor infrastructure, limited library facilities, crowded offices and unreliable internet connectivity. Because students' mathematical understanding is one of every lecturers' main preoccupation, they sometimes photocopy relevant supplementary materials to augment those that are officially recommended. Lack of conceptual understanding among students is indicative of the outdated instructional methods mathematics teachers at the basic and high school levels rely on for their classroom delivery.

In fact, an observation in this study that deserves close scrutiny is students' inability to smoothly transition into high-level mathematics, a pointer to the fundamentally flawed structure in the school mathematics curriculum. Consequently, an overhaul of the entire mathematics curriculum could be a sure way of addressing the seemingly "unappealing" curriculum. To address these challenges, the curriculum should enable lecturers to adopt pedagogical skills that emphasise on concept building and adequately prepares students to link theories to other concepts. Again, lecturers should deliver lessons in a practical methodological mode, making it increasingly easier for students to comprehend.

Lecturers should select instructional materials that are comprehensible enough for students, since mathematics at the university level is by nature abstract and complex. Lecturers should also prepare their lessons carefully taking into consideration students' specific needs and aspirations. When lecturers understand the needs of their students, they will be able to make distinction between difficult and easy topics, and this will encourage them to spend more time on difficult topics.

Lecturers' teaching style also influences Ghana's undergraduate mathematics education. This mode of instruction is necessitated by changes in technology dependency overtime. In as much as some students, and for that matter, lecturers seem to prefer the conventional mode of classroom instruction, others, believe that technology use by lecturers enhances their mathematical understanding. Technology use in of itself is a novelty, but it should not replace every conceivable instructional style. Sometimes a combination of technology use by lecturers and writing on the board should be employed very effectively to ensure that students are given the best mathematics education.

Lecturers should encourage students to work in groups to improve their communication skills. Through such group work, students who have learning difficulties can quickly ask for help. Sometimes breaking students into

smaller and manageable groups is the ideal method to transfer knowledge to the majority of students. However, the high university enrollment, coupled with the limited resources makes this unachievable, especially, when government's spending on infrastructural development has been stretched thin.

Lecturers should endeavor to present material in a practicable manner that links or connects theories to the real world situations. Many lecturers agree that a few courses such topology, real analysis and abstract algebra do not lend themselves to practical orientation. They require thorough understanding of concepts at the rudimentary stages. Therefore, care should be taken to ensure that teaching does not only become theoretical in nature.

Learning is assumed to have occurred if students owned their learning styles and worked independently. Achieving this objective requires students at some point to learn from peers when they encounter problems. As students approach their peers for support, they feel very comfortable and are able to express their thoughts and actions without any fear or intimidation. However, in supporting these average students, care should be taken to ensure that clever students do not only control the learning process but also intimidate the weaker students by their presence.

Encouraging students to think logically and abstractly is an expected result of any good education. In fact, if students are unable to act in such a manner, then society has failed them. Mathematics education is not only about solving theoretical problems. It is about using these ideas to work independently, and becoming a problem solver. Good presentational skills and proper time management are the hallmark of every good student.

Academic programs should enable us solve the myriad of problems confronting us. Thus, the importance of restructuring courses to make them responsive to our needs cannot be underestimated. The ability for students to apply courses in industries is very relevant, since this could help create jobs to propel the growth of the economy.

Undoubtedly, the old methods of teaching have proven ineffective that textbooks and computers are important for research. Without technology integration, teaching falls short of yielding the desired expectation. The spread of new educational technology means there is the need for lecturers to be more conversant with its use in order to prepare students to compete favorably with their peers at the international level.

Academic programs should help us solve the myriad of problems confronting us. Restructuring courses to make them responsive to our needs is very important. The ability to apply courses in industries is very relevant. The old methods of teaching have proven to be ineffective.

Limitations

First, the sample size was not diverse because lecturers were selected from the same locality. To help improve on the validity of the results, a diverse sample from several universities would have been more representative. Second, further questions on the qualitative data might have influenced lecturers' responses over several months. Some relevant literature suggests that many of the insights that come from qualitative processing may not show up until long after the study ends (Greenberg, Rice & Elliot, 1993). Thus, it is possible that lecturers may have experienced more meaningful effects of the qualitative-based processing some months later after the procedure ended, than on the day the data was actually collected.

Conclusion

The current undergraduate mathematics education curriculum is intended to make students become autonomous learners and problem solvers. To achieve this objective requires that we train more qualified lecturers in pure and applied mathematics to be able to connect what lecturers teach to what pertains in industries. Sometimes, an overhaul of the curriculum is needed at some levels that have not yielded the desired result.

References

Adelman, H. & Taylor, L. (2005). Classroom climate. In S.W. Lee, P.A. Lowe, & E. Robinson (Eds.), *Encyclopedia of school psychology* (pp. 88-90), Thousand Oaks, CA: Sage Publications.

Augustine, N. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. Washington, DC: National Academy of Sciences.

Ball, D. (1988). Unlearning to teach mathematics. *For the Learning of Mathematics*, *8*(1), 40 – 48.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W. H. Freeman and Company.

Betz, N. & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science based college majors. *Journal of Vocational Behavior*, *23*, 329-345.

Connelly, F. M., & Clandinin, D. J. (1990). Stories of experience and narrative inquiry. *Educational Researcher*, *19* (5), 2-14.

Cooper, S. & Robinson, D. (1991). The relationship of mathematics self-efficacy beliefs to mathematics anxiety and performance. *Measurement & Evaluation in Counseling & Development*, *24*, 4-11.

Eggen, P. & Kauchak, D. (2007). *Educational psychology: Windows on classrooms*. Upper River Saddle, NJ: Pearson Prentice Hall.

Fraser, B. (1989). Twenty years of classroom climate work: Progress and prospect. *Journal of Curriculum Studies*, *21*, 307-327.

Greenberg, L.S., Rice, L.N., Elliot, R. (1993). *Facilitating emotional change. The moment by moment process*. Guilford Press, New York.

Hackett, G. (1985). Role of mathematics self-efficacy in the choice of math-related majors of college women and men: A path analysis. *Journal of Counseling Psychology*, *32*, 47-56.

Hackett, G. & Betz, N. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education*, *20*, 261-273.

Hall, J. & Ponton, M. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education*, *28*, 26-33.

Inglis, M., Croft, T., & Mathews J. (2011). *Graduate views on the undergraduate mathematics curriculum*. Mathematical Sciences HE Curriculum Innovative Project.

Knowles, M., Holton, E., & Swanson, R. (2005). *The adult learner: The definitive classic in adult education and human resource development*. Burlington, MA: Elsevier, Inc.

Lent, R., Lopez, F., & Bieschke, K. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology*, *38*, 424-430.

Missouri Department of Higher Education [MDHE] (2007). *Report on mathematics in Missouri*. Retrieved May 21, 2014, from http://www.dhe.mo.gov/mathmissourireport.shtml

National Council of Teachers of Mathematics (2008). Equity in mathematics education: A position of the National Council of Teachers of Mathematics. Retrieved on September 20, 2009 from http://www.nctm.org/uploadedFiles/About_NCTM/Position_Statements/Equity%20final.

O'Brien V., Martinez-Pons, M., & Kopala, M. (1999). Mathematics self-efficacy, ethnic identity, gender, and career interests related to mathematics and science. *Journal of Educational Research*, *92*, 231-235.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543-578.

Pajares, F. & Miller, M. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology*, *86*, 193-203.

Patrick, H. & Hicks, L. (1997). Relations of perceived social efficacy and social goal pursuit. *Journal of Early Adolescence*, *17*, 109-129.

Pianta, R., Stuhlman, M., & Hamre, B. (2002). How school can do better: Fostering stronger connections between teachers and students. *New Directions for Youth Development*, *93*, 99-107.

Pierce, C. (2001). Importance of classroom climate for at-risk learners. *Journal of Educational Research*, *88*, 37-42.

Pratt, D. (2002). Analyzing perspectives: Identifying commitments and belief structures. In D. Pratt (Ed.), *Five perspectives on teaching in adult and higher education* (pp. 217-255). Malabar, Florida: Krieger Publishing Company.

Randhawa, B., Beamer, J., & Lundberg, I. (1993). Role of mathematics self-efficacy in the structural model of mathematics achievement. *Journal of Educational Psychology*, *85*, 41-48.

Siegle, D. & McCoach, D. (2007). Increasing student mathematics self-efficacy through teacher training. *Journal of Advanced Academics*, *18*(2), 278-312.

Trend in International Mathematics and Science Study [TIMSS] (2011*). Report on mathematics achievement*. Retrieved October 21, 2014, from https://nces.ed.gov/TIMSS/results11_math11.asp

Spradley, J. (1979). *Deaf like me*. New York City: Random House.

Walczyk, J., Ramsey, L., & Zha, P. (2007). Obstacles to instructional innovation according to college science and mathematics faculty. *Journal of Research in Science Teaching*, *44*(1), 85 – 106.