

Mathematics teachers' efficacy, experience, certification and their impact on student achievement

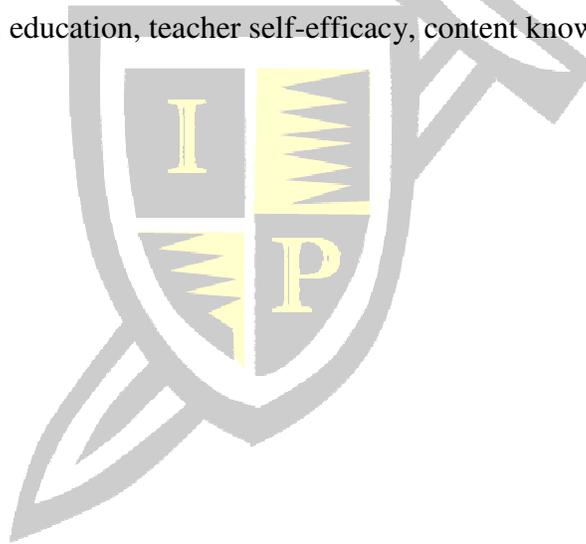
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ABSTRACT

The nature of mathematics teachers' knowledge specific to teaching mathematics is of ongoing concern in mathematics education research (Chapman, 2015). Furthermore, it is well known that teachers have an impact on students' achievement, and for several years mathematics education researchers have been studying teachers' content knowledge (Levenson, 2013). This naturalistic inquiry revealed teachers' perceptions about their content knowledge, their own self-efficacy, and their experience impacted student achievement.

Keywords: mathematics education, teacher self-efficacy, content knowledge



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OVERVIEW

Over the past decade, research has confirmed that teachers have substantial impacts on their students' academic and lifelong success (Chetty, Friedman, & Rockoff, 2014). Simply being knowledgeable in a subject does not necessarily mean one can be effective in teaching it. Putting knowledge into practice is an endeavor that a teacher must effectively translate to. (Bartos, S. A., Lederman, N. G., & Lederman, J. S. 2014). Despite concerted efforts to identify characteristics such as experience, education, and certification that might be correlated with effectiveness, however, the nature of effective teaching still largely remains a black box (Blazar, 2015). Efforts to uncover this "black box" are evidenced through qualitative research in the form of naturalistic inquiry.

LITERATURE REVIEW

Introduction

The nature of mathematics teachers' knowledge specific to teaching mathematics is of ongoing concern in mathematics education research (Chapman, 2015). Furthermore, it is well known that teachers have an impact on students' achievement, and for several years mathematics education researchers have been studying teachers' content knowledge (Levenson, 2013). This study will explore the following: an elementary teachers' experience, teacher self-efficacy, and teaching certification in relation to student achievement. Over time the importance of mathematics in our society has increasingly been acknowledged which in turn has led to more intense scrutiny of our mathematics education system (Hourigan & O'Donoghue, 2015). An elementary teachers' experience begins with their preservice education. Preservice teachers learn mathematics in a variety of situations. The most common form of exposing teachers to learn mathematics is formal in-service courses dealing in a disciplinary-structured way with the content of mathematics (Julie, 2014). After preservice teachers finish their education, they are required to become certified. Teachers have the option of which certification test they wish to pursue. Most elementary teachers receive a generalist certification, which enables them to teach any subject from early childhood through 6th grade. At times teachers are placed in a position in which they may not feel comfortable teaching the content, although they are certified to teach the subject. This is where teachers' self-efficacy may play a role in student achievement. Once teachers are in the field of education they are encouraged to continue professional development. Professional development continues to be the primary vehicle to trigger the increase of standards-based pedagogies in mathematics classrooms (Polly, Neale, & Pugalee, 2014).

Teachers' experience and student achievement

Teacher experience and knowledge is essential to engage students in meaningful and effective mathematical practices in the classroom in order to construct deep understanding of mathematics (Chapman, 2015). Preservice teacher education and professional development are factors that may identify a mathematics teachers' effectiveness in an elementary classroom and the impact of student achievement in the specific content.

Preservice teachers. A large body of international research suggests that many qualified and preservice elementary teachers do not possess appropriate mathematics subject matter

knowledge (MSMK) for teaching (Hourigan & O'Donoghue, 2015). While a majority declare that elementary mathematics teachers need MSMK, the question remains as to what this means and how it can best be achieved. In former times, a 'minimalist' view was common, where one was considered to have sufficient knowledge if they could 'do' the mathematics covered in the curriculum (Hourigan & O'Donoghue, 2015). Now this view point has been rejected for the fact that math content has become more rigorous at the elementary level. If one goal of teacher education is to ultimately improve teaching, then there needs to be more of a focus on understanding the knowledge drawn on by teacher educators as they teach content to preservice teachers (Castro-Superfine, 2014).

Professional development

Professional development in education is of utmost importance in order to keep up with the demands of more rigorous math standards. In the state of Texas most educators who hold any teaching certification are required to maintain 150 hours of professional development every five years. Professional development helps teachers acquire new teaching strategies or ways to implement content more effectively. Based on the findings from Polly, Neale, and Pugalee (2014), a professional development program led to statistically significant gains in teachers' mathematical knowledge for teaching, self-reported enactment of standards-based pedagogies, and teachers' beliefs about both mathematics as a content area and the overall teaching and learning of mathematics.

Teacher efficacy and student achievement

Teacher efficacy is a teachers' confidence in their ability to promote student learning. It is, for example, the extent to which teachers believe that they can promote students' learning, even if the conditions are difficult (Künsting, Neuber & Lipowsky, 2016). If a teacher has high confidence in their abilities, student learning and achievement will be greater. Researchers realize the importance of teacher efficacy construct as a predictor of performance in teaching mathematics in particular, and in education and research in general (Katz & Stupel, 2016). Content knowledge and personal teaching efficacy are positively related. No significant relationship is known for content knowledge and outcome expectancy (Newton, Leonard, Evans & Eastburn, 2012).

Teachers' certification and the impact of student achievement

In Texas, the State Board of Education gives prospective educators a certification path in which an elementary teacher can teach any subject from early childhood through 6th grade. Educators who choose to receive this certification will be able to teach a subject in which they can possibly have weak content knowledge. A study indicated that the number of mathematics teachers' content courses was a better predictor of student achievement than the number of mathematics education courses (Telese, 2012). In Texas, with the introduction of the State of Texas Assessments of Academic Readiness (STAAR), which appears to be a more rigorous state assessment, and increasing state assessment standards, it is imperative that effective teachers are in all classrooms (Fox & Peters, 2015). In a state that requires assessments for students to be promoted, teacher-training programs should also consider adding to their course requirements

one on preparing teachers for high stakes assessments.

STATEMENT OF THE PROBLEM

There is a problem in South Texas elementary math classrooms. Despite the fact that teachers should be competent and effective in their subject matter, many still lack the knowledge needed to perform at a level essential for students' long term success. Studies conducted throughout America show that teachers lack essential knowledge for teaching mathematics (Tchoshanov, 2011). This problem negatively impacts student achievement because, the lack of teacher effectiveness in the content in which they teach inhibits student learning. A possible cause of this problem is a teachers' lack of experience, their self-efficacy and the teaching certification they hold. Elementary teachers across Texas who hold a generalist certification may teach any subject kindergarten through sixth grade. However, teachers are sometimes placed in a core subject area, such as math, in which they lack the content knowledge needed to perform at a required professional level. Perhaps a study which investigates mathematics teachers' view on teaching mathematics, their efficacy, and thoughts on teacher certification, by a qualitative naturalistic inquiry, could be a step closer to remedy the situation.

PURPOSE OF THE STUDY

The purpose of this study is to describe how teachers in three rural South Texas elementary schools view teaching mathematics and their perception of content knowledge certification impacting student achievement.

CONTRIBUTION OF THE STUDY

This study will contribute the knowledge of the field of mathematics in the area of teacher content knowledge and their effectiveness in the classroom. Furthermore, this study will determine if teacher self-efficacy and a teachers' certification impacts student achievement in mathematics. Individuals and societies that can use mathematics effectively in this period of rapid changes will have a voice on increasing the opportunities and potentials which can shape their future (NCTM, p.40).

METHODOLOGY

Introduction

The research methodology utilized for the project was qualitative in nature, specifically, naturalistic inquiry. A naturalistic study is usually never fully established before the study begins, but rather it emerges as data are collected, preliminary analysis is conducted, and the context becomes more fully described (Erlandson, Harris, Skipper, & Allen, 1993). Furthermore, naturalistic studies are impossible to design in any absolute way before the study is actually undertaken (Lincoln & Guba, 1985).

Research Design

There has been a void in the literature of teachers' describing their efficacy, experiences, and perceptions of teaching mathematics in regards to their teaching certification. This void also fails to examine the impact of student achievement in respect to the aforementioned description of teachers. The most suitable research design for this naturalistic small scale study was a case study design. This case study examined teachers' perceptions of teaching mathematics, focusing on teacher efficacy, experience, and certification and the impact of student achievement. Data from interviews was coded and analyzed for themes.

Instrumentation

Naturalistic inquiry demands a human instrument (Lincoln & Guba, 1985; Patton, 2002) as the primary source of data gathering. The researcher, in this study, conducted semi structured interviews which were recorded, transcribed, and examined for themes. Semi-structured interviews are open-ended, but generally follow a script and covers a list of topics (Bernard, 2002). In this study, the interview followed a scripted list of interview questions and stayed within the general scheme of questions throughout each interview.

Participants

All sampling is conducted with some purpose in mind (Lincoln & Guba, 1985). The respondents chosen were 3 teachers who have taught K-3 math and an administrator who serves as a math facilitator at an elementary campus, each are key figures in the interviews that were conducted (Erlandson, et al. 1993). All respondents were from south Texas elementary schools, two of whom the researcher works with. A fifth participant, who was a 4th grade math teacher, was unable to participate in a scheduled interview due to personal reasons. Rescheduling became an issue and therefore was not able to participate in the research. Participants were interviewed on their perceptions of teaching elementary mathematics. The participants were contacted in person or by phone to explain the purpose of the research and to set up interviews. Once agreement was made for an interview, the researcher proceeded to meet face to face with the participants at individually scheduled times. Before the interview began, the researcher provided an informed consent document in which the participant agreed and signed.

Site Selection

“The researcher should seek to find the best site possible within the boundaries of his or her resources, and the primary guides for the site selection are the specific research topic problem and questions” (Erlandson, et al., 1993, p. 54). This small-scale study focused on south Texas elementary schools, therefore any south Texas elementary school would suffice for this particular study. The site selection chosen was based on accessibility to the researcher. The four participants work at schools within a thirty-mile radius of one another.

Data Collection Process

Lincoln and Guba note that sometimes the only data collection instrument utilized in a naturalistic inquiry is the inquirer, the sources that instrument utilizes may be both human and

non-human (1985). Human sources include taped interviews, (Lincoln & Guba, 1985) which is the type of data collection that was utilized in this study. There are different types of interviews. According to Bernard, the concept of interviewing covers a wide array, from unstructured interactions, through semi-structured interviews, and to highly formal interactions (2002). For this study, data was collected through a series of four semi-structured interviews.

Data Analysis

“Qualitative inquiry demands meticulous attention to language and deep reflection on the emergent patterns and meanings of human experience,” (Saldana, 2013, p. 10). Data analysis for this study was done by manually coding transcriptions of the participant’s interviews. Saldana mentions that coding requires that one wear a researcher’s analytic lens (2013). Upon the first interview, data was being analyzed. Themes did emerge, however they were not fully evident as more research and interviews needed to be conducted. Transcriptions were typed in a Word document. Coding was input in a color-coded table, also in a Word document.

Trustworthiness and Credibility

“Trustworthiness is established in a naturalistic inquiry by the use of techniques that provide truth value through credibility, applicability through transferability, consistency through dependability, and neutrality through confirmability” (Erlandson et al., 1993, p. 132). Techniques that the researcher used to establish trustworthiness and credibility included: member checking and purposive sampling. Member checking was conducted by emailing interview transcriptions to participants for a review. Participants were also able to add additional comments if they felt the need; however, all participants said the transcriptions were accurate and did not wish to add any additional comments. Purposive sampling is used to maximize information, rather than to facilitate generalization (Erlandson et. al., 1993). Participants were purposefully selected as to gain credible information on the study being conducted. The participants ranged from kindergarten through third grade and a math facilitator from an elementary campus was also selected with a purpose in mind.

Significance and Summary

Through qualitative naturalistic inquiry the researcher was able to interview mathematics teachers in order to gain insight into their perceptions of teaching mathematics. Their voice has made a contribution to the literature in respect to the impact they have on student achievement based on their efficacy, experience, and certification.

RESULTS

Introduction

After thorough analysis of data collected, it is evident that the teachers interviewed feel much the same when it comes to teaching elementary mathematics, they feel somewhat guarded since it is elementary math, yet find it challenging as rigor increases. Melanie, who was a previous high school math teacher, now an elementary math facilitator had a different

perspective. She said: “Even though it seems easy, we can say, “oh it’s the easiest thing to do, anybody can teach math at the elementary level,” not everybody can teach math.” For this very reason, this study was conducted. Often administrators, even teacher preparation programs feel a generalist certification will suffice at the elementary level. However, student achievement may be negatively impacted as a result. The following section will describe the participants of the study. Participants were given pseudonyms as to keep their Responses confidential. Further, the findings will be outlined based on the themes that emerged from the data collected.

DESCRIPTION OF PARTICIPANTS

Cassidy

Cassidy was the first participant interviewed. She had previously taught seven years of high school English and is currently in her third year of teaching first grade. Cassidy is certified to teach English Language Arts 8-12, Speech 8-12, and EC-6th Generalist. Cassidy had this to say about teaching mathematics to elementary students: “I have seen it’s changed from when, of course, I was younger. The way they learn the math is different, it is more difficult to me, in my opinion.”

Melanie

The second interviewee was Melanie, who is not an elementary mathematics teacher, but rather an administrator serving as a math instructional facilitator at the elementary level. Melanie was a high school mathematics teacher for 17 years, a high school counselor for 3 years, and is currently an instructional facilitator at an elementary campus. Melanie is certified in secondary mathematics 6-12 and EC-12 School Counselor. Although Melanie is not actively teaching elementary mathematics, she is able to observe other teachers teaching math.

I don’t have teaching experience at the elementary level, but I’ve observed elementary math classrooms. I can coach teachers and tell them what they could be doing differently and making sure they’re using the correct math terminology.

Alaina

Alaina, an EC-4 certified teacher, was the third participant interviewed for the study. Of the participants interviewed, Alaina has the most experience teaching elementary math. She has taught 2nd and 3rd grade math for a combined total of nine years. She had this to say about teaching math: “Teaching elementary mathematics has been kind of a rollercoaster ride. I’ve seen everything from the simplest curriculum to the most difficult, which is where we are now.”

Jasmine

Jasmine, who is a first-year teacher, was the last participant interviewed for the study. She has been around the education field for six years serving as a substitute teacher. Her certification is EC-6 Generalist. She is currently teaching kindergarten, but has had experience substitute teaching all grades of elementary math. When asked about her experience teaching

math, this is what she had to say: “Teaching elementary mathematics has been rather interesting; teaching in the kindergarten level has also been fun.”

FINDINGS

After analyzing data from interviewing the respondents the study revealed several themes. The themes that emerged included: being knowledgeable in content aids in student achievement, having a passion and motivation or a positive self-efficacy for a particular subject supports knowledge of that subject and the experience one has can be a determining factor in success or lack of success in a subject that is being taught.

Knowledgeable in math content

One theme revealed that being knowledgeable in content aids in student achievement. For instance, Cassidy stated the following:

I also feel the knowledge the teacher has with the math, and especially the mistakes, common mistakes that students make. Right away, we can pick up on it, and they can fix it. That comes from knowledge of math, like, ‘Oh, I have a student that,’ or ‘They’re making this mistake because,’ and then they can fix it.

Likewise, Melanie said:

Students that are already weak in math tend to be at a disadvantage when the teacher does not know exactly what she’s supposed to be teaching conceptually. So, they do the best they can, but is it the best for the students?

Melanie stated it best with her last statement: “So they do the best they can, but is it the best for the students?” Often teachers do the best they can with the math knowledge they have. At times though, that knowledge may be limited to what the student needs. Hence, is it best for the students? Furthermore, Alaina stated the following: “Math knowledge in relation to student achievement, I think, is pretty important only because if you don’t know what you’re teaching, then they’re not going to know what to learn.” Jasmine continued with the same premise on her thoughts of how important it is for teachers to be knowledgeable in math content in order to have successful students. She believes:

A teacher should be very knowledgeable in math . . . teaching elementary mathematics sets the foundation for the students as they get older. If they have a very poor mathematics foundation, they will only struggle as they get into junior high and high school.

All four participants felt strongly that if students are to be successful in math, the teacher teaching must know the content, no matter how simple it may seem. Teachers need to be able to understand the how and why students are making the mistakes they make. Common misconceptions of math content also should be acknowledged.

Teacher Self-Efficacy

A second theme showed that being motivating, confident and passionate about math supports teacher knowledge and student achievement. Teacher self-efficacy is a term used to

describe such passion, confidence, and motivation. For instance, Melanie was passionate about teaching math and made the following statement:

Then, looking at the teachers that are passionate about math because they like it, they do so much better with it versus those that just go through the motions because they put them to teach something that they don't really want to be doing.

Hand in hand with passion, is motivation. Furthermore, Cassidy had this to say:

“In terms of teaching math? Okay, I teach 1st grade presently. I feel that right now, I could be motivating and I’m pretty competent.” If a teacher is motivating and passionate about the subject they teach, it supports the knowledge and competence that they possess in order to teach the subject that is being presented. Student achievement, thus results in positive outcomes. Jasmine had the following to say about her efficacy in terms of teaching mathematics:

I feel rather confident and I know if I do encounter some problem or question, I can go to somebody higher and find a solution to what I might not have the answer to or not understand complexly. I can just go ask somebody . . . an upper grade teacher.

Keep in mind, Jasmine teaches kindergarten and knows that there is a possibility that she might not know it all. Alaina, who is our veteran elementary math teacher describes her efficacy as such:

In the beginning, I felt pretty confident when I first started teaching because, like I said, it was so simple, and within the past three years when the state changed, it got a little complex not only for the students, but more for me because it was a whole new . . . It felt like a whole new subject. It felt like I wasn't teaching second grade anymore. It felt like I was teaching more fourth grade, more fifth grade.

Being confident, motivating, and passionate about teaching math will impact student achievement in a positive way since, as evidenced by the participants, stems from math knowledge.

Experience

A third theme indicated that the experience one has can be a determining factor in success or lack of success in a subject that is being taught. Two of the participants were previous high school teachers. Cassidy taught English at the high school level, now currently teaches 1st grade.

I am not a math major, or an education major, so I went and got my certification through an alternative certification. I didn't have to take any kind of math class. I did have to pass the test, however, it was elementary math. It wasn't very difficult.

Cassidy, as previously mentioned teaches 1st grade and mentioned that she is “pretty competent” when it comes to teaching math. She also stated the following: “However, like I said, maybe 4th, 5th, and 6th grade math, I would have to really do research before I taught. Really learn it first.” Melanie, who previously taught high school math, now an elementary math facilitator makes note of the following:

I’ve been a mathematics teacher for 17 years at the secondary level. As far as content, I know content. I can tell you what needs to be taught, how it should be taught as far as math vocabulary, looking at different data, what the students are weak in, where we need to go with it.

Of the two participants who taught at the high school level, Melanie seems to have more experience with math. Although, she does not directly teach math to elementary students, her knowledge in

the subject matter will be beneficial to elementary math teachers whom she coaches. Cassidy's experience has been very minimal at the elementary level, however still feels "pretty confident" in teaching her first graders. Jasmine, although has yet to teach a full year, has had experience being a substitute, teaching elementary grades up to 6th grade. Through her experience, she feels: "At all grade levels you must have a lot of hands on, because often times many of the students do not grasp the information just by working out a problem, they want to see concrete examples." Her response is indicative of a typical elementary teacher. In most elementary classroom students are learning through hands on experiences. Alaina, who has only taught elementary math to second and third graders had the following to say about her experience:

Teaching elementary mathematics has been kind of a rollercoaster ride. I've been teaching for nine years and I've seen everything from the simplest curriculum to the most difficult, which is where we're at now. I believe when I started, the math was very general. It didn't seem so . . . rigorous.

CONCLUSION

Based on the participant data, all participants agreed that strong math content is significant to student achievement and that minimal content knowledge is insufficient. Participants also concurred that their own efficacy to be successful was important to student achievement. Finally, actual classroom experience with students at varied grade levels was also shared by participants as significant to positive student achievement in mathematics.

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