Comparing Perspectives of Mathematics and Special Education

Lauren Stephansen

Under the direction of Dr. Angel Abney

Georgia College

Abstract

There exists several different learning theories that have developed over the years as an attempt to determine how students learn. This paper outlines the learning theories presented by Jean Piaget, B.F. Skinner, John Dewey and Lev Vygotsky and discusses several different educational belief systems proposed by Capo and Garmston. It focuses on comparing mathematics educators and special educators beliefs about the teaching and learning of mathematics.

Introduction

Education has been of interest to me ever since I was a child. I have always had a passion for teaching others. In more recent years, after taking several Mathematics Education classes and learning about different teaching styles, I have become interested in the different methods and beliefs that teachers practice and believe. More specifically, I have become interested in the thoughts of not only mathematics educators, but also educators of special needs students. I have heard that there exists a difference in perspectives between Mathematics and Special Educators and that they do not always align. I am interested in finding out if this is the case. In this area of research, there has not been much interaction between the fields of mathematics and special education.

One of my goals in looking at the perspectives of mathematics and special educators is to investigate why and what we could do to bridge this research gap. The research question that I will be investigating is "What are the similarities and differences of perspectives on teaching and learning between mathematics and special education?"

Learning Theories

There are several theories regarding the teaching and learning of mathematics and what methods of teaching are most effective. In researching these different methods and ideas of how to lead lessons in the classroom, I looked more closely at the ideas of Piaget, Skinner, Dewey and Vygotsky. Piaget believes that humans learn through experiences. He is known to be the "pioneer of constructivism" (Steffe, 1995). Constructivism is a teaching philosophy based on the concept that learning is the result of mental construction. This epistemology suggests that students construct their own understanding by reflecting on their personal experiences and by relating the new knowledge with what they already know (Clements, 1997).

In Piaget's theory of cognitive development he states that humans go through a series of four stages: sensorimotor stage, pre-operational stage, concrete operational stage and formal operational stage. During each stage he contends that the experiences humans have contributes to the knowledge they obtain during that stage. At the sensorimotor stage, which occurs between the ages of zero and two, infants and toddlers obtain new knowledge through physical experiences. During the pre-operational stage, occurring between the ages of two and seven, the use of language is developed and humans are able to understand symbols. In the concrete operational stage, from age seven to eleven, children can start to think more logically but are unable to comprehend abstract or hypothetical ideas. At the last stage, the formal operational stage, which occurs from age twelve into adulthood, humans develop the ability to think abstractly, use deductive reasoning and perform logical thought. Piaget's theory of cognitive development offers the idea that students cannot just be handed information and be expected to understand and use it immediately. They need to be given the opportunity to construct their own knowledge. This knowledge building comes from experiences that they have in and out of the classroom.

Skinner's theory of behaviorism is about how he believes humans learn best. He places a lot of emphasis on the idea that "satisfying or reinforced behaviors are conditioned responses, but punished behaviors can become eliminated and replaced with desirable ones" (Matthews, 2014). The idea is that teachers can control the outcomes of their students based on how they respond to the students' actions. This theory is founded on the belief that for learning to occur there should be a connection made between a stimulus and the response. Behaviorists believe that learning occurs in the presence of some sort of reinforcement. Skinner believes that if the teacher is aware of when their students have done something well they should be praised through comments that show that their behavior was desirable and therefore should be repeated. He also

believes that students should be encouraged to practice discovery learning where they would be given the opportunity to learn and discover things by themselves and the teacher would correct them through guided learning. Guided learning is more student focused that can be more fun and leads the students towards different ways of thinking (Structured vs. Guided Teaching, 2014).

Dewey (1938) proposed a learning theory based on experience and its relationship to education. He believes that "Sound educational experience involves both continuity and interaction between the learner and what is learned," (p. 10). He discusses the opposition between traditional and progressive education. He coins traditional education to be,

> a system that consists of bodies of information, skills, developed standards, and rules of conduct that worked historically, and that encourages a student attitude of docility, receptivity, and obedience. The task of educators in traditional education is to communicate knowledge and skills, and to enforce rules of conduct onto the new generation (p. 20).

He describes progressive education as

> a system that criticizes traditional education in that it imposes adult standards, subject matter, and methods upon a young generation. It provides minimal active participation by students in the development of subject matter. Progressive education offers learners the following: growth and expression of individuality; free activity; learning through experi ence; the acquisition of skills as a means of attaining ends which are vital and appealing to students; and, becoming acquainted with a changing world (p 20).

He believes that educators must recognize and understand how closely related education and personal experience are.

> Dewey (1938) explains that the conceptions of experience should show in plans for de ciding upon methods of instruction and discipline, subject matter, and upon the material

and social organization of the school. Experience should not be just a term that doesn't indicate the appropriate operations to implement it (p. 28).

Vygotsky's theory has become the basis for research in cognitive development in what is commonly known as the Social Constructivism Theory. Vygotsky focuses on the importance of social interaction in cognitive development. He believed that a sense of community can play a big role in the process of development. He argues that "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function" (1978, p. 90). He believed that social interaction comes before development. He also coined the term "Zone of proximal development (ZPD)" which is "the range of tasks that a child is in the process of learning to complete." "The ZPD is the distance between a student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability solving the problem independently" (Moll, 2013).

Educational Belief Systems

There are several educational belief systems proposed by Capo and Garmston. The five belief systems that I have focused on are academic rationalist, self-actualizer, cognitive processor, technologist, and social reconstructionist (Powell, 2010, p. 102-104). The academic rationalist sees the purpose of education to be the transmission of cultural heritage, basic knowledge, skills, and academic concepts from one generation to the next. The self-actualizer perceives the purpose of education as the nurturing of each child's unique individual potential. The cognitive processor believes that the primary functions of education are to develop clarity of thought in students, to use intellectual reasoning, to solve complex problems and make rational decisions. The technologist believes that learning can be measured through behavior and sees the purpose

of education as producing young people who will function effectively in an ever-changing, complex technological society. The social reconstructionist is motivated by the belief that education can make the world a better place (Powell, 2010, p. 102-104). Depending on which educational belief system(s) a teacher falls under, this can determine what factors motivate one to be a better teacher and what teaching and learning means to them.

Methods

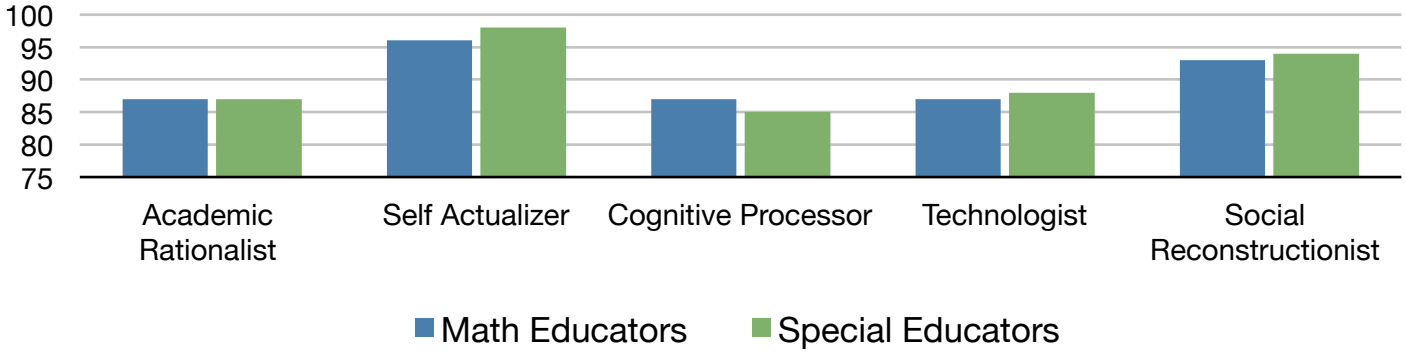
For my research, I used a sample size that included: two Mathematics Education majors, two Special Education majors, three Mathematics Education professors and three Special Education professors. All of my participants were from a University in the South. I conducted interviews with the volunteers where they discussed different questions regarding teaching styles and educational belief systems. The questions I asked were: "In what setting do you think students learn best: individual work, group work, or lecture and why?", "When teaching your students, do you think it is better to give students all the information and expect them to immediately understand and use it or allow them to construct their own knowledge using the teacher as a guide?" and "Do you think students learn best with or without manipulatives?" From these questions, I was able to compare the different perspectives between the Mathematics educators and the Special educators.

Participants also completed a survey about educational belief systems (refer to appendix). This survey asked ten questions regarding different aspects of education and they were asked to rank the statements according to the degree to which they believed them. After completing this survey, they tallied up their score and were able to see which belief systems they most aligned with. From this survey, I was able to see the differences and similarities between the two de-

partments and compare their beliefs. Overall, I compared and contrasted the different answers from the interviews and surveys. I used constant comparative analysis to analyze the participants' responses to the interview questions. From this, I was able to compare and characterize the beliefs and practices of the selected mathematics and special educators. In looking at the educational beliefs survey, I determined which learning theory participants aligned most with based on the way they thought a classroom should be run. I also compiled all the quantitative data from the educational belief systems survey and was able to compare these results graphically.

Results

After examining the data I gathered from the survey regarding educational belief systems, I came to the conclusion that Mathematics and Special educators have more in common than I predicted. From looking at the graph, one can see that the height of each bar is relatively close; in fact, the academic rationalist column is exactly the same. The graph shows that the two highest belief systems were self actualizer and social reconstructionist. Recall that the self-actualizer perceives the purpose of education as the nurturing of each child's unique individual potential and the social reconstructionist is motivated by the belief that education can make the world a better place. I think this shows that both departments of educators truly believes in their students and wants to help them to be the best that they can be and in doing this, they will be more successful in this world. The graph shows that the lowest score was for the cognitive processor. The cognitive processor believes that the primary functions of education are to develop clarity of



thought in students, to use intellectual reasoning, to solve complex problems and make rational decisions. I think the fact that this is the lowest rank in my data shows that the teachers true motivation is not for the students to just be able to complete complex problems, but that they would actually understand what they are doing.

By examining the answers to the interview questions, I was able to see more of how each teacher would be in a real classroom environment. I made sure to ask probing questions with the

hopes that it would help to uncover how the teachers really acted while in the classroom setting. I found that many of the answers between the Mathematics education side and the Special education side were very similar. When asked which setting they thought that students would learn best, almost all the participants believed that students learn best when placed in a variety of settings depending on what the level at which they are learning and the material that is being covered. One mathematics education professor stated,

> I believe that students need to experience a variety of learning environments. All stu dents should have opportunities to work individually and in groups. It is important to learn independently, but it is also important to learn cooperatively.

Similarly, a pre-service special Education teacher said,

> I think that students need a mixture of all three so that information can be differentiated and so each student can understand it based on how they learn. I think that group work is especially important in instruction so students can have more involvement in the learning process and also so that students can interact and learn from each other.

One difference that I did notice from this question was that all of the special education participants mentioned the concept of differentiation and none of the mathematics education participants mentioned this idea. One special education professor answered the question based on which stage her students were learning. She said,

> Students learn using a variety of delivery settings, depending on the student's ability to learn and the stage of learning. For example, at the initial guided-practice stage, teacher behaviors require interesting hooks to motivate…..during this stage, the purpose of learn ing is introduced and prior knowledge is connected with the newly introduced informa tion in individual, small or whole groups. The dependent stage of learning is where

> mnemonics for learning and practice are provided in order to develop fluency. It is at this stage, where individual or small group work occur often. Lecturing an entire group may become ineffective…

The next question I asked was whether or not they thought students learned better with manipulatives. Again, I found that the answers between the two departments were similar. They both agreed that the use of manipulatives can help the students to understand the material. One mathematics education professor stated,

> I believe that the use of manipulatives or even drawings or technology can help students develop many of the formal algorithms or formulas that we use. However, they can also be useful in helping students determine their own strategies for finding solutions to exer cises such as division of fractions.

Similarly, one special education professor said, "During the concrete stage of math learning, manipulatives are highly recommended to help students understand the purpose of particular operations. Visual illustrations are needed for the representational phase, and symbols are needed for the abstract phase." This yet again shows that special educators place emphasis on the idea of differentiation and meeting individual students needs at different phases. Another pre-service special educator answered, "Manipulatives help students develop conceptual understanding of math. They help show the ideas in more than one way increasing the students' understanding of the concept. I think manipulatives also help students take ownership of their knowledge of math."

Another question they were asked to answer was if they thought it was better to give students the information needed and expect them to understand it or allow them to construct their

own knowledge using the teacher as a guide. Yet again, the answers I received were very similar between the two departments. A mathematics education professor answered with,

> I believe that students should construct their own knowledge. Under the belief that knowledge is constructed, teachers cannot simply transfer knowledge to their students. Students are active learners constructing their own understanding. Learning is facilitated through discovery, experimentation, lectures and meaningful tasks. I believe that students learn best when they work cooperatively and develop understanding using their prior experiences, discourse, and reasoning.

Another pre-service special educator had a very similar answer. She said,

> I think in order for students to completely understand all aspects of the information, students must construct their own knowledge using the teacher as a guide. I am a huge believer in constructivism. I think teaching students to think is the most important part of education and widens their knowledge with experiences.

Implications and Conclusions

My findings from my research showed that mathematics and special educators tend to have similar perspectives when it comes to teaching. I thought this was interesting because it is not at all what I expected to find. After observing my data, I believe that my participants aligned most with the theories proposed by Piaget, Dewey and Vygotsky. I believe this to be true because they focused specifically on the idea that students should be given the opportunity to actually experience mathematics and construct their own knowledge. This idea perfectly aligned with Piaget's theory of constructivism where he suggests that students construct their own understanding by reflecting on their personal experiences and by relating the new knowledge with what

they already know (Clements, 1997). It also reflects the work of Dewey where he believes that education and experience are closely related. They thought students learned best in an atmosphere where they were asked to engage in discovery learning and not just given a procedure to memorize in order to complete some problems. They also thought students benefitted from working in groups and having the chance to learn cooperatively with their peers. This shows that my participants think that having a sense of community and working together can foster better learning in the classroom, which aligns with the work of Vygotsky.

There were some limitations that occurred in my research. All of my participants were professors and students from the same university. Answers may have varied if the participants came from a variety of universities. Also, the Special Education students have been influenced by the Mathematics Education professors, so that could have something to do with why the believe the things that they do. Another limitation was that I was unable to find participants who are currently teaching mathematics or special education in schools. I think that these results would have been very interesting to observe because these teachers are practicing these ideas in their classrooms everyday. With collecting this data, my results may have been different than the ones I found.

When I first started researching for this project, it was extremely difficult to find articles that focused on both mathematics and special education. I found that there seems to exist a huge gap in the area of research between these two fields. From the data I collected, the beliefs and methods from both the mathematics and special educators very closely aligned. Since they have so much in common, I think that they could work well together and that more research should be done in this area to help bridge that gap. I think that both fields could collaborate together and learn from each other. Mathematics educators tend to have thorough knowledge in mathematics

where they understand the concepts well and are able to justify why certain mathematical concepts are the way they are. They are aware of what tasks can help students best, able to use various models and manipulatives and are familiar with technology that can help students when learning mathematical concepts. Special educators are skilled in the area of differentiation and being able to cater to the needs of each individual student depending on what level they are learning and what disabilities they may have. I believe that with these skills and working together, these two fields could grow and become better educators overall. This could be very beneficial, especially considering that inclusion classrooms are becoming more common in today's schools where we have special needs students placed in regular classrooms. The world of education is always striving to improve, and I believe that this is one more way that we could move forwards.

Appendix

For each of the statements below, rank the sentence completions from 5 through 1 to reflect your personal educational values. Place 5 next to the statement that is closest to your value preference. Then, select the second-closest sentence completion and place 4 next to it, and so on.

Next, insert the numerical response to each sentence completion in the scoring diagram. Add up each column.

1. The most important purpose of education is to
A___ assist students to learn how to learn.
B___nurture the individual child's unique potential.
C___produce trained young people who can function successfully in our ever-changing, complex technological society
D___inculcate traditions and values necessary for students to become constructive members of society
E___foster a new global society in which men and women can live in peace

2. The most important job of the school is to
A___foster wisdom through the rigorous study of history, literature, sciences, mathematics and so forth.
B___provide students with the knowledge and values necessary to resolve social injustice and problems of society
C___help student to develop intellectual reasoning to solve problems
D___cultivate a love of learning and self-fulfillment
E___design effective instructional strategies that develop student academic skills and competencies

3. The primary responsibility of the teacher is to
A___assist students in forming a global society based on mutual respect and equality of race, ethnicity, and gender
B___diagnose learners' needs and abilities and establish measurable learning objectives
C___allow full development of the student's creativity and sensitivity
D___transmit to young people basic knowledge, skills, and academic concepts
E___develop in students clarity of thought and precision in communication

4. The most important educational outcome for students is to
A___develop personal integrity and self-fulfillment
B___become intellectually discerning, rational decision makers
C___become responsible global citizens
D___understand the heritage and values of the past in order to walk boldly and wisely into the future
E___become skillful in reading, writing, speaking, and computing

5. The best instructional methods include
A___problem solving, Socratic method, and inquiry
B___computers and learning systems with opportunities to diagnose student entry levels and prescribe according to what is known and what is yet to be learned

C___demonstrations, lectures, seminars, memorization, and drill
D___cooperative learning, simulations, role play, and outdoor learning pursuits
E___multisensory instruction, student choice, self-directed learning on the part of the student, and individualized instruction

6. In an outstanding school, emphasis must be placed upon
A___the future of our planet, peaceful coexistence, the threat of overpopulation, and the protection of the natural environment
B___scholarship, high academic standards, and intellectual rigor
C___time on task, skills mastery, quality assessment, and accountablilty
D___the whole child, choice, democracy, creativity, trust, and caring
E___cognitive processes, metacognition, and high-level critical thinking

7. The best curriculum includes
A___classical literature and great books
B___field trips, real-life situations, and community service
C___task analysis, outcome-based learning programs
D___learning centers, interdisciplinary studies, and thematic approaches
E___problem solving, higher-level thinking, and decision making

8. Assessment of student achievement should be based upon
A___mastery of skills and competencies, pre- and posttests
B___self-evaluation and demonstrations of increased learning autonomy
C___how well students perform in actual problem-solving situations, application of knowledge
D___summative examinations, achievement tests, and content mastery
E___student involvement in constructive social change, development of a social conscience, and empathy

9. The best metaphor for education is
A___an input-output system in which data and opportunities to learn skills are provided
B___nurturing every child's unique potential
C___information processing
D___an instrument for constructive social change
E___transmission of essential truths and values from one generation to the next

10. Rank the following statements from 5 (most agree with) to 1 (least agree with):
A___"Human beings are meaning makers, and schools and teachers mediate those capacities."
B___"The primary purpose of education is to civilize-to free the individual from the fetters of provincialism and prejudice by coming to know the knowledge and the wisdom of the past."
C___"Education has a sacred responsibility to bring about a better, more humane future."
D___"Learning can and must be demonstrated and measured-schools must be accountable."
E___"Each child is different, and his or her full potential can be nurtured."

References

Clements, D. (1997, December). (Mis?)Constructing Constructivism. Teaching Children Mathematics, 1, 198-200.

Cole, M. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Crotty, M. (1998). The foundations of social research: meaning and perspective in the research process. London: Sage Publications.

Davis, B. (1997). Listening for Differences: An Evolving Conception of Mathematics Teaching. Journal for Research in Mathematics Education, 28, 355-376.

Dewey, J. (1938). *Experience and Education*. New York: Macmillan.

Glasersfeld, E. v., Larochelle, M., Ackermann, E., & Tobin, K. G. (2007). Key works in radical constructivism. Rotterdam: Sense Publishers.

Ma, L. (1999). Knowing and teaching elementary mathematics teachers' understanding of fundamental mathematics in China and the United States. Mahwah, N.J.: Lawrence Erlbaum Associates.

Matthews, L. (n.d.). Behaviorist Theory of Childhood Education. Retrieved December 1, 2014, from http://everydaylife.globalpost.com/behaviorist-theory-childhood-education-3963.html

Moll, L. (2013). *L.S. Vygotsky and education*. Routledge.

Powell, W. R., & Powell, O. (2010). Becoming an emotionally intelligent teacher. Thousand Oaks, Calif.: Corwin.

Rubenstein, R. (2004). *Perspectives on the teaching of mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Silverman, D. (2005). Doing qualitative research: a practical handbook (2nd ed.). London: Sage Publications.

Social Development Theory (Vygotsky) | Learning Theories. (n.d.). Retrieved November 6, 2014.

Steffe, L. (1995). *Constructivism in education*. Hillsdale, N.J.: Lawrence Erlbaum.

Stein, M. K. (2000). Implementing standards-based mathematics instruction a casebook for professional development. New York: Teachers College Press.

Structured vs Guided Teaching. (n.d.). Retrieved November 6, 2014, from http://sitemaker.umich.edu/wong.356/structured_vs_guided_teaching&config=Z7r9D2dNESSQPXGr