Position 1: Instruction guided by the constructivist learning theory enhances student engagement learning.	
What are some facts that support this position?	**What are some facts that counter this position?**
• Constructivist teaching methods were developed because of the nation's recognition that students were not being educated to live in our new informational society. We were still teaching math as if nothing in the world around us had changed. (National Research Council, 1989)	• This method of teaching veered away dramatically from the basic skills movement. Having basic skills in math is a requirement for being able to function in the new information age as well. (National Research Council, 1989)
• Kim's (2005) research proved that students who received constructivist instruction out-performed students who received traditional instruction on teacher created post tests. • • Boaler's (2001) research shows that students taught in a constructivist manner are able to apply their understanding from the experiences to both procedural and conceptual assessment questions whereas students taught in a traditional classroom are able to find success on procedural questions, but not on the conceptual problems on the same assessments.	• The individual teacher implementation is not considered in these cases. In addition, the population of the students and students' prior mathematical knowledge is also not taken into account. Kim's (2005) • Hirsch (1997) states that while constructivism was brought about to improve student achievement, this is actually not the case. There has not been an overall improvement in student performance in the years since constructivism has been introduced into education.
• Constructivist teaching helps with student motivation and anxiety towards math. Students are more invested in their learning, interested in the topic, and feel more successful because of the process. (Boaler, 2001) • Mathematics only becomes useful to students when they are engaged in it and	• Just because students are motivated and less anxious doesn't mean that they are learning the math. There is no guarantee that students are developing accurate understanding. (Tobias & Duffy, 2009) • Traditional teaching does not have to be about just performing algorithms. It is the teacher's job to help students make

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doing it, not when they are listening to it and memorizing it. Many students struggle with math because they are not confident in their accuracy and ability - they will gain confidence through engaging in the math, questioning, and exploring. (NRC, 1999) • Boaler (2001) found that students who were taught in a constructivist manner were able to see the connections between what they were learning and the world that they live in. Those students who were taught in a more traditional manner did not see an application of what they were learning to anything other than the classroom. • NCTM (2000) states that students need to be DOING mathematics, exploring concepts and constructing meaning themselves in order to truly understand the concept. Computational approach takes away from the "beauty" of mathematics, so children (especially at the middle school age) are less interested and therefore learn less.	connections to the real world and assist them in doing this in either type of classroom (Herrera & Owens, 2001. • The only way a student can understand what a teacher or anyone else is saying is through a complex, sometimes strenuous activity of constructing meaning from words. (Alfieri et al, 2011) • Hearing a lecture—in the event that one understands it—requires an active construction of meaning. Listening, like reading, is far from being a passive, purely receptive activity. But the very universality of constructivism implies certain drawbacks for the practical application of the theory. Since most learning activity, including listening to a lecture, is constructivist, constructivism is an uncertain guide to teaching practice. (Hirsch, 1999) • Mayer (2004) & Kirschner et al (2006) argue that little empirical evidence exists to support the statement that learning by doing enhances learning, especially for novice learners with little foundational knowledge to pull from.
• By promoting an understanding of the concepts and overall importance and application of math, students will be more willing and engaged in learning and understanding the process as well. (Hekimoglu & Sloan, 2005) • Type of understanding (conceptual or procedural) is driven by the teaching practices in the classroom. Students who are taught in a traditional classroom may be able to successfully perform on procedural tasks, but not on more open-ended conceptual tasks. Teaching in a constructivist manner results in students' possessing a more conceptual understanding of the material, which they are also able to apply to	• Students who do not have a strong foundation of math skills are set up to fail in a constructivist classroom. When students have a more solid math foundation, they are more successful with a constructivist model than when the material is less familiar. (Alsup, 2004) • Education blogger (Educationrealist, 2013) looks into Boaler's research and finds that there was actually huge variation in student performance for students in the constructivist classroom, which he believes proves that constructivism works for high ability students, and traditional teaching improves procedural understanding for

procedural tasks (Boaler, 2001).	students of lower ability. • The amount of useful construction and learning that occur depends chiefly on the amount of relevant background knowledge the student already possesses rather than on the mode of instruction. (Hirsch, 1999)
• Equity Constructivism allows for all students to access the math no matter their skill base because they are making meaning themselves, and reasoning through the math at their own pace and own level. It also allows for culturally relevant material that engages students in the learning of mathematics. (Allexsaht-Snider & Hart , 2001) • Constructivism values what students bring to the experience of learning math. Students are encouraged to develop their own strategies and methods which only enhance their understanding of the material (Clements & Batista, 1990).	• Culturally relevant material is necessary for high quality teaching. (Allexsaht-Snider & Hart , 2001) • There must be some fact based instruction in math. All strategies are not necessarily right. It seems that if students develop their strategy that they may experience a loss of confidence if and when this strategy is proven ineffective. (Kirschner et al, 2006)

Position 2: Instruction guided by the constructivist learning theory is not a practical approach to teaching.	
What are some facts that support this position?	**What are some facts that counter this position??**
• The nature of math requires the knowledge of skills. Hirsh (1997) argues that constructivism postpones significant knowledge as it veers away from trying to give the knowledge to students. Many elementary students walk away from their classrooms without these important foundational skills. • Liu and Matthews (2005) note that the role of "passive perception" and learning that	• Skills are being learned in a constructivist classroom. Students develop the necessary skills and procedures making them more meaningful and memorable. (Seeley, 2009)

occurs in a traditional classroom are too easily dismissed as bad or wrong by constructivists. There certainly is a place for this in the classroom.	
• Clements & Batista (2009) emphasize the high level of skill that is required for teachers in order to be able to pose tasks, helps students make connections, and facilitate the learning in a constructivist classroom. Many teachers are not trained in order to be able to do this. Liping Ma (2010), Especially elementary teachers who have a weaker conceptual understanding of mathematics in general.	• Advocates explain failures not because the method is at fault, but because these educational methods require a great deal of expertise and have not always been implemented well in actual classrooms. This doesn't refute the message, only the implementation. (Clements & Batista, 2009)
• Students needing extra help make more progress when whole class instruction is emphasized over individual tutorials (Hirsh, 1997). • It is not realistic to individually teach lessons to each student. Imparting knowledge effectively to an entire group of students results in more students learning at the same time. Since constructivism requires that students create their own knowledge and use their own strategies, it is possible that every student in the class needs guidance or support as they work through their own strategy. This is not realistic for a teacher to manage. (Hirsch, 1999) • Mayer (2004) concluded that constructivism as hands-on-activity is a formula for educational disaster. Constructivist supporters emphasize active learning. Many of the constructivist materials require learning to be behaviorally active, but not necessarily cognitively active. Although they are engaged in activity, they may not be learning. Mayor suggests that in constructivist behavioral learning is emphasized too early in the learning process, when learners should be	• Constructivist teaching requires students to work collaboratively which limits the need for the teacher to be the only person in the room with the answer. Students will engage in cognitive activity as a result of behavioral engagement in an appropriately selected task. (Skemp, 1978) • This is why much research has come out as well as professional development on the implementation of constructivism in the classroom and also why the execution varies from classroom to classroom. (Marzano, 2011)

cognitively active. • Mayer (2004) Constructivists argue that learning by doing enhances learning; however, there is little evidence existing that supports this statement given novice learners. Novice learners do not possess the underlying mental models, or "schemas" necessary for "learning by doing."	
• The purpose of instruction is to help students store content in long term memory. When processing new material, working memory is used, but it is inadequate because of the limited capacity to process and then move the content into long term memory. Constructivist teaching requires students to work within the confines of their working memory because students are processing new, unfamiliar information. While working memory is being used to process this new information, it cannot be used to search long term memory for problem solving strategies, making the process of constructivism challenging for students. (Kirschner, 2014)	• Students do not have to rely on memory because they know how to pull from their previous knowledge to come to the answer. Students do not have to remember one set procedure to use. (Van de Walle, 2003) • Richardson (2001) talks about how deep understanding comes from the interaction between old and new material which means that students would need to be able to work within their working memory while using their long term memory - a traditional approach does not lend itself to working within both.

Summary and Recommendation:

Constructivist theories of teaching and learning are based on children constructing their own knowledge and conceptual understanding through their own activity. They are able to make connections between the new knowledge and previous knowledge. Those that support the constructivist approach to teaching say that students perform higher than students who were taught using the traditional methods. Students taught using the constructivist approach are able to answer standard procedural questions and conceptual questions where students that were taught traditionally were able to perform on standard procedural questions, but had difficulty on the non-standard conceptual questions.

Students who are taught constructively are said to be more engaged in their learning and have less anxiety towards mathematics. These students were able to see the connections between the mathematics they were learning/doing and the real world applications for this knowledge. The constructivist approach allows for all students to access the material because the learning builds from previous knowledge. Because the students are better skilled at making connections, they are able to pull from previous experiences to build new knowledge.

Those that do not think that a constructivist approach to learning is the best approach worry about students building their own knowledge. Students might not have significant background knowledge or might be inexperienced with making connections to prior knowledge to develop accurate understandings of the new material without being told. The research might suggest that students with higher mathematics ability fare well under the constructivist model, but not students that have weaker foundations in mathematics. Just because students are motivated to learn does not mean that they have actually learned the material and that frequent assessing must be done in order to ensure that students have actually learned the material. Those that opposed constructivism suggest that it is a teacher's responsibility to relay the necessary information and then help students make connections to the real world.

Most teachers do not have constructivist backgrounds and would therefore need extensive training on how to teach in this manner. Also, students have not previously been taught in this manner, so the students would have to be taught a new way of learning in order for the constructivist approach to be effective. Students, parents and teachers are part of the success chain for students. Using constructivist methods almost eliminates parent involvement because parents are not familiar with these methods and then find it difficult to help students at home. Constructivism has a place in the learning system, but has flaws as an absolute.

Students may benefit with some constructivist principles integrated, but need structure and evaluation to succeed. Some suggested next steps would be to get all teachers training on teaching for understanding. No matter one's opinion on constructivism, a balanced approach to math should be taken. A balanced approach refers to ensuring that students are learning skills, developing a conceptual understanding, and being able to apply their understanding and skills to a task. Whether you go to a full constructivist method or a hybrid method, teachers need some training on how to do more problem-based instruction and how to help students build from previous knowledge. Then math groups need to be given time to discuss the new learning and create and find resources to implement in the curriculum and then have time for vertical articulation in order for any changes to be successful across the board. Administrators should ensure that all teachers are prepared to teach for understanding. Administrators should also expect a level of consistency in each building and across the district and support the new methods of teaching.

References

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Education Psychology, 103*(1) 1-18.

Allexsaht-Snider, M. & Hart, L.E. (2001). Mathematics for all: How do we get there? *Theory Into Practice, 40*(2), 93-101.

Alsup, J. (2004). A comparison of constructivist and traditional instruction in mathematics. *Education Research Quarterly, 28*(4), 3-17.

Boaler, J. (2001). Mathematical modeling and new theories of learning. *Teaching Mathematics and its Applications, 20*(3), 121-128.

Center for the Study of Mathematics Curriculum. (2004). *Curriculum and evaluation standards for school mathematics.* Retrieved from http://www.mathcurriculumcenter.org/PDFS/CCM/summaries/standards_summary.pdf

Clements, D. H. & Battista, M. T. (1990). Constructivist learning and teaching. *Arithmetic Teacher, 38*(1), 34-35. ©1990 by the National Council of Teachers of Mathematics.

Educationrealist. (2013, July 19). Reform math: An isolationist's view [web log post]. Retrieved from http://educationrealist.wordpress.com/tag/jo-boaler/

Hekimoglu, S. & Sloan, M. (2005). A compendium of views on the NCTM standards. *The Mathematics Educator, 15*(1), 35-43.

Herrera, T.A. & Owens, D.T. (2001). The 'new new math'? : Two reform movements in mathematics education. *Theory Into Practice, 40*(2), 84-92.

Hirsch, E. D. Jr. (1997). Why traditional education is more progressive. *American Enterprise, 8*, 42-45.

Hirsch, E. D. Jr. (1999). *The Schools We Need: And Why We Don't Have Them*. New York, NY:

Random House.

Kirschner, P. A. & Sweller, J., & Clark, R. E. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist, 41*(2), 75-86.

Liu, C. H. & Matthews, R. (2005). Vygotsky's philosophy: Constructivism and its criticisms examined. *International Education Journal 6*(3), 386-399.

Ma, L. (2010). *Knowing and teaching elementary mathematics: Teachers' understanding of fundamental mathematics in China and the United States (Studies in mathematical thinking and learning series).* New York, NY: Taylor and Francis.

Marzano, R. J. (2011). Art and science of teaching: The perils and promises of discovery learning. *Educational Leadership,* 86-87.

Mayer, R. E., (2004). Should there be a three-strikes rule against pure discovery learning? *American Psychologist, 59*(1) 14-19.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*. Reston, VA: Author.

National Research Council (NRC). (1989) *Everybody counts: A report to the nation on the future of mathematics education.* Washington D.C: National Academy Press.

Richardson, V. (2001). Constructivist mathematics instruction and current trends in research on teaching. In T. Wood, B. Nelson & J. Warfield (Eds.), *Beyond classical pedagogy.* Mahwah, NJ: Lawrence Erlbaum Associates.

Seeley, C. L. (2009) *Faster isn't smarter: Messages about math, teaching, and learning in the 21st century*. Sausalito, CA: Math Solutions.

Skemp, R. R. (1978). Relational understanding and instrumental understanding. Arithmetic Teacher, 26(3), 9-15.

Tobias, S. & Duffy M. D. (Eds.). (2009). *Constructivist instruction: Success or failure?* New York, NY: Routledge.

Van de Walle, J. A., (2003, April 1). Reform mathematics vs. the basics: Understanding the conflict and dealing with it. [Web log post]. Retrieved from http://mathematicallysane.com/reform-mathematics-vs-the-basics/