Annotated Bibliography on

How We Help Learners Be Engaged Problem Solvers

Victoria Amarasiri

College of Saint Elizabeth, ACT I 601

December 2019

Annotated Bibliography on
How We Help Learners Be Engaged Problem Solvers

Abstract

This annotated bibliography is of sources reviewed for a report on "How We Help Learners Be Engaged Problem Solvers."

The goal of the paper is to identify proven approaches for engaging learners in problem solving and surfacing those best practices that have been shown to be effective. Mathematics should be taught through problem solving. While Common Core recommends this approach, a major challenge in a pedagogy focused on problem solving is that it can also be one of the most expeditious ways to disengage a classroom of learners. You probably have had the experience; You throw out a challenge for a child to solve and they just stare at you unsure of where to begin. Yet, problem solving has been shown in research to lead students to a deeper learning of mathematics. Hence my question, "How Do We Help Learners Be Engaged Problem Solvers?

Annotated Bibliography

Callard, J. (2009). Mathematical Problem Solving Is Boring: A Study Into The Motivational Impact of NRICH Problem Solving Materials Within The Primary Classroom. Retrieved from http://NRICH.maths.org.

Problem solving is the "heart" of mathematics and children must solve many problems to get to a deeper understanding of mathematics. However, not all problems are equal. This source examines the impacts that a problem to be solved can have on a child. Problems from NRICH are the source for engaging problem types to compare against the problems that a child is given in the classroom. It finds that the problem itself can impact a child's engagement of the process and that problems are best solved collaboratively.

This is a highly useful scholarly master thesis from part of a Masters of Education at the University of Exeter in 2009. It is a primary source, though the author may be biased as her resume surfaces a relationship with NRICH. Callard's taxonomies for what makes a good problem, a successful problem solver, and a safe environment are useful. While the study is small, it remains significant because of the dramatic positive impact that the NRICH problems had on engaging children and keeping them on-task.

Chapin, S. H., OConnor, M. C., & Anderson, N. C. (2009). Classroom discussions: using math talk to help students learn, grades K-6. Sausalito, CA: Math Solutions.

This book provides a compelling case for using communication in mathematics classrooms to promote a deeper and more engaged student learning experience. The concept is that by allowing students to speak out what they are seeing in math enables the student and the teacher both where knowledge may still be "incomplete, shallow or passive". Math talk also creates a math community in the class that fosters learning within a safe environment and this enables students to further their understanding.

The source is a useful scholarly primary source from a 4-year research project funded by the US Department of Education, Project Challenge, a program to enhance learning opportunities for urban students with potential talent in mathematics. Extensive deployment has resulted in continual review, updates and new examples.

Using math talk to reshape how we engage our students in problem solving would well support my research, especially as there is a chapter dedicated to problem solving and math talk. The classification employed will also be useful (i.e. concepts, procedures, problem solving strategies, reasoning and vocabulary), as will the troubleshooting section and its use in differentiated learning situations.

Cherif, A. h, Jedlicka, D. h, Verma, S. h, Uddin, K. h, & Movahedzadeh,, F. h. (2017). Brain Talking: Classroom Activity to Engage Students in Deep and Meaningful Learning. Journal of Education and Practice, 8(32), 156–174. Retrieved from https://www.iiste.org/Journals/index.php/JEP/article/download/3062/3103

The purpose of this source is to develop a lesson plan for a science class based on an activity that is genuine and promotes a deep understanding of subject matter. The use of role-playing is used to show students how this can help in their own lives.

This is a reliable scholarly source, although a secondary source as the author did not demonstrate this lesson plan in action. Without statistics, I wonder whether the authors are biased and what are the outcomes of schools that have tried this curriculum. The authors imply that as we all have brains, we will all be equally interested in the subject. This is amiss of social contexts that could have been covered (e.g. the health effects on the brain that Brazil is seeing from mosquito-born encephalitis).

As a result of this source, I have a better understanding of what it can mean for a problem to be fully authentic and personally relevant to a student. Key factors are the take-aways, such as teacher pedagogy, use of role-playing and student-centered learning.

Cockcroft, W. H. (1982). Mathematics Counts: Report of the Committee of Inquiry into the Teaching of Mathematics in Schools under the Chairmanship of Dr. W.H (pp. 83-108). Cockcroft. London: HMSO.

The comprehensive source is concise and well written, and that it is dated 1982 shows that there are perennial aspects of math that we are still struggling to incorporate in the classroom today. This book is a report of recommendations that covers all aspects of primary and secondary school math needed for student success in higher education, employment and adult life. The section that covers Problem Solving in Primary Schools is directly relevant to my research.

This useful scholarly primary source is an academic report by a committee to inquire on teaching of mathematics in elementary and secondary schools in England and Wales. The committee met extensively in group and with teachers, companies and citizens across the country and participated in international conferences. This reference will support my thesis by providing the foundation of citable actions for improving how we teach problem solving in school. There is also a section that focuses on gifted and less-able children.

Annotated Bibliography on
How We Help Learners Be Engaged Problem Solvers

Colgan, L. (2018). Hey, It's Elementary: Share-Worthy Parent Engagement Materials for Math... No Fake News! *Gazette - Ontario Association for Mathematics, 56*(4), 37–40. Retrieved from http://www.cse.idm.oclc.org/login?url=https://search-proquest-com.cse.idm.oclc.org/docview/2057942723?accountid=10328

> "Only 14% of a child's time awake is spent at school," is the authors response to why parents need to be engaged in children's learning in math to achieve good outcomes. The author contends that parents can be a significant contributor to a child's success in building a deeper understanding of mathematics.
>
> This is a useful scholarly source, with primary first-hand experiences and resources for enabling parent engagement. However, this article is a secondary source, citing extensively from other sources to build the case for why parent engagement is so crucial.

Ewing, B., & Sarra, G. (2018). Working with incarcerated indigenous and low socioeconomic status youth and their teachers to improve learning outcomes in mathematics. Curriculum Perspectives, 38(2), 117–128. doi: 10.1007/s41297-018-0056-8

> Ewing and Sarra collaborate with incarcerated indigenous students and their teachers with the goal being to identify each's perspective on how to best improve student math outcomes. In the process, they identify a need for improved data collection on education in youth detention centers. While the students' recommendations are driven by what they see as expected in a math class, the teachers recommend the types of individualized adjustments they make to engage their students. The authors note that successful teachers must have strong knowledge and differentiated background to have the confidence and ability to make these constant adjustments.
>
> This scholarly primary source is limited in its usefulness in that its goal, to show collaboration between students and teachers to achieve best strategies is not truly what happens. The teachers continue to use what they know works. However, I do see better that problem solving requires a strong math skillset and education background.

Finkel, D. (n.d.). Retrieved October 20, 2019, from https://mathforlove.com/.

> Dan Finkel wants every student to love math but feels that school math has lost its beauty and aesthetics. Math for Love is his small company whose point is to help spread the love of math that Finkel has with everyone. To do this, Finkel has created board games, syndicated puzzles and artwork to keep the play and beauty in math. As an educational consultant, Finkel provides teachers with professional development.
>
> Finkel has Five Principles of Extraordinary Teaching, which are: Start with a question, Students need time to struggle, Teachers should not be the answer key, Say yes to your student's ideas, and "play!" Finkel acknowledges the challenges on a teacher to perform at this level, that they must have the confidence and background to do this and to this effort supports Math Teacher Circles and professional development.

Math4love.com is a useful popular primary source even though it is not scholarly. Oddly, Finkel holds a PhD in Algebraic Geometry, a BS in Math and has taught for 15 years. It lacks the gated process of a journal article and is not peer-reviewed. But unlike a journal, Math4love.com is a living website constantly morphing from the feedback of the education community, and the website and his being an education consultant with many relationships provides for a grass-roots wide-reaching review of his articles.

Garner, M. L., Watson, V., Rogers, B., & Head, C. (2017). Influence of a Mathematics Teachers' Circle on Elementary Teachers Use of Problem Solving. School Science and Mathematics, 117(7-8), 317–328. doi: 10.1111/ssm.12250

The goal of the article is to determine the impact of math teachers' circles (MTCs) on teachers, from schools with minority economically disadvantaged populations, on their use of problem solving. MTCs are defined as a recurring networking event for mathematics professors and elementary math teachers to meet-up and collaboratively solve problems. The objective of these sessions is to help generalists gain the confidence and background to engage in problem solving in their teaching and improve attitudes towards using problem solving at the center of teaching. We see that students become more engaged when the teacher is a confident problem solver.

This article is a useful scholarly primary source that supports how teachers can become stronger at engaging students in problem solving, by improving their backgrounds and confidence by attending MTCs.

Hilton, A. (2018). Engaging Primary School Students in Mathematics: Can iPads Make a Difference? International Journal of Science and Mathematics Education, 16(1), 145–165. doi: 10.1007/s10763-016-9771-5

Hilton's research attempts to statistically prove that using iPads can make a difference in engaging students in math. Ultimately, Hilton demonstrates the equal importance that iPad technologies and teacher pedagogies have on good math outcomes. Her results do not corroborate her thesis, and iPads statistically show to neither improve nor detract from student engagement. Still, her use of interviews surface that the iPads are appreciated by teachers and learners alike and that they "are not going anywhere."

This is a three-year study in Queensland, Australia, with the school chosen as it was in the process of introducing iPads to grades 2 through 6. This peer reviewed scholarly journal is a not-so-useful primary resource, providing a collection of statistical data and results from a qualitative survey. The author shows bias that student-centered pedagogy is more important than technology by citing resources that corroborate that belief. It misses the concept of impermanence and its proven effect on problem solving. However, what is useful is the taxonomy used for measuring engagement in problem solving that focuses on student self-perception and enjoyment of math. A context where use of iPads were advantageous, such as engaging challenged learners, is also useful.

Kalman, R. (Ed.). (2011). III. Introduction. In Math Olympiad Contest Problems (Vol. 2, pp. 1–20). Bellmore, NY: MOEMS

Lenchner believes that "mathematics evolved as the result of problem solving", from a series of challenges thrown back and forth from one mathematician to another, which is not at all the way we study math today. Children love a "good problem" and want to show that they can do it. Characteristics of a good problem are defined as: it is interesting so that the student wants to see how it ends, it appears to the student as useful work, it allows for multiple creative strategies and is challenging but not intimidating. Lenchner believes that math competitions are good and that we love to compete with the reasonable chance of "succeeding". However, adults must keep the contest low key and the children must feel they are in a safe environment.

This source is a useful scholarly primary source that can be used in support of how math clubs and good problems can help engage in engage students in problem solving. The source develops a new concept – that perhaps we can accept that the classroom is not an advantageous place to explore problem solving as mathematics was intended, due to limited time and background. Perhaps it is in the math club, in-school or after-school, that is where our math friends can throw down challenges to each other as Dr. Lenchner proposes was once the way of math.

Liljedahl P. (2018) Building Thinking Classrooms. In: Kajander A., Holm J., Chernoff E. (eds) Teaching and Learning Secondary School Mathematics. Advances in Mathematics Education. Springer, Cham

This resource positions that children are simply not engaged in learning and teachers have placed students in a situation of a "non-thinking classroom," where we cannot begin to expect children to engage in problem solving. The author's question is, "How do we build a culture of thinking in our classrooms?". The author defines a "thinking classroom" as "a classroom that is not only conducive to thinking but also occasions thinking, a space that is inhabited by thinking individuals as well as individuals thinking collectively, learning together, and constructing knowledge and understanding through activity and discussion." The author sets out to establish the elements of problem-solving that a teacher needs and the tools that can help teachers address these needs.

This scholarly research article is the result of 10 years of research and is published as part of a peer-review journal that is released in a book series, a secondary source of the author's own research. It is still what the author sees to be true. However, Liljedahl is a professor of mathematics education and president of the Canadian Mathematics Education Study Group and this helps support what he is seeing as usable citation.

This source provides an actionable list of steps that can be implemented, and groups them by most impactful and easiest to implement. Unique ideas are presented, like vertical impermanent surfaces having an impact on problem solving.

López leiva, C. A., & Khisty, L. L. (2014). "Juntos pero no revueltos": microaggressions and language in the mathematics education of non-dominant Latinas/os. Mathematics Education Research Journal, 26(2), 421–438. doi: 10.1007/s13394-013-0105-4.

"Juntos pero no revueltos" means "alongside but separate". The source provides a look at a Latino girl and her experiences with covert racial aggressions from her teacher and peers in an after-school math class setting and explores the longer term effects on the child. This source demonstrates how racial microaggressions in the classroom are all too common and cause a student to withdraw from what should be a safe environment.

The is a useful scholarly primary source that fills out the context commonplace (e.g. poor minority backgrounds) that many sources inadequately address. The goal, to demonstrate how racism is common, the damage that is causes and to remind the reader that it is a discriminatory and exclusionary practice, is strongly supported through the qualitative case study provided.

Matang, R. A. S., & Owens, K. (2014). The role of indigenous traditional counting systems in childrens development of numerical cognition: results from a study in Papua New Guinea. Mathematics Education Research Journal, 26(3), 531–553. doi: 10.1007/s13394-013-0115-2

The Papua New Guinea government enacted a policy for the use of indigenous systems of learning within public schools. This research shows that there was an improvement in mathematical skills in those children that learned mathematics using their own systems when compared to the indigenous children that learned in English and used English conventions for mathematics.

While this was a scholarly primary source. It afforded the opportunity to see ethnic groups learn mathematics in their language and use their counting systems. But the research pool was limited and the long-term effects of the child staying within their indigenous group were not covered. I was hoping for whether the opportunity to learn two number systems was useful longer term which was not covered.

Mills, K., & Kim, H. (2017, October 31). Teaching problem solving: Let students get 'stuck' and 'unstuck'. *Education Plus Development*. Retrieved from brookings.edu/blog/education-plus-development/2017/10/31/teaching-problem-solving-let-students-get-stuck-and-unstuck/

This article offers a different angle on what it means to help students engage in problem solving, from a Literacy Interventionist who sees problem solving as a problem of metacognition. She helps students learn the art of "turning struggles into strategies." Mills talks about metacognition and how her goal is to help her students learn to manage their mental processes towards achieving their goals. Classroom culture, Mills says, is established by "normalizing the struggle" (i.e. name it, acknowledge it and call it a sign that we are growing). She believes it is also important for the classroom environment that allows students to take ownership of their problems, and to allow for safe failure,

This is a popular secondary source that employs the author's knowledge of metacognition to explore problem solving with her students. This source was both inspirational and insightful, sharing advice for what works from a teacher with a that is obviously not caught up in the busywork of teaching. The term "normalizing the struggle" is new for me, and I can see how students will be inspired to hear that their problem-solving struggle is a sign of their growth.

Papanastasiou, E. C., & Bottiger, L. (2004). Math clubs and their potentials: making mathematics fun and exciting. A case study of a math club. International Journal of Mathematical Education in Science and Technology, 35(2), 159–171. doi: 10.1080/00207390310001638395

The purpose of this source is to describe the root of success of a math club at St. Paul's Episcopal Day School in Kansas City, Missouri. Math clubs provide opportunities for students to collaborate with peers, help provide a sense of purposefulness, and provide a low stress environment. The children at this school are high achievers and the math club has extremely high attendance rates. Children surveyed were found to attend the math club simply for the chance of collaborating with friends while eating donuts and working on fun problems, but also enjoyed the interesting problems, and useful mental shortcuts. The author feels that developing a positive attitude towards math in middle school can set a path towards advanced math in high school for a student, however the study was not able to demonstrate linkage of this to the math club.

This source was a light qualitative source with limited findings, and cites often unproven causal effects (e.g. math clubs lead to better high school math outcomes.) The author uses broad studies and weak surveys to develop the research. It is scholarly; however, it is not clear that the author was at the club (vs. examining results remote or after the fact.) To be a useful source, it would need linkage of the math club to improved mathematical performance. As the math teachers were the coaches, linkage to success should have been easy to track. Also, the context of this particular school lacked any diversity.