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Learning to Teach

Language Arts, Mathematics,
Science, and Social Studies
Through Research and Practice

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Language Arts, Mathematics, Science, and Social Studies *Through Research and Practice*

Learning to Teach Language Arts, Mathematics, Science, and Social Studies Through Research and Practice publishes manuscripts that address curricular innovations, thought-ful discussion of current issues for practice, or essays that inform, advocate for a position or persuade. Manuscripts must address subject-matter specific interations of teachers and learners.

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Section on Language Arts

Section on Mathematics

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Language Arts

Decoding Skills
How These Skills Are the Answer to the Reading Problem that Affects Most Students

Laura Guenin

Abstract: Decoding skills are the answer to major reading issues for students. This report examines different ways that decoding words can effectively increase a student's reading comprehension level, and analyzes particular decoding strategies for teachers to implement with their students. This will help each student to enhance their own ability to comprehend what he or she is reading. It also compares two different teaching approaches. One uses decoding strategies and the other is a whole language approach that only deals with words in context. This document also shares the research on decoding that explains how students can decode unfamiliar words. It shows that teachers who implement decoding skills with their students will have the best strategies for teaching struggling readers.

Introduction

The National Institute for Literacy (NIFL) (2008) states that "there is consistent data showing failure to develop basic decoding skills by first grade is predictive of lifelong poor literacy" (as cited in Reutzel, Brandt, Fawson & Jones, 2014, pp. 49-50). I have found that reading is the most important subject in school at present, especially in the primary grades (kindergarten through second grade). Reading is a very complex subject that comprises the areas of phonological awareness, phonics (now called decoding), vocabulary, fluency and comprehension. Decoding skills are particularly essential. As Calfee & Dunn (1986) stated, "when a child begins school, his or her ability to analyze the sounds in words correlates with later reading achievement" (cited in Eldredge, Quinn and Butterfield, 2001, p. 202). As a teacher, I have found throughout my many years of teaching first grade that if a child is not a strong reader then he or she will have problems with learning throughout school. It influences learning in all other subjects for that student.

The ability to decode words is the most critical skill needed for students to be successful with reading comprehension. As Gale (2004) stated, "the process of decoding is used automatically and with such speed in fluent readers that we often take it for granted; however, for struggling readers, an inability to decode can have a severe impact on their reading experiences" (p. 25). The purpose of this article is to show how important it is that preservice, primary, and secondary teachers as well as administrators understand the impact that teaching decoding skills has on students. These skills will benefit the students and help them become more self-sufficient readers.

The Benefits of Decoding Over Whole Language

Decoding is the ability to gain word knowledge when it comes to letter and sound relationships. It includes learning the patterns of different letter groupings along with being able to pronounce new words. Students benefit from decoding being taught in a detailed and a systematic way. This is done by first teaching them the different sounds of a word, and then how to blend all the sounds together to correctly read the word.

In the past, there were two different ways for educators to teach their students reading in the primary grades. Decoding used to be called phonics. Anderson, Hiebert, Scott and Wilkinson (1985) wrote that "phonics ought to be conceived as a technique for getting children off to a fast start in mapping the relationships between letters and sounds" (cited in Chard & Osborn, 2000, p. 108). The other approach was called whole language. In this approach students learn the new words by reading books they are interested in. Weaver (1994) states that "whole language advocates regard reading as a top-down process whereby the most important thing a child can bring to the reading experience is his or her prior knowledge of language and the world" (cited in Kouri, Selle & Riley, 2006, p. 237). However, most students come to school with little or no prior knowledge of the written language so learning decoding strategies benefits them. Teachers can help them with this approach. Decoding gives students the ability to sound out the word, say it, and then to reread the sentence for comprehension purposes. Whole language, on the other hand, requires students to guess at words based on how those words relate to the story. Today, researchers have concluded that teaching decoding strategies in reading is the best way to educate our youth.

Decoding words is a slower way to look at each new word, which is presented to the students as a series of letters and the sounds that are associated with them. Snow, Scarborough and Burns (1999) argued that "letter-sound decoding is a far more efficient and accurate process than guessing a word's identity on the basis of context." They went on to say that "many professionals believe that if a child's reading is hampered by the inability to decode words through letter-sound information, reading fluency and comprehension will ultimately be compromised" (cited in Kouri, Selle & Riley, 2006, p. 238). In schools today, many students have difficulty with reading at different grade levels. The students have trouble decoding words as well as understanding word families and chunking words. As Kuhn, Schwanenflugel and Meisinger (2010) stated, "the process of decoding print must become an automatic, subconscious, effortless habit so that the mind is free for text comprehension" (cited in Wolf, 2016, p. 11). Decoding words is the most crucial skill needed so that students will be successful. It helps the students to reach the next step, reading comprehension. Therefore, teachers who continue to teach decoding strategies to their students make those students more competent readers when they move on to the next grade.

Decoding
The Research Behind It

Decoding is one of the developmental reading stages for learning how to understand the words that compose a sentence. It then leads to students comprehending what they are reading in a story. Decoding is a successful approach when the primary teacher works with his or her students to improve their pronunciation and knowledge of words. A key figure in the education field, Lev Vygotsky, was interested in the cognitive development of the child and argued for such a cooperative relationship. He thought that a cooperative relationship between the teacher and his or her students was essential to the growth of each student. Teaching decoding strategies to students fosters such relationships. As McLeod (2014) wrote, Vygotsky wanted "children to seek to understand the actions or instructions provided by the teacher then internalizes the information, using it to guide or regulate their own performance" (p. 10). One of Vygotsky's (1978) principles was that of "The Zone of Proximal Development" which states "that the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance" (p. 86). Teachers can take each of their students from their own "zone of proximal development" dealing with decoding strategies, helping them internalize the teacher's guidance. A student learning these different decoding strategies or skills with the help of their teacher or parent can improve their knowledge of words and how to decode them.

The National Governors Association Center for Best Practices and The Council of Chief State School Officers (2010) stated "that the goal of beginning reading instruction is to help students move as quickly as possible toward comprehension of a broad range of complex and content-rich texts." It goes on to claim that "phonics instruction is a gateway toward achieving that end because it helps students acquire the necessary prerequisite skills to decode unfamiliar words in complex texts" (cited in Reutzel, Brandt, Fawson & Jones, 2014, pp. 49-50). Coyne et al (2013) conducted an experimental research study on supplemental beginning reading intervention which supports this argument, and phonics instruction. It showed that the students who received the early reading intervention experimental condition in kindergarten continued to outperform comparison students at the end of first grade with significant findings on all measures of word reading, spelling, reading fluency and reading comprehension. (p. 40)

Coyne et al. found that the phonics group did better learning the different decoding strategies than the comparison group. These results were shown at the end of kindergarten. Students were checked again the following year and the results were the same; the experimental group continued to do better that the comparison group.

Many earlier studies also support teaching phonics and decoding skills. For example, the National Reading Panel's meta-analysis concluded "that systematic phonics instruction helps all children learn to read with greater success than nonsystemic or no phonics instruction" (NICHD, 2000, p. 9). Research has shown that the different decoding strategies ultimately helps students move from decoding words to comprehension. It also increases the fluency rate for reading text from a slow pace to a faster one, making reading more automatic and less stressful for struggling readers.

Implementing Decoding Skills into the Classroom

Teaching students phonics begins with decoding words, then moves on to word families. These are words that can be learned together like "it," "fit" and "sit" because those words have the same ending letters. It finally ends with students working on multisyllabic words, separating them into their syllables like "sup/per." The student decodes each part to figure out the unfamiliar word. The teacher's job is to get their students to understand and strategically decode the new words that are presented to them throughout the student's academic years in school.

There are many different strategies for teaching this. One is to have all the letters that relate to the spelling words for the week on a sheet of paper. The students will cut out each letter and then put them in alphabetical order. This gives the students a way to organize all the letters needed for the activity. The teacher then says a word like cat, then repeats it, but this time sounding each letter individually: /c/ /a/ /t/. The students will find those letters which are on their desk, and the whole class touches each letter card, saying the sound then saying the word.

The teacher can move on to decoding harder words by grouping the words into word families or practicing rhyming words. Another way is to use the word ladders that take away one letter from a word to form a new word. Intermediate grades and special education classes in high school can do word ladders with their students. These classes can also work on word families or rhyming words within a poetry lesson. All teachers can work with students on multisyllabic activities that involve separating new unknown words into their syllables.

One easy way to teach decoding skills is for teachers to use word families when presenting a new concept like the short /a/ sound. The teacher has the students sound out a word like /at/. The teacher will then proceed to have the students add a consonant at the beginning of it. An example would be to put the consonant letter- /r/ at the beginning of the word /at/ to make rat. The teacher may also decide to teach the students to sound out the word by chunking it. This is done by say the consonant sound then the word family ending. An example of this would be the consonant letter /m/ sound then say the word family of /ail/ and that makes the word mail.

It is important for students to understand the connection between a letter and its sound as well as how to put the letters together to make a word. Teachers will then want their students to link words together to make complete sentences.

Conclusion

There is a plan of action that involves all teachers from preservice, elementary, secondary and also special education teachers dealing with teaching decoding strategies to their students. It is the teacher's job to educate all their students including the struggling ones who are having problems processing information. All teachers can do this by teaching a curriculum rich in decoding strategies. Pinnell & Fountas (1998) state that students should know about the features of print, a large core of high-frequency words, understand simple and complex letter-sound relationships, notice and use patterns in words, use a repertoire of word solving strategies and for students to use references, resources and to proofread. (cited in Hudson, 2005, p. 8).

Teachers should have a cooperative relationship with their students as they work at the different decoding strategies to improve reading comprehension. Administrators need to understand the importance of educators teaching their students to decode words. They should be willing to assist by providing support and to supply any necessary materials. The teacher's plan of action is simple: just to get busy and teach decoding strategies to their students!

References

Anderson, R. C., Hiebert, E. H., Scott, J. A., & Wilkinson, I. A. G. (1985). *Becoming a nation of readers: The report of the commission on reading*. Washington, DC: National Institute of Education.

Calfee, R., & Drum, P. (1986). Research on teaching reading. In M. C. Wittrock (Ed.), *Handbook of Research on Teaching* (pp. 804-849). New York: Macmillan.

Chard, D., & Osborn, J. (2000). Phonics and word recognition instruction in early reading program: Guidelines for accessibilities. *Learning Disabilities Research & Practice, 14*(2), 107-117, Lawrence Erlbaum Associates, Inc.

Coyne, M. D., Simmons, D. C., Hagan-Burke, S., Simmons, L. E., Kwok, O., Kim, M., Fogarty, M., Oslund, E. L., Taylor, A. B., Capozzoli-Oldham, A., Ware, S., Little, M. E., & Rawlinson D. M. (2013). Adjusting beginning reading intervention based on student performance: An experimental evaluation. *Council for Exceptional Children, 80*(1), 25-44.

Eldredge, J. L., Quinn, B., & Butterfield, D. D. (2001). Causal relationships between phonics, reading comprehension and vocabulary achievement in the second grade. *Journal of Educational Research, 83*(4), 201-214.

Gale, M. (2014). Remedial reading instruction: A review of research in decoding. *Illinois Reading Council Journal, 33*(3), 23-29.

Hudson, R. (2005). Word work strategies to develop decoding skills for beginning readers. Florida Center for Reading Research, Florida State University. Accessed at http://www.fcrr.org/staffpresentations/RHudson/word_work_RF_Longisland_FCRR.pdf

Kouri, T. A., Selle, C. A., & Riley, S. A. (2006). Comparison of meaning and graphophonemic feedback strategies for guided reading instruction of children with language delays. *American Journal of Speech-Language Pathology, 15*, 236-246.

Kuhn, R. M., Schwanenflugel, P. J., & Meisinger, E. B. (2010). Aligning theory and assessment fluency: Automaticity, prosody and definitions of fluency. *Reading Research Quarterly, 45*(2), 230-251. doi:10.1598/RRQ/45.2.4

McLead, S. A. (2014). Lev Vygotsky. 7-22. Retrieved on January 15, 2017 from http://www.simplypsychology.org/vygotsky.html

National Governors Association Center for Best Practices and Council of Chief State School Officers (2010). Common Core State Standards. Retrieved October 27, 2011 from http://www.corestandards.org/

National Institute for Literacy. (2008). Developing early literacy: Report of the national early literacy panel. National Center for Family Literacy.

National Institute of Child Health and Human Development. (2000). Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction (NIH Publication No. 00-47690). Washington, DC: U. S. Government Printing Office.

Pinnell, G.S., & Fountas, I. C. (1998). *Word matters: Teaching phonics and spelling in the reading/writing classroom*. Portsmouth, NH: Heinemann.

Reutzel, D. R., Brandt, L., Fawson, P. C., & Jones, C. D. (2014). Exploration of the consortium on reading excellence phonics survey: An instrument for assessing primary-grade students' phonics knowledge. *The Elementary School Journal, 115*(1), 49-72.

Snow, C. E., Scarborough, H. S., & Burns, M. S. (1999). What speech-language pathologists need to know about early reading. *Topics in Language Disorders, 20*(1), 48-58.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological process.* Cambridge, MA: Harvard University Press.

Weaver, C. (1994). *Understanding whole-language: From principles to practice.* (2nd ed.) Portsmouth, NH: Heinemann.

Wolf, G. M. (2016). Letter-sound reading: Teaching preschool children print-to-sound processing. *Early Childhood Education Journal, 44*, 11-19.

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Laura Guenin received a bachelor's degree in early childhood education from the University of Toledo in 1987. She has spent the last twenty two years teaching first grade for Toledo Public Schools. Laura decided to return to the university thirty years later to earn a Master of Education degree.

The Writing Problem
Teacher Self-efficacy and Instruction

Catherine Haskins

Abstract: Writing is a struggle for many secondary students. The Common Core State Standards and state testing have led to an increased focus on writing, but there has been little improvement in performance. This is in part because the writing problem is no longer an English Language Arts (ELA) problem. All content areas need to work to improve student writing ability. This article explores two causes of low student writing ability: low teacher self-efficacy and ineffective teacher education programs. In order for students to become better writers, teachers not only need to become better writers, but also to believe that they are better writers. And teacher education programs need to support teacher candidates with writing instruction specifically tailored to their content areas so they are prepared to teach students how to write.

Introduction

"You're the problem!" I only half-jokingly exclaimed. I was having a conversation with a seventh grade social studies teacher about writing in his classroom. I asked how often and what type of writing he used and he said he never had his students write. "Sometimes they will write a couple sentences for an extended response, but that's it." My ELA mind was fuming. As I was half-way into explaining the importance of writing across content areas, he stopped me and said "Nope, that's your problem." It was as if he had slapped me.

"What about your own writing?" I continued to press the subject. He looked at me puzzled. "Do you think of yourself as a good writer?" I clarified.

"No, not really," he responded. I happen to know that he is actually a very good writer, and his low self-efficacy surprised me.

I wish I could say that this is an isolated incident, or one particular teacher's view on writing. Ask any secondary ELA teacher about the biggest challenge for their students, and most often they will say writing. But why? Why do so many students struggle with writing? Students are entering universities needing to take remedial writing courses. In a time of the third-grade reading guarantee, state standards, and frequent standardized tests, students are still unable to properly write.

There is no one answer for why students struggle to write. However, it is not a new problem, instead dating back to at least the late 1800's when Harvard University implemented a writing requirement for admission (Nagin, 2003). One would think education had improved over time. "Increasingly, however, officials at graduate schools of law, business and journalism report gloomily that the products of even the best colleges have failed to master the skills of effective written communication so crucial to their fields" (Sheils, 1975, p. 1). While this quote sounds like it could come from a modern day exposé on writing at the university level, but it is actually from the 1975 Newsweek article "Why Johnny Can't Write." Forty years later we are still talking about why Johnny can't write, so how do we solve this probelm?

To answer this question, we need to look at the cycle of writing as a whole. If the teaching of writing has been an issue for at least 150 years, it is possible that the people who are teaching writing are simply not good writers. Therefore, to solve the problem of poor writing, we must start by looking at the teachers themselves.

Why is Writing Important?

Writing instruction is an ELA problem. But it is also a social studies problem. A math problem. And a science problem. All content areas use writing to some degree, whether in a lab report, a proof, or an essay about types of government. Therefore, all teachers need to know how to teach writing. Writing also positively impacts learning. Emig states that "[w]riting involves the fullest possible functioning of the brain, which entails the active participation in the process of both the left and the right hemispheres" (1977, p. 125). People learn in three ways: by doing, icons, and representation. The benefit of writing in enforcing learning is that it utilizes all three of those types of learning at the same time (Emig, 1977). Writing is unique in the way it allows the brain to function. This makes it a valuable skill and important technique in any learning environment.

Self-Efficacy

To understand how teacher self-efficacy affects the students, self-efficacy itself must first be understood. Self-efficacy is a person's belief in their own ability to complete and succeed on a task (Jani & Mellinger, 2015); in the case of writing self-efficacy, their ability to complete and succeed in writing.

Once beyond the high school classroom, students are offered little direct writing instruction in the educational system. Students may take a couple composition classes, but then are left to their own devices. Thus "teacher candidates dislike writing; they believe that they receive inadequate instruction and feedback; and although many receive high grades on their papers and in their courses, many teacher candidates consider themselves to be poor writers" (Gallavan, Bowles & Young, 2007, p. 64). This is contributing to the low self-efficacy in teacher candidates at the collegiate level. One of the most puzzling components of self-efficacy is that many of the teachers received high marks in writing, yet they still feel they are not good writers. If an assessment is valid and reliable, an A should equal a good writer. However, the high mark alone is not enough for teachers to have high self-efficacy. While Gallavan et al. do not offer a correlation between the low self-efficacy and the professors, we can speculate it is due to limited writing instruction and a lack of specific and timely feedback from the instructor.

As a result of receiving inadequate writing instruction and feedback, students in university programs feel low-self efficacy as writers. In some cases, students are turning in papers, and not receiving feedback on them until the end of the term. Most students at the university level should be able to write without additional instruction. Even in literature courses, it is rare for a professor to spend time teaching writing skills. However, based on their survey of teacher candidates' personal beliefs on writing, Gallavan et al. (2007) point out that this leads students to have low self-efficacy as writers.

It is important for teachers to be proficient writers in order to be able to teach writing. Not only do they need to be able to write, but they need to have high self-efficacy in terms of their writing ability. A teacher's writing ability matters because, "teacher expertise is the most significant factor in student success" (Nagin, 2003, p. 59). This low self-efficacy causes many teachers to shy away from teaching writing because they 1) do not like it, or 2) do not think they are good enough writers themselves to teach it to students.

Teacher Education Programs

Teacher writing ability is only one component of the problem. For a teacher, being a good writer is simply not enough. It is a necessary component of pedagogical content knowledge, but in order to be a successful teacher of writing, the teacher must also know how to teach writing.

Teachers may have low self-efficacy as writers because they received minimal instruction on how to teach writing in their teacher education programs, especially in content areas other than ELA. Yet with the influence of the Common Core State Standards, "the role of writing in learning across the disciplines becomes more apparent," and "every teacher has a responsibility to incorporate it in his or her classroom" (Nagin, 2003, p. 60). Therefore, teaching writing should be taking place in all teacher education programs, no matter the content area. Many, if not all, teacher education programs require at least one content reading course. Part of the course involves teaching writing to learn strategies in all content areas. Students practice how they can implement the strategies within their particular content area. While this requirement is a step in the right direction, it still does not offer enough support to teacher candidates with their own writing, nor with how to teach writing.

Gillespie, Graham, Kiuhara, and Hebert (2014) found teachers that used writing-to-learn strategies (notetaking, short answer responses, etc.) in the classroom without ever having been taught how to properly implement them. Students do not benefit from writing just to write (Bangert-Drowns, Hurley, & Wilkinson, 2004). They need to be properly taught the appropriate skills. Yet, if the teacher does not know how to write, or teach writing, even after graduating from an accredited teacher education program, the students will not learn the required skills. A major concern is that "composition pedagogy remains a neglected area of study at most of the nation's thirteen hundred schools of education" (Nagin, 2003, p. 5).

Teachers should feel confident entering a classroom and teaching writing relevant to their content area. However, many teachers received only minimal instruction in how to teach writing to their students. According to the Gillespie et al. study, "most teachers reported they received minimal (47 %) or no formal preparation (23 %) during college on how to use writing to support learning, with 24 % reporting adequate preparation and 6 % reporting extensive preparation" (2014, p. 1051). Not surprisingly, language arts teachers received the most training in writing instruction.

Some teachers are using writing-to-learn strategies in the classroom, however they are often not using them correctly. Simply having the students fill in blanks or write without composing does not influence learning in the same way as writing-to-learn strategies. Yet this is essential. "With the emphasis that CCSS now places on using writing as a tool to support student learning, it is important that colleges, universities, schools, school districts, and state departments of education do a better job of preparing teachers" (Gillespie et al., 2014, p. 1066). If teachers are expected to teach writing to their students, they should receive writing instruction in their teacher preparation programs.

In order to break the cycle of poor writing ability, teacher education programs need to integrate writing instruction into their curriculum for all content areas, not only ELA. This should include two foci: improving teachers' writing ability, and teaching techniques for writing instruction. Therefore, teachers will be prepared to teach writing in a heavily tested and standard-driven era. If teacher education programs change their curriculum to include more writing instruction, future teachers will be able to teach students how to write and the cycle of poor writing will end.

Professional Development

There is still hope for teachers getting ready to start their first job, or already teaching, even if they have little idea how to implement writing to learn strategies. The answer is successful professional development opportunities that focus on writing ability. As in the teacher education programs, there need to be two components of a successful professional development: a focus on improving teacher writing ability and on teaching the teacher writing instruction strategies.

However, currently professional development, similar to teacher education programs, does not focus on writing. "[M]ost teachers reported they received minimal (45 %) or no formal inservice preparation (11 %) on how to use writing to support learning, with 38 % reporting adequate preparation and 6 % reporting extensive preparation" (Gillespie et al., 2014, p. 1051). Even if their professional devleopment has focused on writing at times, writing instruction is always evolving and teachers should be constantly reflecting and reevaluating their teaching practices. Successful professional development opportunities can help teachers learn or strengthen not only their teaching of writing, but their own writing ability themselves. One example of successful professional development model is the National Writing Project, which began in 1973 at the University of California, Berkely and has spread to 175 sites in all 50 states (Nagin, 2003, xi).

The National Writing Project

The National Writing Project (NWP) is a professional development opportunity that has a two-step approach, and that illustrates how improving writing and improving teachers' self-efficacy go hand in hand. First, it uses a "teachers-teaching-teachers model that draws on the knowledge, expertise, and leadership of successful classroom teachers" (Nagin, 2003, p. xi). This strategy grants more credibility to the presenters, because the people leading the program are renowned teachers from the field rather than outside consultants. Secondly, the program focuses on improving the writing ability of the teachers themselves. It places a high value on the self-efficacy of teachers: "one form of participation above all other is expected at NWP staff development: writing teachers must write" (Nagin, 2003, p. 65).

Bifuh-Ambe

Of course, the NWP is not the only effective writing professional development. To determine what makes a successful professional development, Bifuh-Ambe (2013) looked at a professional development opportunity in Massachusetts that combined elements of the National Writing Project, and the Writer's Workshop model. Bifuh-Ambe examined what makes a professional development worthwhile, and concluded that successful programs should allocate time during the professional development for teachers to focus on strengthening their own writing ability. It is also important for teachers to understand the importance of their own writing ability. Another successful component of professional development was a workshop model in which the participants were able to discuss and collaborate with other teachers.

This professional development program increased teachers' positive attitude toward writing, as well as their self-efficacy about their own writing. However, for some reason this professional development contributed to negative shifts in teachers' perception of their ability to teach writing, especially in terms of generating ideas, giving feedback, collaboration, and control of writing. Despite this negative shift, teachers reported learning new strategies and ways to implement writing instruction into their classrooms.

Conclusion

The challenge of teaching writing is not a new problem, yet the education community is still struggling with how to solve it. There are many spokes on the wheel of writing: two important ones are teacher's self-efficacy and knowledge of writing instruction. Teachers themselves need to be proficient writers, and more importantly, they need to see themselves as such. Not only will they then have a more positive attitude toward writing in general, but they will have more confidence when teaching it to their students. Secondly, teacher education programs need to include writing instruction as well as how to teach writing in ways specific to particular content areas. This will prepare a new generation of teachers to teach writing and to have a high degree of self-efficacy as writers. For teachers already in service, beneficial professional development opportunities should be offered. These include teachers-teaching-teachers approaches such as the National Writing Project, as well as other programs that focus on improving teachers' writing ability and self-efficacy. A combination of these changes can help to break the cycle of poor writing in our schools.

References

Bangert-Drowns, R. L., Hurley, M. M., & Wilkinson, B. (2004). The effects of school-based writing-to-learn interventions on academic achievement: A meta-analysis. *Review of Educational Research, 74*(1), 29-58. doi: 10.3102/00346543074001029

Bifuh-Ambe, E. (2013). Developing successful writing teachers: Outcomes of professional development exploring teachers' perceptions of themselves as writers and writing teachers and their students' attitudes and abilities to write across the curriculum. *English Teaching: Practice and Critique, 12*(3), 137-156.

Emig, J. (1977). Writing as a mode of learning. *College Composition and Communication, 28*(2), 122-128. doi: 10.2307/356095

Gallavan, N. P., Bowles, F. A., & Young, C. T. (2007). Learning to write and writing to learn: Insights from teacher candidates. Action in Teacher Education, 29(2), 61-69. doi: 10.1080/01626620.2007.10463449

Gillespie, A., Graham, S., Kiuhara, S., & Hebert, M. (2014). High school teachers use of writing to support students' learning: A national survey. *Reading and Writing: An Interdisciplinary Journal, 27*(6), 1043-1072. doi: 10.1007/s11145-013-9494-8

Jani, J. S., & Mellinger, M. S. (2015). Beyond "writing to learn": Factors influencing students' writing outcomes. *Journal of Social Work Education, 51*(1), 136-152.

Nagin, C. (2003). *Because writing matters: Improving student writing in our schools.* San Francisco: Jossey-Bass.

Sheils, M. (1975). Why Johnny can't write. *Newsweek*, Dec. 8, 1975, pp. 58-63.

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Using Elements of Hip Hop to Promote Student Engagement

Edward McDaniel Jr.

Abstract: Incorporating hip-hop into the classroom is an effective way to increase the engagement of students, especially in urban schools. The use of hip-hop in education has become more popular in recent years and is a tool that can potentially benefit many teachers. Several studies were looked at that showed positive outcomes when teachers communicated and interacted with their students in a culturally congruent manner. By incorporating hip-hop while student teaching, the author observed a noticeable increase in student engagement.

Introduction

Ms. Emcee is an 8th grade English teacher in a predominantly African-American school. She has been reading articles on the effectiveness of using hip-hop in the classroom to motivate students and to increase academic performance. Prior to reading materials about hip-hop and African American culture, Ms. Emcee frequently dismissed the cultural relevance of hip-hop and often corrected students' "broken English." However, she noticed that no matter the number of times she corrected the students' speech, they ultimately reverted back to the "incorrect usage."

Ms. Emcee usually began her class with a warm up activity. Lately she noticed that her students seemed unenthused and their engagement was limited so she decided to try a different approach. "Good morning, class. Today we will forego the warm up and I would like to spend the first few minutes of class teaching you a chant that I think will be helpful. After you have learned the chant and are comfortable with saying it, I would like to begin each day and conclude each day with a recitation of this chant." She explained the purpose of the chant, gave detailed instructions, and then led the class in the following chant:

Student: "Ms. Emcee."

Mrs. Emcee: "Yes, student?"

Student: "Whose world is this?"

Mrs. Emcee: "The world is yours, the world is yours!"

Whole class: "It's mine, it's mine, it's mine!"

Mrs. Emcee: "Whose world is this? It's yours."

Whole class: "It's mine, it's mine, it's mine."

This chant was easy for the students to catch onto because it is derived from the lyrics of a classic hip-hop song called "The World is Yours" by Nasir Jones.

The song was released in 1994 and still resonates with people of all ages who have an appreciation for hip-hop. The students were able to recognize it immediately when Ms. Emcee presented it to them and so they caught on quickly and were very motivated to chant it loudly.

What is Hip-Hop?

During the 1970s, DJ Kool Herc began expressing himself through hip-hop music. He was living in the Bronx where hip-hop became an outlet for all of the social struggles that many were facing. By the 1980s, hip-hop was a part of the mainstream culture in the United States. In the late 1980s, groups like Native Tongues were strongly using hip-hop as a way to express their relationship to the sociopolitical climate. For example, the group NWA (Niggaz Wit Attitudes) put out a "gangsta" rap album entitled "Straight Outta Compton." (Lightning Guides, 2015).

Jenkins (2011) argued that knowledge and mental power do not seem to be respected aspects of hip-hop within the popular culture. Discussions about hip-hop in our culture almost never include how smart and clever the artists are. The way that the intelligence of hip-hop artists is ignored seems to be a small example of how the experiences and viewpoints of African-American men in general are essentially disregarded by our society. In other words, the fact that the abilities of verbose and brilliant hip-hop artists are ignored is just a microcosm of a larger problem in that African American males are devalued in classrooms and American society as a whole (Jenkins, 2011).

At the same time, according to Bridges (2011), hip-hop has gained some popularity in education in city schools. Teaching has taken ideas and elements from popular culture as a means to help with instruction for decades. Bridges discusses the increase in popularity of using hip-hop in the classroom in his article "Towards a Pedagogy of Hip-Hop in Urban Teaching Education." This increase is likely due to the need to find new ways to help Black students who are struggling academically. Bridges looked at three different "organizing principles" that come from hip-hop culture that include "call to service, commitment to self-awareness, and resistance to social injustice." He found that these principles existed when looking at the relationship between hip-hop music, pedagogy and styles of teaching used by educators in urban settings.

Hip-Hop in Real Time
Root Words and Poetry

I completed my student teaching at a K-8 school in Toledo. As part of our curriculum we reviewed Greek and Latin roots. The root at this particular time was "port." It was evident that the students were bored with their current routine and I felt that they were capable of so much more. I decided to try a different approach and I wrote the following to a Tupac instrumental:

> *Gather around class, let's explore and dig deep, the root "PORT" meaning "CARRY" words for this week, we'll start it off with TRANSPORT, to take or carry people or goods from one place to another, by means of transportation…plugged up my mic, and*

> *then I laced this…who can now, define PORTABLE? "I can, it means easy to carry or move around…there's other words that we need to study, like DEPORT which means to force, a person who is not citizen, to leave a country…behold the flipside as I pick my, next words to teach folks, which is IMPORT, meaning to bring a, product into a, country to be sold…here's something I engage in from time to time, When I exercise my mind, it allows me to TELEPORT an imaginary phenomenon, in which a person or object is moved across a distance instantly, knowledge is priceless, and since I know this, you won't get charged, for these poetic bars I've kick for free, the only thing that I ask that you give to me, a passing grade to do that study intensively.*

When my mentor teacher played the recording for the students, they perked up, were bobbing their heads to the beat, and were clearly listening to the lyrics. Several students turned and looked at me and asked with excitement, "Is that REALLY you, Mr. McDaniel?" They seemed shocked that a teacher was capable of putting a hip-hop song together that they would enjoy.

All of the students had Google accounts that were used for sharing assignments and materials with the class. My mentor teacher uploaded the song to their accounts so they could use it to study. She also proposed that if anyone could write their own hip-hop song using the root words and perform it for the class, it would serve as a formative assessment instead of taking the written exam. Their music teacher decided to use my song as a lesson in her class as well. Students in other classes began approaching me and asking, "Did you REALLY write that song? You got bars!"

Another example of using hip-hop in the classroom came when I had my students watch a video of a spoken word artist who performed at a TED Talk event. Throughout the year we had watched a lot of TED Talk videos and students were relatively familiar with the platform. This particular TED Talk was called "Infuse and Inspire" and the artist delivered a very captivating performance of one of his poems.

Students were mesmerized by the performance and expressed that they had really enjoyed the video. I distributed note cards and posed the question "if you could speak to this young man what is one question you would ask him?" After every student turned in their note card we proceeded with our reading for that day. The surprise that was to come later in the week was that I had made arrangements for the performer from the video to come to the school as a guest speaker.

The only information I gave my students was that we were scheduled to have a guest speaker on Thursday. I never mentioned that it would be the man from the video or that he was a good friend of mine. When he came into the classroom, the students were very surprised and instantly engaged when they made the connection that he was the performer from the Ted Talk video.

Mr. Martinez led the class in a discussion on spoken word poetry, haikus, rhyme schemes, and provided some interesting facts about the poet Paul Laurence Dunbar. He then had the students write haikus and encouraged them to share their poems with the class. I was surprised to find some of my students who typically under performed in class really became immersed in the activity and produced some really impressive poems.

Mr. Martinez went on to perform several of his pieces for the students and shared videos of young people their age reciting poems at open mic venues. Since Mr. Martinez's poetry is very personal and autobiographical in nature, I used a similar format to conclude the lesson on poetry. I had the students write biographical poems with the following example to help guide their writing:

Your first name____

4 adjectives that describe you ____

Son or daughter of ____

Lover of (3 people or things you love) ____

Who feels (3 feelings you have) ____

Who needs (3 things you need ex. More freedom, sleep, money, etc.) ____

Who gives (3 things you give ex. Time, a shoulder to lean on) ____

Who fears (Three fears you have) ____

Who would like to see (3 things you would like to see) ____

Who lives (The city where you live) ____

Your last name ____

The entire class applauded and thanked Mr. Martinez for his time and for teaching them about spoken word poetry. After Mr. Martinez had left the room, I asked the students what they thought about the day's events. They very enthusiastically shared that they had really enjoyed themselves. One student asked, "Mr. McDaniel, why don't we do more stuff like this?"

Why Should Teachers Use Hip-Hop in the Classroom?

There need to be changes to the way in which our society views knowledge in order to reflect the viewpoints of minorities. In order to do so, we must first acknowledge that racial minorities have a perception that is based on their historical experiences of being downgraded and disregarded in our society. An important way to recognize the viewpoints of minorities is to listen to their stories about their experiences. Hip-hop is great vehicle for creating both thinkers and writers, which is beyond what most schools have done for minority students (Jenkins, 2011).

Gloria Ladson-Billings' book Dreamkeepers (2009) offers excellent examples of how to teach African-American students and models how to use the theories derived from her research to make improvements. Ladson-Billings contends that the pedagogical instruction that most teachers who work with African-American students get is subpar and comes from outdated ideas. In order to really succeed in the classrooms, teachers need to go down a different path that truly allows them to help their students achieve success. Within the last few years there have been more people examining just how to help students who are racially and linguistically diverse grow in their academics. Ladson-Billings argues that it is important for teachers to communicate and interact with their students in a way that is "culturally congruent." She defines cultural congruency as speaking and communicating in styles and patterns that look like the culture of the students.

Morrell and Duncan-Andrade (2002) discuss their experiences teaching in an urban high school and seeing the positive effects of hip-hop music being incorporated in the classrooms in their article "Promoting Academic Literacy with Urban Youth Through Engaging Hip-Hop Culture." Not only did they find that the use of hip-hop impacted the students of color, but it seemed to be an effective tool for all students, regardless of their race or ethnicity. They found that hip-hop was able to help students develop strong literacy and increase their critical consciousness.

Their article further discussed how hip-hop music was created by urban residents and therefore offers something to which the students can relate. Hip-hop came from inside the city and illuminates urban citizens' desires and dreams. In fact, every issue that most students in urban schools face is likely represented somewhere in hip-hop. Some hip-hop artists even view themselves as educators and strive to build consciousness within their community. By increasing their critical consciousness, the oppressed can make movement towards developing literacy and eventually freeing themselves from their oppression, and this is true not only of hip hop artists but students as well (Morrell and Duncan-Andrade, 2002).

Conclusion

It is evident that hip-hop is a tool that can be used in classrooms to increase student involvement and their level of enthusiasm. There are endless ways that teachers can incorporate hip-hop into their lessons and they can customize it to fit their teaching styles. Teachers who are less familiar with hip-hop can simply start using hip-hop chants to help motivate and encourage their students. Teachers who are more comfortable can start incorporating hip-hop into their lessons by having the students read and write lyrics with their vocabulary words. Regardless of how hip-hop is used in the classroom, it can have positive effects for both the teachers and the students, and can not only make learning fun, but can also increase its relevance and value.

References

Bridges, T. (2011). Towards a pedagogy of hip hop in urban teacher education. *The Journal of Negro Education, 80*(3), 325-338.

Jenkins, T.S. (2011). A beautiful mind: Black male intellectual identity and hip-hop culture. *Journal of Black Studies, 42*(8), 1231-1251.

Ladson-Billings, G. (2009). *The dream-keepers: Successful teachers of African-American children.* San Francisco, CA: Jossey-Bass.

Lightning guides. (2015). *Voices of black America.* Berkeley, CA: Author.

Morrell, E. & Duncan-Andrade, M.R. (2002). Promoting academic literacy with urban youth through engaging hip-hop culture. *English Journal, 91*(6), 88-92.

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Preparing Students to Write in Professional Environments

Andrew Sanctis

Abstract: American businesses annually spend billions of dollars in efforts to improve their employees' writing abilities in the workplace. Current methods of writing instruction are not adequately preparing students for professional environments, and in order to alleviate these issues, adaptations must be made in secondary classrooms to foster writing self-efficacy and mastery. Through the use of reflective writing activities, meaningful assignments, and lesson plans incorporating technology, teachers can help students develop as writers and better prepare them for the workforce.

Introduction

Every year, students across our nation graduate high school at a commencement ceremony, symbolizing the start of their new lives. When they enter the workforce, employers expect them to be proficient in basic skills and knowledge so they can adequately perform the tasks asked of them. Why is it, then, that so many graduates are unprepared when it comes to their basic writing skills? According to a 2004 report by the National Commission on Writing for America's Schools, Families, and Colleges, American businesses annually spend up to $3.1 billion in order to improve communication skills in the workplace. these skills include writing emails, reports, and other forms of professional correspondence, as well as vocabulary, professionalism, and oral communication. How can educators address these issues in order to better prepare students for professional environments?

Developing Writing Self-Efficacy

We all know that many students dread writing, regardless of the content area. Nothing elicits audible frustration and anguish from students like a writing assignment, but does it always have to be a battle to get them to put pencil to paper? Many students are apprehensive when it comes to writing because they don't feel confident in their abilities. Psychologist and professor Bandura (1997) explained that self-efficacy, which he defines as "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives," plays a large role in how an individual perceives and acts upon their emotions, thoughts, and behaviors (p. 2). Bandura's research suggested that mastery experiences, or repetitions of an activity until successful, are the most effective method of creating a sense of efficacy. By repeating a task with guided instruction and improving, a person learns the skill and understands that they are capable of performing it individually in the future. This provides a student with the ability to successfully perform that same task in a different environment and on their own. Simply put, if a student learns how to write well through practice and believes that they are capable of doing so, their will alleviate their own apprehension and be able to blossom as writers.

Mascle (2013) directly addressed the parallel between self-efficacy and writing ability, Mascle (2013), expanding on Bandura's theory. According to Mascle "instructional practices that work to diminish apprehension about writing can have long-term positive effects on the writer, such as improving writing confidence" (p. 218). This foundation of self-efficacy must be in place before we can expect students to believe that they are writers. Mascle also argued that students must be offered meaningful writing tasks. One of the issues is that students often do not see the value in writing activities because they do not seem meaningful. When a student honestly believes that what they are doing lacks value, they will be less likely to take the assignment seriously. Mascle argued that one way to overcome this problem is for teachers to provide meaningful, varied opportunities to write, models of performance from poor to exemplary, and feedback from both the instructor as well as peers. In regards to assignments being meaningful, teachers should offer writing activities that students are most likely to believe foster skills which they will use in the future. These activities could include writing professional correspondence, memos, incident reports, employee evaluations, and even workplace climate surveys. The idea is to develop student proficiency with the types of writing they will likely encounter, as they will be more likely to see them as valuable activities while at the same time improving skills such as grammar and mechanics.

Reflective Writing

While educators are explicitly responsible for preparing students with the skills (such as writing) they will need to succeed, ethics, values, leadership principles, and character development are also a large part of a school district's mission, and these traits must be molded in order for students to succeed after high school. It is not uncommon for a school's mission statement to directly state that its purpose is to prepare students to be productive citizens. With that in mind, how can character development and leadership be incorporated into a classroom? While character development and leadership are often discussed in social studies classrooms, they can also be incorporated into ELA classes, as well. One way is for the students to engage in what is referred to as reflective writing, where students write specifically about themselves. This is an excellent way to make the activity personal and meaningful to the students since they are the topic of their own work. Through reflective writing, they can be pushed to think critically about who they are, including about their own strengths and weaknesses, thus developing an awareness of areas of themselves that might be improved.

By reflecting about themselves as citizens and leaders through writing, students can be brought to analyze their own roles, how they can be effective in these roles, how to better set goals (both personally and professionally), and they can also investigate leadership theory and practice (Lawrence, 2013). Such activities can also nurture civic responsibility. Social studies classrooms are not the only place in which civic responsibility can be discussed, just as English classrooms are not the only place where writing can be taught. Through reflective writing strategies, teachers across content areas have the opportunity to engage their students with activities that require critical thinking about individuals and society as a whole. By doing this, teachers can foster character development so that students not only envision themselves as productive citizens, but also as employees who have a developed sense of themselves and their place in society. These reflective activities can lead students to examine and develop themselves as professionals, and since they are writing activities, can at the same time sharpen writing skills necessary for the business environment. Sentence structure, tone, audience, purpose, spelling, and punctuation are all possible focal points of these writing activities, which serve a dual purpose of improving the "hard" and "soft" skills necessary for success in business. This idea was emphasized by Lawrence when she explained that reflective writing "has the potential to better prepare students for the realities of the business setting they will soon enter" (p. 203).

Content Standard Creativity

Teachers are well aware that there are certain expectations of what they should be teaching in their classrooms. Argumentative essays, for example, are a staple of the ELA classroom, but outside of academic environments, will most students ever write another one after they graduate and enter the workforce? Writing emails, on the other hand, will be a common task in almost every career field, especially as technology has advanced and become the standard medium of communication. Teachers have a responsibility to prepare students for both college and employment and must take into account what types of activities they are teaching in order to provide the most benefit. The challenge is designing lesson plans and activities that align valuable writing activities with the current content standards. While this might seem a daunting task, it is possible to accomplish.

The Ohio College and Career Readiness Anchor Standards (2017) address the skills expected of students but do not mandate assignments that teachers must use to develop these skills. For instance, comprehending and clearly articulating ideas, writing for a purpose, and demonstrating understanding and usage of point of view, tone, audience, and word choice are all included in these standards. While it is expected that students end the year with grade level proficiency in these skills, teachers have a lot of autonomy in how they teach them to their students. By designing lesson plans that are relevant and valuable, teachers can incorporate activities which teach to these standards while still preparing students for their futures. One example is teaching student to write effective emails. Writing an email is relatively simple conceptually. An individual has something to communicate, so they write a short form of correspondence and hit the send button. It seems like a simple assignment, but it can be used in multiple ways. Is the author a supervisor, a peer, or a subordinate? Who is the recipient? What message are they trying to convey? Is it a simple request, a disciplinary action, a proposal, or a congratulatory e-mail? Standards relating to purpose, audience, and tone can be incorporated into this simple assignment, merely by having the students change roles. While students are developing their writing skills in regards to the standards, they are also learning about how the greeting, body, and salutation of an e-mail are properly formatted, developing their skills as young professionals before entering the workforce. By being creative with the content standards, teachers can provide valuable activities that allow students to develop professional skills and self-efficacy.

Work-Study Programs

Students attending career centers or earning their high school diplomas through work study programs are often overlooked. Unfortunately, these students are often stigmatized as low-achievers, but they enter society with the same diplomas as a traditional student, the only difference being that many of these individuals will enter directly into the workforce without further academic training. For these students, high school is the last opportunity to develop their writing ability in an academic setting. Therefore, it is essential that teachers do everything in their power to properly prepare them, as they are less likely to receive direct instruction in writing after they graduate. These students in particular can benefit from lessons with meaningful and relevant writing activities directly related to the students' field of study. Kohn (2015) has argued that students often do not see the connection between academic and workplace writing, arguing for the benefits of mentorship programs that connect academics and the workforce. While Kohn's research focused on business students at the collegiate level, his argument applies across levels. Students fortunate enough to have a robotics lab, or certification programs for electricity, for instance, can complete writing assignments that correlate to what they are learning and what they are likely to produce in that field. For example, an expository paper that articulates what went wrong with a robotics project and how it might be improved could be a valuable opportunity for a student not only to master their content, but also to address writing standards regarding purpose, central ideas, and language usage. And since career-tech instructors typically have years of experience in their fields and know what types of writing will be expected of students after gaining employment, they can teach authentic writing skills in their subject area.

Technology

For several reasons, including a lack of resources or a teacher's own low self-efficacy, some teachers still teach using traditional methods instead of using a multifaceted approach incorporating technology. In some classrooms every assignment is handwritten despite students openly expressing their distaste for writing; lectures bore students, who quickly begin daydreaming; and the resources that are available collect dust on tables in the back of the classroom. While these traditional methods have some value to, technology is an integral part of our daily lives and shouldn't be cast aside in a classroom. Upon entering the workforce, students will have to master technology even at low-wage, entry-level jobs. Restaurant servers, for example, commonly use automated machines (and sometimes even tablets) to place orders; grocery store employees use electronic scanning guns to stock shelves; and secretaries' lives revolve around their computers and telephones. In corporate environments, a mastery of technology is even more vital, as employers will expect proficiency in developing reports, conducting meetings using technology to provide visual representations, and putting together and delivering presentations involving media. Therefore, it is essential that educators prepare students with the most current technology available to them. This will not only increase proficiency with the technology itself, but will also provide opportunities for students to develop higher levels of self-efficacy. Recent research comparing classrooms taught with traditional methods versus those which incorporated technology has shown that using technology and interactive lessons resulted in "lower apprehension levels and higher grades" (Davis, Fisher, & Forde. 2009, p. 11). Student engagement, improved self-efficacy, and writing skill improved through the use of SMARTBoards and more modern teaching strategies. This suggests that the use of technology may help improve writing self-efficacy and mastery.

Conclusion

Currently, many students are entering the workforce unprepared in terms of their writing abilities. Changing this may appear to be a monumental task, but by altering their teaching strategies and activities and incorporating more technology, educators have the opportunity to better prepare their students for success. By focusing on improving students' self-efficacy as writers, teachers can help them develop the confidence and skills to perform proficiently in the workforce. As Bandura (1997) stated, "individualized instruction tailored to students' knowledge and skills enables all of them to expand their competencies" (p. 12). If teachers reflect upon what students truly need to be successful after graduation, they can tailor their instruction in order to adequately prepare them for the realities of the workforce, while remaining within the confines of the curriculum and state standards.

References

Bandura, A. (1997). *Self-efficacy.* Harvard Mental Health Letter, 13(9), 4-7.

Davis, L., Fisher, D., & Forde, C. (2009). Teaching with technology to decrease writing apprehension and increase writing skills in a business communication course. *Business Education Digest, 18* (11), 1-12.

Kohn, L. (2015). How professional writing pedagogy and university–workplace partnerships can shape the mentoring of workplace writing. Journal of Technical Writing and Communication, 45(2), 166-188. doi: 10.1177/0047281615569484

Lawrence, H. (2013). Personal, reflective writing: A pedagogical strategy for teaching business students to write. *Business Communication Quarterly, 76*(2), 192-206. doi:10.1177/1080569913478155

Mascle, D. D. (2013). Writing self-efficacy and written communication skills. *Business Communication Quarterly, 76*(2), 216-225. doi: 10.1177/1080569913480234

National Commission on Writing. (2004). Writing: A ticket to work . . . or a ticket out: A survey of business leaders. New York: College Board. Retrieved from http://www.collegeboard.com/prod_downloads/writingcom/writing-ticket-to-work.pdf

Ohio Department of Education. (n.d.). Ohio's Learning Standards for English Language Arts. Retrieved June 15, 2017, from http://education.ohio.gov/Topics/Learning-in-Ohio/English-Language-Art/English-Language-Arts-Standards

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Mathematics

The Risks of Using Homework in Middle Grades Math Classes

Alaina C. Hem

Abstract: The assigning of homework is a widely used practice in education. However, requiring it comes with several risks. First, many students have very different levels of parent involvement at home, meaning that some are at a disadvantage in terms of completing homework. Similarly, differences in resources at home affect students' abilities to complete their homework. Language barriers and disabilities are also factors that can cause difficulties for students when they are at home and beyond the help of the teacher. In addition, homework can be very stressful for all parties involved. Before assigning homework, teachers should carefully consider the diverse needs, advantages, and disadvantages that their students have. They should understand their purposes for giving homework and decide if those purposes could be better served by using in-class activities.

Introduction

Imagine what happens after you assign homework. Student A is driven home by his mother. Once there, he is greeted with a healthy snack and juice. He relaxes for an hour in a clean, quiet home. Then, his private tutor arrives and they head over to a well-lit table, Student A's favorite place to study. He works through the assignment and the tutor interjects when necessary. Once he completes all of his homework, the tutor leaves and the family sits down to a nice dinner. Student A's parents congratulate him for working so hard and doing well in school. "You'll do great things" they say. After spending more time with his family, he lays down in bed, dreaming of becoming an astronaut, an engineer, or a rock star. He knows he can do anything he sets his mind to.

Student B takes the bus home. Her parents try to help her with the assignment but they struggle to understand the questions, since English is not their first language. She eventually gives up asking them for help. Student B is not sure why she is even doing this assignment. She's never been good at math and that was not going to change. She decides to just write down nonsense for every question.

Student C walks home with a few of his young siblings from school. As soon as he gets there, his mother leaves and he is left to watch his six siblings, one of still a baby and needs constant attention. He tries to work on his assignment but the chaos in the room makes it impossible to focus. He makes another attempt once his siblings have gone to bed but he is unsure how to even start. It seems like the assignment is in a foreign language. Angrily, he crumples up the assignment and throws it away.

The next day, Student A turns in a beautifully completed assignment. Student B hands in the assignment but it is sloppily done and you can tell little thought was put into her answers. Student C does not turn it in at all. Since some students did well, you feel that the assignment must have been appropriate for this class. Yet students B and C feel that they must be stupid, incapable of completing an assignment that was made for them. Student B decides she hates math. Student C shuts off completely in class, humiliated.

What if you had given this same assignment in class? Consider the differences for students B and C. Student B would have received the help she needed and you could have encouraged her when she doubted her abilities. She might have decided that math is not so bad after all; maybe she would even pursue a career involving math. After working with Student C for a while, you would have realized how to differentiate this assignment to his needs. As a result he would have felt more confident in this subject and would know that he could come to you when he struggles. Even student A would have gained more from this assignment than he did at home because he was able to collaborate with several other students. Through this collaboration, he considers new strategies, ideas, and perspectives that he and his tutor had not thought of.

These scenarios demonstrate the reality that students often go home to unequal situations. As a result, assigning homework frequently widen the achievement gap because it allows students with more resources to do better than those with less. Teachers can mostly control the environment in their classrooms but they cannot control what happens once their students leave school. Of course, these scenarios make it seem that giving assignments in class will solve all educational issues. Of course, doing so will not. However, clearly this issue requires further examination.

Issues to Consider

History of Homework in the United States

As Cooper, Robinson, and Patall (2006) make clear, public attitudes toward homework have been cyclical. Prior to the early 1900s, homework was considered to be an essential part of all students' educations. In the 1940s, public attitudes toward homework changed. It was then seen to be an intrusion on other home activities and problem-solving skills were placed above drilling. However, this changed in the 1950s when the United States felt the need to remain competitive with the Soviet Union after they launched the Sputnik satellite. Then, in the 1960s, homework was seen as a source of intense pressure on students and educators decreased their use of this practice. This pattern for and against homework has continued into current times. Once again, educators are beginning to doubt the usefulness of this practice.

Attitudes Toward Homework

There are three important perspectives toward homework to consider, the parent's, the student's, and the teacher's. According to Brock, Lapp, Flood, Fisher, & Han (2016), "many parents expect homework for their children and feel that it improves their children's academic performance" (p. 354-355). Many teachers similarly view homework as a method to improve student achievement and to communicate with parents. However, many teachers seem to simply assign homework because they feel it is expected of them (by parents and their district). And students reportedly find little intrinsic value in completing homework, instead doing it in order to please their parents and teachers and to avoid getting in trouble (Brock et al., 2016).

Research -- Too Many Variables

While a good deal of research supporting the use of homework to increase learning, as Cooper et al. (2006) point out virtually every study that does so had major flaws, primarily because there is no way to control all of the variables involved. For example, many studies involved using different teachers with different instructional techniques on different students. Scientifically speaking, there are too many variables in those experiments to draw any conclusions. According to Trautwein, Koller, Schmitz, & Baumert (2002), these flaws in research have led to conflicting results.

The disagreement is primarily due to methodological weaknesses in the studies reviewed. Most of the original studies included in the reviews have at least one methodological flaw that might affect their internal, external, or statistical validity, the most prominent being the lack of randomization procedures, lack of control for pretreatment differences, short treatment duration, small sample sizes, and questionable approaches to hierarchically ordered data (p. 27-28).

In fact, Cool and Keith (1991) showed that controlling certain variables (motivation, ability, quality of instruction, coursework quantity, etc) actually caused the results of their studies to no longer present a positive relationship between homework and achievement.

Further, most results support the use of homework with high school students, but not younger students. Cooper et al. (2006) found almost no correlation between the completion of homework and achievement in elementary students. In-class study proved to be more helpful for these students. And of course the research findings only apply if the students were actually able to complete their homework. Therefore, research must be carefully considered before it is used to support the use of homework.

Parent Involvement

One clear disadvantage for the hypothetical students B and C was their lack of parent involvement. "Research suggests that parent involvement with their children's homework is associated with improved academic performance" (Balli, Wedman, & Demo, 1997, p. 1). According to Balli et al., 95% of students reported that they did better in school when their parents helped them with their homework. However, not all students have the luxury of parent involvement with their homework. Some have parents that need to constantly work to support their children. Some have parents that cannot speak English and therefore have trouble helping with their homework. Others have parents that are unfortunately just not interested. It is the teacher's duty to give these students the chance they deserve. Homework only makes their already difficult lives harder.

Socioeconomic Status and Other Differences

Socioeconomic status can affect students' abilities to complete homework. As Ktisantas, Cheema, and Ware (2011) make clear:

> Research has challenged the benefits of homework with the view that the use of homework expands the achievement differences between high and low socioeconomic status (SES) students, where students from higher SES backgrounds have more resources and their parents are better prepared to assist them than students from lower SES backgrounds (p. 310-312).

Societal perceptions can also affect a student's ability to complete homework. Female students reported lower self-efficacy even when they performed equally to or better than male students. Similarly, African-American students reported lower self-efficacy than their Caucasian peers (Kitsantas et al., 2011).

Language barriers are also a common issue with homework. According to Brock et al. (2016):

> in the past decade the number of English language learners in U.S. schools has more than doubled. Also, children from nondominant backgrounds comprise from three fourths to almost all of the students enrolled in the nation's largest school systems. English language learners will make up 40% of the school-age population in U.S. schools by the 2030s (p. 351).

Thus Student B's scenario is not fictional for many students.

Students with disabilities must also be considered when teachers contemplate assigning homework. These students need more support and resources than others but a teacher cannot guarantee that they will receive what they need outside of school. According to Callahan, Rademacher, & Hildreth (1998), "lack of homework completion has been reported to be a major factor contributing to poor academic performance and school failure of youth at risk and youth with disabilities" (p. 131).

Psychological Effects of Homework

A reported potential benefit of assigning homework is increased student self-efficacy. However, as previously shown, outside influences can prevent this effect for the students that need it most. Homework can also be stressful. According to Brock et al. (2016), "homework can be a source of stress and burnout for children as well as their parents" (p. 355). Students protest about the amount of time that homework takes away from leisure activities. "Many students consider homework the chief source of stress in their lives" (Cooper et al., 2006).

Purposes of Homework

For the most part, teachers' reasons for assigning homework are good. Cooper et. al (2006) describe the purpose of homework as giving students opportunities to practice and review the content they learned in class. According to Dettmers, Trautwein, Lüdtke, Kunter, & Baumert (2010), homework serves the purpose of "enhancing student performance and self-regulation." It is seen as a way to tap into potentially educative time (Paschal, Weinstein, & Walberg, 1984). Kitsantas et al. (2011), also state that researchers view homework as a tool to increase self-efficacy. All of these purposes for homework are good. However, because of differences in home situations, these purposes can only be fulfilled for certain students. A better means to these ends is doing the assignments in class. This way, the teacher can make sure that all students have the resources, assistance, and encouragement they need.

An Alternative to Homework

After considering the above, teachers may be wondering what an alternative to homework is. As previously stated, the purposes to assigning homework are generally good. How can we, as educators, fulfill these purposes without homework? One possibility was illustrated in the introduction, assigning that work to be completed in class. Practicing concepts learned in class is important, but it does not necessarily have to be done at home. In my classroom, I have given students practice problems that would traditionally be assigned as homework to work on as "morning work" to warm up for the day. If students need more time, I can give them the option of completing the problems on their own time but I do not force them to so.

Conclusion

Before assigning homework, consider the diverse needs and situations of your students. Consider what your purpose behind assigning homework is and if you could better fulfill that purpose in class. Many teachers base their decisions to assign homework on the research but it is important to remember that the research is flawed and that even if homework has benefits, such benefits only apply if students are actually able to complete their homework. The risks in assigning homework to middle grades students are numerous and should be considered by all teachers.

References

Balli, S. J., Wedman, J. F., & Demo, D. H. (1997). Family involvement with middle-grades homework: Effects of differential prompting. *The Journal of Experimental Education, 66*(1), 31-48. doi: http://dx.doi.org/10.1080/00220979709601393

Brock, C. H., Lapp, D., Flood, J., Fisher, D., & Han, K. T. (2016). Does homework matter? An investigation of teacher perceptions about homework practices for children from nondominant backgrounds. *Urban Education , 42*(4), 349-372. doi: 10.1177/0042085907304277

Callahan, K., Rademacher, J. A., & Hildreth, B. L. (1998). The effect of parent participation in strategies to improve the homework performance of students who were at risk. *Remedial & Special Education, 19*(3), 131-141.

Cool, V. A., & Keith, T. Z. (1991). Testing a model of school learning: Direct and indirect effects on academic achievement. *Contemporary Educational Psychology, 16*, 28-44. doi: 10.1016/0361-476X(91)90004-5

Cooper, H., Robinson, J. C., & Patall, E. (2006). Does homework improve academic achievement? A synthesis of research, 1987–2003 . *Review of Educational Research, 76*(1), 1-62. doi: 10.3102/00346543076001001

Dettmers, S., Trautwein, U., Lüdtke, O., Kunter, M., & Baumert, J. (2010). Homework works if homework quality is high: Using multilevel modeling to predict the development of achievement in mathematics. *Journal of Educational Psychology, 102*(2), 467-482. doi: http://0-dx.doi.org.carlson.utoledo.edu/10.1037/a0018453

Kitsantas, A., Cheema, J., & Ware, H. W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics, 22*(2), 310-339.

Paschal, R., Weinstein, T., & Walberg, H. (1984). The effects of homework on learning: A quantitative synthesis. *Journal of Educational Research, 78*, 97-104.

Trautwein, U., Koller, O., Schmitz, B., & Baumert, J. (2002). Do homework assignments enhance achievement? A multilevel analysis in 7th-grade mathematics. *Contemporary Educational Psychology, 27*(1), 26-50.

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Striving for a Conceptual Understanding of Mathematics for All Students

Jessica M. Kuohn

Abstract: The process of learning to learn mathematics starts with an educational approach of allowing the students to discover mathematical concepts. This discovery enforces conceptual understanding in mathematics and eliminates the need for rote memorization of procedures and formulas. For this teaching style to be successful, educators must be willing give students control of their own learning. By allowing students to process mathematical concepts individually, teachers help them make real-life connections and build their knowledge of mathematics collectively and across all grades levels.

Introduction

We regularly hear educators, students and parents say things like, "he was never a math person," or "math was never really my strongest subject." Such beliefs lead individuals to think that they are incapable of being effective mathematical problem solvers at any level. Why do so many people believe that we are incapable of mathematical problem solving? How can we as educators assist students to become problem solvers and eliminate the preconceived notion that not all individuals are mathematical thinkers? This research is based upon the study of successful mathematics teaching as well as of the theories of mathematics; its goal is to provide every student an equal opportunity at accomplishing problem-solving mastery.

Why is Conceptual Understanding in Mathematics Important?

Individuals often believe that they are incapable of mathematical thinking and problem solving, even though this is rarely if ever true. All students (at any level) are capable of becoming great problem solvers, but misconceptions or gaps in one's mathematical education can leave them with "holes" in the web of mathematical knowledge that everyone must acquire in order to successfully proceed in their mathematical education.

According to Dreyfus and Eisenberg (1996), all students possess an equal ability to learn mathematics, and this can be nurtured by teaching them mathematical problem solving skills. In order to obtain these skills, knowledge needs to be created by and within the individual to ensure learning and understanding. Therefore, students should be prompted to construct their own learning of mathematics. When educators do not allow students to do so, they are hindering individuals' learning processes. An educator's role in the classroom is to be a resource, and not to "pour" information into students.

One example can be seen in figure 1, which pertains to students' misconceptions about solving two-step equations. As educators, this is one reason why we need to be very familiar with content we teach--because this familiarity allows for the quick identification of misconceptions so that we can then lead students to the discovery of why their answers are incorrect. Students' mastery and deep understanding of mathematics can essentially eliminate misunderstandings such as the failure to notice that an equation needs to be balanced. In order to do so in figure 1, we must subtract five from each side, otherwise the equation will not remain equal.

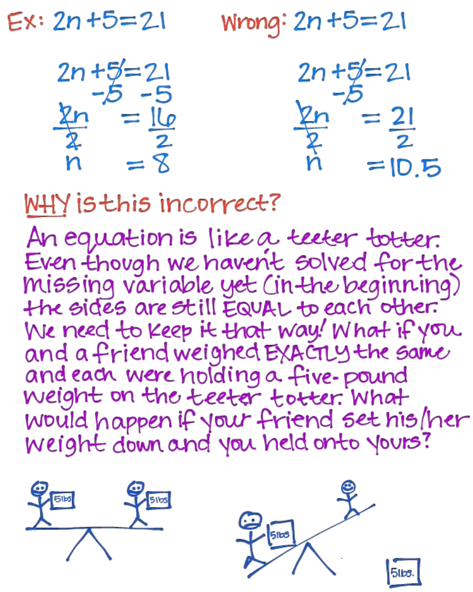

Figure 1: Example of a student's misconception about how to properly solve for a two-step equation, along with an explanation of why it is a misconception.

Classroom Examples

To further explicate misconceptions that are common when teachers rely on teaching by rote memorization, I have included several examples from the classroom that may challenge students and may lead individual students to believe that they are incapable of mathematical thinking. First, we can look at an example of multiplying and dividing fractions. If a student lacks a basic understanding of the relationship between multiplication and division of fractions, this will cause a barrier in algebra when students are expected to multiply and divide to simplify given expressions. Teaching sixth, seventh and eighth grade for the past five years, I have noticed students struggling with remembering how to multiply and divide fractions. Students have memorized the fact that they need to flip one fraction, but they struggle with remembering which operation needs a fraction flipped to the reciprocal, as well as which fraction within the given problem needs to be flipped (the first or the second). I often hear, "keep it, change it, flip it," which is a phrase taught to students to help them memorize the way to solve division problems without actually understanding the reasoning for applying these methods (see figure 2). It usually takes some time at the beginning of the year to address this issue with students. I allow them to engage in discussion and to figure out that division was the operation for which applying this memorized slogan yielded the correct answer. I then present students with a problem where numerators and denominators have common factors, and ask students to solve the problem using that method. Once students have arrived at an answer and have come to a consensus with their classmates, I ask them to solve the problem straight across numerators and denominators, as if they were completing a multiplication problem (see figure 3). Students are often baffled, and instantly believe that their previous teachers have been making them do unnecessary work for years, they question whether the "keep it, change it, flip it" rule in fact, ever needed to be applied.

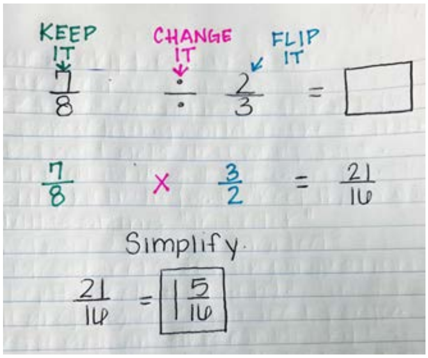

Figure 2: The "Keep It, Change It, Flip It" method often taught in middle grades.

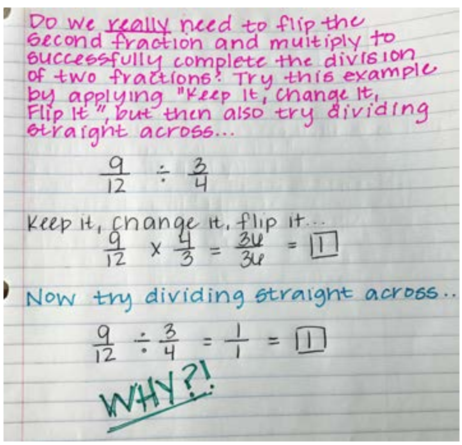

Figure 3: An example of a division problem where flipping the second fraction is not necessary to receive an answer without complex fractions.

To elaborate on this process and relate this example to my research, I allow students to discover that the process of flipping the second fraction in a division problem will yield the same answer as completing the problem without flipping the second fraction to the multiplicative inverse. This process is a simple way to eliminate complex fractions from your final answer. Once students are able to understand why they are doing what they are doing, they will no longer need to memorize an unnecessary "rule" to remind them how to complete a problem. For this reason as educators, we need to strive for the discovery of mathematics for all students, and move away from teaching mathematics through memorization.

A final example often seen in the classroom is students' understanding of the application of the property of exponents (see figure 4). When I began teaching, I used to teach the six properties of exponents through memorization. We would record all properties in books and fill the books with colors in order to be "engaging." Unfortunately, this method did not help students understand why the rules work, and therefore students easily forgot all properties of exponents over time. In figure 4, we can see the discovery process of the "quotient of powers" exponent property. We can focus on the rule and rote memorization, but if we eliminate the memorization and focus instead on understanding we can eliminate the need to memorize formulas completely.

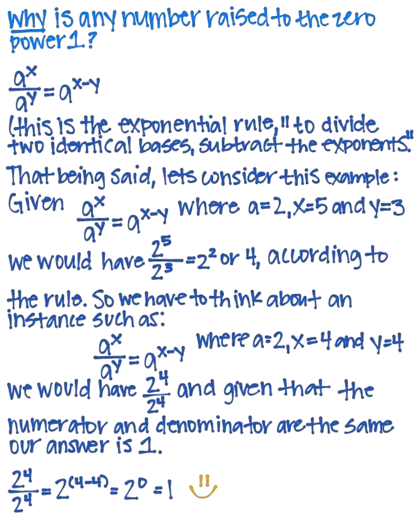

Figure 4: Example of discovery of why exponent properties work.

Why is Discovery Important?

Greer (1992) believes that it is easy for educators to skip the teachings of intermediate representations and move onto the teachings of expressions and surface clues (particularly in the case of multiplication and division), therefore eliminating the probability of conceptual connections being made. These misconceptions and gaps in mathematical education will then carry into students' future mathematical education. For example, if there are underlying deficiencies in the early stages of multiplication and division, then there will most likely be difficultly in conceptual understanding of complex mathematics involving multiplication and division as well.

The Educator's Role

There is a difference between the "doing" and the "understanding" of mathematics. Hiebert and Lefevre (1986) argued that conceptual understanding of mathematics is defined as being rich in relationships. It is a method of connecting the prerequisite knowledge with the current knowledge being learned, and therefore creating a web of mathematical knowledge. Procedural knowledge is composed of formal language and algorithms. Procedures can be learned by rote memorization, yet the understanding of procedures can also be violated by rote learning. Educators must do their best to understand where conceptual knowledge ends and where procedural knowledge begins. In addition, we need to provide students with an education that allows them to tie conceptual and procedural knowledge together as often as possible. By recognizing these methods of teaching, we can once again eliminate the "need" for rote memorization.

Educators can avoid a reliance on student memorization by paying close attention to their instructional methods. Jaworski (2005) therefore explained the importance of educators' knowledge of the curriculum and pedagogy of mathematics in order to understand how to incorporate mathematical activities into the classroom, as well as the necessity of having background knowledge about each individual student in order to be successful. Achieving these goals as an educator is often difficult because of the complexity of education. Each child's experience in education should be student-driven and not teacher-focused.

According to Mayer and Hegarty (1996), research shows that students perform well on state tests that involve basic arithmetic computation, but tend to perform poorly on tests with higher-level skills that involve things like mathematical problem solving. Students are often able to solve mathematical computations, but they cannot apply the same procedures to multi-step word problems. This is one important reason why there needs to be a shift in the curriculum and the way that mathematics is taught. The focus should be on conceptual understanding and making connections to the real world. As educators, we need to recognize this and to reevaluate our teaching methods. We also need to consider how problem solvers solve problems. As stated by Saxe, Dawson, Fall, and Howard (1996), "A fundamental assumption that dominates today's discussions of the psychological nature of mathematical thinking is that it is a construction of the human mind" (p. 120). Mathematical concepts are not created by an individual's environment or through language, but rather are created by individuals based on the relevance of situations within their life. Problem solving happens when a problem solver understands the process of how to arrive at answers, and are less concerned with the answers themselves. And the individual construction of mathematical understanding means that we cannot treat every student the same; we must consider their backgrounds and personal experiences in which mathematics can be related.

Emerging Themes Within the Research

The first emerging theme within my research is the shifting process and approaches toward teaching mathematics. Schoenfeld (1992) and Fuson (1992) have both claimed that educators should be focused on new knowledge about the thinking of students as well as have new goals in the processes of education to assist students in their learning. When we use the term "problem," we should focus on the inquiry-based thinking in mathematics and not routine procedures with rote memorization. Students do not develop problem solving strategies by being "taught" and then completing repetitive problems. Yet this was how mathematics was often taught in the past, which regularly resulted in gaps of understanding.

A second emerging theme is the importance of teacher knowledge. According to Fennema and Franke (1992), teachers' understanding of content is one of the most important factors of teaching. It is imperative that we are able to understand misconceptions of students in order to "fix" problems and fill in the holes where given content is not understood. We can give a student as many problems to solve as we would like, but if they do not understand why they are doing what they are doing, there is no point to the repetition. Jaworski (2005) believed that it is important to get learners to learn based on discovery, but that educators need to guide students in the right direction so that they learn what they need to learn. Without our guidance in mathematical discovery, students may stray away from the curriculum in which they need to learn.

Readings on modern teaching strategies also stress the importance of educators' content knowledge. If an educator has not mastered and understood a given mathematical concept, they will be unable to recognize the misconceptions of their students, and will most likely fail to identify a way to guide students to the approach through discovery. In addition, teachers without content mastery are typically incapable of providing students with the proper resources to create an engaging environment.

Another emerging theme can be found in almost every example of recent research: every individual is capable of learning mathematics. Dreyfus et al (1996) believe as educators, we should never assume that some people cannot grasp mathematical problem solving skills. Thinking patterns in mathematics can always be learned.

A further theme with the research relates to the cultural background of individuals. When we think about making learning engaging, it doesn't necessarily mean we need to utilize puzzles, coloring, and activities to make the learning fun. A truly engaging environment is one in which students are interested in the learning, and can relate their mathematical discoveries to real-life situations. Given that everyone has a different background, their methods of learning and engagement in the content should be unique to their own personal experiences, and a variety of experiences should be offered.

The last theme is the avoidance of rote memorization. One of the biggest problems in the classroom is teachers treating mathematical problem solving as a process of rote memorization instead of focusing on actual problem solving and conceptual mastery. It is important for children to learn numbers in their own cultural experience. If students lack this conceptual understanding, the mathematics that is taught in younger grades can directly affect the comprehension of mathematics in later grades. For example, Schoenfeld (1992) tells us when we use the term "problem", we should focus on the inquiry-based thinking of mathematics and not routine procedures with rote memorization.

Conclusion

Educators need to continue their education so that they can provide the best learning experiences for all students. This doesn't necessarily mean that all educators need to attend continuing education classes, but rather that they should adopt new methods of teaching, focused on allowing students to learn how to learn by themselves. A focus on mathematical concepts will allow students to have a conceptual understanding of mathematics, and therefore can eliminate the need of rote memorization.

References

Dreyfus, T., & Eisenberg, T. (1996). On different facets of mathematical thinking. In R. J. Sternberg & T. Ben-Zeev (Eds.), *The nature of mathematical thinking* (pp. 253-284). Mahwah, NJ: Lawrence Erlbaum Associates.

Fennema, E., & Franke, M. L. (1992). Teachers' knowledge and its impact. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 147-164). New York: Macmillan.

Fuson, K. C. (1992). Research on whole number addition and subtraction. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 243-275). New York: Macmillan.

Greer, B. (1992). Multiplication and division as models of situations. In D. A. Grouws (Ed.), *Handbook of research on mathematics and learning* (pp. 276-295). New York: Macmillan.

Hiebert, J., & Lefevre, P. (1986). *Conceptual and procedural knowledge in mathematics: An introductory analysis*. Hillsdale, NJ: Lawrence Erlbaun Associates.

Jaworski, B. (2005). Development of the mathematics teacher educator and its relation to teaching development. In T. Wood (Ed.), *International handbook of mathematics teacher education* (Vol. 4, pp. 1-27). Rotterdam, The Netherlands: Sense Publishers.

Mayer, R. E., & Hegarty, M. (1996). The process of understanding mathematical problems In R. J. Sternberg & T. Ben-Zeev (Eds.), *The nature of mathematical thinking* (pp. 29-53). Mahwah, NJ: Lawrence Erlbaum Associates.

Saxe, G. B., Dawson, V., Fall, R., & Howard, S. (1996). Culture and children's mathematical thinking. In R. J. Sternberg & T. Ben-Zeev (Eds.), *The nature of mathematical thinking* (pp. 119-144). Mahwah, NJ: Lawrence Erlbaum Associates.

Schoenfeld, A. H. (1992). Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334-370). New York: Macmillan.

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Using More Sophisticated Technology to Teach Mathematics

Maurice Young

Abstract: Over time, the debate about using technology in the classroom has evolved as much as the technology itself. Not only has the role of technology grown and shifted in the classroom, but also the level of technological sophistication has changed the way these tools are used. Employing these tools in the mathematics classroom allows students to no longer take a somewhat passive role, treating technology as either their master or servant. Rather, these tools allow the technology to become the students' partner or an extension of themselves. In addition, students can now engage in the role of active learners by producing and/or publishing content previously not possible. Even though the TI-83/84 has its place in the mathematics classroom, particularly considering the high-stakes testing relationship, mathematics educators must embrace the ever-growing tools of Web 2.0 to become even more efficient and effective.

The Debate about Technology in the Classroom

Technology's role in education has long been a source of debate, and the content area of mathematics is no different than others. From the beginning of my teaching career, controversies about several types of technological tools in mathematics have occurred. In the late 1990's, the use of graphing calculators in a mathematics classroom was the hot debate topic of concerning technology. As the rigor and requirements of our mathematics courses progressed through the next several years, the acceptance of the graphing calculator came to be commonplace, so much so that now, several years after that debate's beginning, our high-stakes graduation testing in Ohio allows for the use of the TI-83/84 series. With the advent and evolution of Web 2.0 tools, a new debate has begun about utilizing technology in the mathematics classroom.

One of the main obstacles to incorporating technology is navigating past the fear teachers may have that their students may lose proficiency in basic skills. As Goos (2010) wrote, "[f]ears are sometimes expressed that the use of technology, especially hand-held calculators, will have a negative effect on students' mathematics achievement" (p. 67). Studies on this impact, however, have contradicted this. Examining studies conducted by several researchers, Goos (2010) concluded that "meta-analyses of published research studies have consistently found that calculator use, compared with non-calculator use, has either positive or neutral effects on students' operational, computational, conceptual and problem-solving skills" (p. 67). In addition, implementing technology effectively in the classroom allows certain remedial but time-consuming tasks to be avoided, while allowing larger, more important relationships to appear more rapidly. For instance, comparing the effects of replacing "x" with "x – h" in a function can more efficiently be determined when learning about translations, because the time-consuming task of graphing many functions by hand to discover the pattern would not allow for the rich discussion of "what if's" that naturally follow with technology. Thus technology allows us to more quickly identify misconceptions. In addition, using this technology allows students to begin making connections to authentic problems. As Pierce and Stacey (2010) stated "[i] mproved speed and accuracy allows access to real world tasks, using real world data where pen-and-paper calculations may be too error prone or time consuming." In addition, accurate observations of these faster and correct results "may support their learning of pen-and-paper skills" (p. 7). Wolfram (2010) further disputes the idea that focusing less on "the basics" dumbs down mathematics by showing that mathematics problems in the real world are not solved as easily as the problems in mathematics textbooks, such as easily factored quadratics (Wolfram, 2010). As Wolfram put it, "the problem we've really got in math education is not that computers might dumb it down, but that we have dumbed-down problems right now."

The Roles of Technology in the Classroom

To begin the discussion about effectively using technology in the classroom, its fundamental roles must be examined. Technology can take on several distinct roles in the mathematics classroom. Goos, Galbraith, Renshaw and Geiger (2003) identified these as the role of master, servant, partner and extension.

Master

Technology assumes the role of master when students are dependent upon the technology to perform mathematic functions for them without consideration for the outcome. For instance, students allow technology to be their master when using calculators to perform basic functions without acknowledging potential errors in either input or output. Goos et al. (2003) described this role by stating that students may become subservient to technology if a "lack of mathematical understanding prevents them from evaluating the accuracy of the output generated by the calculator or computer" (p. 78).

Servant

Technology assumes the role of servant when students use technology only as a means of replacing basic functions. For example, students make technology their servant when using a calculator to perform the simple operations of addition, subtraction, multiplication, and division. Goos, Galbraith, Renshaw and Geiger (2003) defined this role by stating, that technology is a servant if used by students or teachers only as a fast, reliable replacement for mental or pen and paper calculations, but the tasks of the classroom remain unchanged" (p. 78).

Partner

Technology assumes the role of partner when students use it to provide opportunities for understanding that would have been either too time consuming in the past, or to explore relationships that may not have presented themselves through non-technological means. For instance, students graphing several parabolas (or using sliders) on Desmos or GeoGebra to explore the importance of the leading coefficient on the graph. Rather than taking the time to graph several of these parabolas, utilizing the technology allows for connections and relationships to be discovered in a much more accelerated and efficient manner. Goos et al. (2003) described this role by stating that technology is a partner "by providing access to new kinds of tasks or new ways of approaching existing tasks" (p. 79).

Extension

Technology assumes the role of an extension of self when students utilize it as a part of their normal routine, allowing them to engage complex mathematical processes. For example, students using technology as an extension of self would allow independent discovery of the relationship between the type of roots of a quadratic and their location on the Cartesian plane. Goos et al. (2003) described this role by stating that technology becomes an extension of self when students "integrate a variety of technological resources into the construction of a mathematical argument so that powerful use of computers and calculators forms an extension of the individual's mathematical prowess" (p. 80).

Analysis of Technology Metaphors

Progressing through the four metaphors of technology's roles in the classroom also increases the engagement level of the students. In the roles of master and servant, students are not using technology to its upmost benefit, but rather using it to replace insubstantial tasks. In the role of partner and extension, students begin to incorporate technology in ways to enhance their learning. Therefore, mathematics teachers must present the technology where students do not become dependent upon it, but rather use technology as a partner and an extension of themselves to scaffold learning. As Olive and Makar (2010) argued, "if we consider the technological tools as providing access to new understandings of relations, processes, and purposes, then the role of technology relates to a conceptual construction kit" (p. 138).

The Roles of Web 2.0 Tools in the Classroom

Web 2.0 tools offer teachers a way to bring 21st century tools into the classroom. Just as in the discussion of technology in the classroom, Web 2.0 tools also play roles in the classroom depending upon how they are used. Luckin et al. (2009) defined these roles as researcher, collaborator, producer, and publisher.

Researcher

Luckin et al. (2009) claim that "researchers" are different than the traditional notion of a researcher, in that a Web 2.0 researcher shows "little evidence of critical enquiry or analytical awareness" (p. 94). Such a researcher does not contribute to creating original content on the web, but instead is a "learner who commonly refers to online resources as a means of retrieving information and/or extending their knowledge base" (p. 94).

Collaborator

Collaborators are students who mostly utilizing their web resources for "file sharing, gaming and communicating, with only few examples of collaborative knowledge construction" (Luckin et al., 2009, p. 94). A collaborator also uses "online networks and technologies to work together with others, whether they be peers, teachers or other 'experts'" (Luckin et al., 2009, p. 96).

Producer and Publisher

Producers and publishers are characterized as "sharing experience through social networking sites" (Luckin et al., 2009, p. 94). Producers and publishers are viewed as the most original contributors, because they create and/or publish content such as "photos, artwork, music, podcasts, games, etc." as well as "blogs, wikis" and other material (Luckin et al., 2009, p. 97).

Analysis of Web 2.0 Roles

Analogous to the discussion of the technology metaphors, as students progress through the roles of Web 2.0 learners, their learning enhances. As a researcher and collaborator, students participate in their learning, but do not create content. On the other hand, producers and publishers are creating their own content, leading to heightened understanding of content.

The Evolution of Technology in My Classroom

Early on in my teaching career, I embraced the use of the TI-83 Plus calculator in my classroom. I attended several professional learning opportunities to further enhance my own understanding about these instruments and their worth. I embraced this technology and marveled at its ability to explore relationships in five minutes that otherwise by traditional, non-calculator methods would take an entire period. I used these amazing tools to facilitate my students to utilize technology as a partner or an extension of themselves. We could compare and contrast the graphs of several parabolas at once, while recognizing patterns, intercepts, vertices, and other fundamental concepts quickly and efficiently.

Yet in the past several years, my attitude towards the TI-83/84 has gradually changed due to the abundance of Web 2.0 tools. While the TI-83/84 price point has remained stable throughout my tenure as a mathematics educator, more free Web 2.0 tools have become available as this resource continued to grow. Imagine being told to pay the 1999 price for a first-generation Blackberry while others are getting the newest iPhone or Samsung Galaxy for free! The TI-84, released 5 years after the TI-83 Plus in 2004, offers only "480 kilobytes of ROM and 24 kilobytes of RAM," while having had an MSRP of $150 for over ten years (McFarland, 2014, para. 2).

Not only are the Web 2.0 tools much more accessible and affordable, but they also provide a sophistication that the TI-83/84 cannot match. In addition, with the introduction of these far superior tools, students who were once using the TI-83/84 as a partner or extension of themselves may have regressed to where the TI-83/84 is now in the servant or master role. For instance, when students compare the graphs of a function with roots nearby one another on a TI-83/84, sometimes they will not acknowledge more than one intercept because of the pixel size of the graph. In Figure 1 and Figure 2, the graphs of y = (x – 1)(x – 1.5)(x – 2) are shown, both with the domain restriction [-4,4] and the range restriction [-5,5]. The low-quality level in Figure 1 does not allow for students to observe the three intercepts that the more sophisticated graph in Figure 2 enables. This mistake in viewing one x-intercept instead of three demonstrates how the low quality of the TI-83/84 graph has become a hindrance to students' understanding.

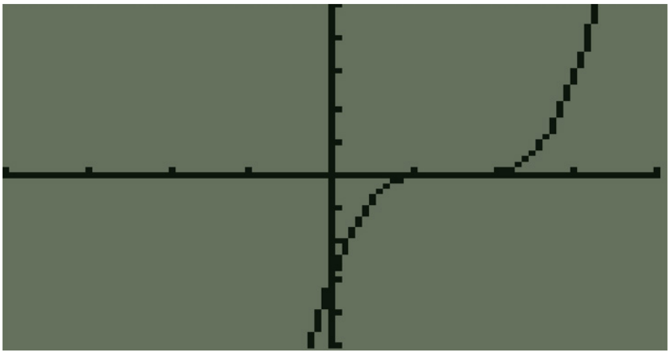

Figure 1: TI-83 screenshot of y=(x - 1)(x - 1.5)(x - 2)

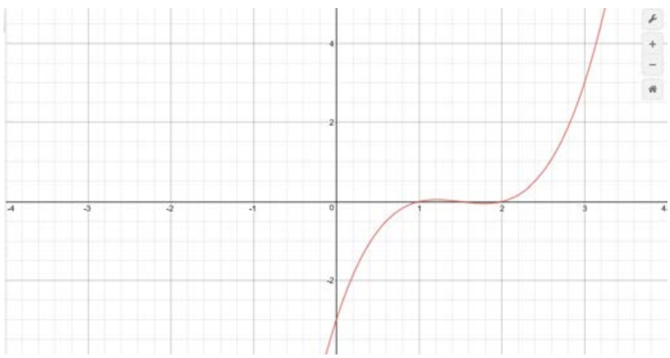

Figure 2: Desmos screenshot of y=(x - 1)(x - 1.5)(x - 2)

In addition, other Web 2.0 tools open up learning in ways that the TI-83/84 cannot,nnot, even with the use of their Calculator Based Ranger (CBR) or Calculator Based Laboratory (CBL). For instance, using Phet.edu, students can simulate repeatedly the path a certain projectile (such as a cannonball, car, piano, etc.) takes when launched at various angles and velocities. Multiple simulations allow for observations of various outcomes, while with the CBR/CBL, these activities are usually restricted to one or two trials, since the materials are often too expensive or it is impossible to perform experiments. Through these new possibilities, teachers begin to find themselves presented with a chance to explore real-world content by using these technologies as an opportunity to leap into a problem, rather than the traditional "teach to solve a problem" approach. "Instead of starting with detail, teachers may choose to approach topics through different entry points e.g. starting with an overview or real-world motivating application, using technology to generate results, and then going back to look at details" (Pierce & Stacey, 2010, p. 10).

Some have argued that because high-stakes testing now utilizes the TI-83/84 that mathematics teachers should continue utilizing these tools in their classroom, while using books that also integrate this technology into the content. Peter Balyta, president of education technology at Texas Instruments stated, "TI calculators continue to be trusted on 60 high-stakes exams around the world -- including the SAT, ACT, AP and IB exams" (as cited in McFarland, 2017, para. 6). However, ironically, school districts in Texas have already begun piloting efforts to incorporate Web 2.0 tools into their state testing (Locke, 2015, para. 2). By utilizing efforts throughout the school, teachers could block Wi-Fi and camera access, while ensuring students only had access to Desmos during the testing period (Locke, 2015, para. 5). In addition to the Texas pilot, "Smarter Balanced, which administers school proficiency tests in 15 states, is building a digital calculator into its tests this spring" based off the Desmos brand of graphing utility (McFarland, 2017, para. 1-3).

Conclusion

While there is definitely still a need for TI-83/84 calculators in mathematics classroom due in particular to high-stakes testing, we must increase our use of newer and more sophisticated technology. The TI-83/84 series were adequate when they were first utilized in the late 90's and 2000's, as they allowed students new abilities to build relationships, such as comparing graphs and scenarios quickly. However, with our ever-evolving resource of online tools, apps, etc., teachers can be even more efficient and sophisticated in their use of mathematics technology and prepare students to use technology that was truly developed in the 21st century.

References

Goos, M. (2010). Using technology to support effective mathematics teaching and learning: What counts? Paper presented at the Australian Council for Educational Research meeting, Melbourne, Australia.

Goos, M., Galbraith, P., Renshaw, P., & Geiger, V. (2003). Perspectives on technology mediated learning in secondary school mathematics classrooms. *Journal of Mathematical Behavior, 22*(1), 73-89.

Locke, C. (2015, April 30). Texas district pilots Desmos as alternative to graphing calculators. *EdSurge*. Retrieved from https://www.edsurge.com/news/2015-04-30-texas-district-pilots-desmos-as-alternative-to-graphing-calculators

Luckin, R., Clark, W., Graber, R., Logan, K., Mee, A., & Oliver, M. (2009). Do web 2.0 tools really open the door to learning? Practices, perceptions and profiles of 11-16 year old students. *Learning, Media and Technology, 34*(2), 87-104.

McFarland, M. (2017, May 12). Can we finally retire the overpriced TI-84 calculator? *CNNMoney*. Retrieved from http://money.cnn.com/2017/05/12/technology/ti-84-graphing-calculator/index.html

McFarland, M. (2014, September 2). The unstoppable TI-84 Plus: How an outdated calculator still holds a monopoly on classrooms. *Washington Post*. Retrieved from https://www.washingtonpost.com/news/innovations/wp/2014/09/02/the-unstoppable-ti-84-plus-how-an-outdated-calculator-still-holds-a-monopoly-on-classrooms/?utm_term=.a5beda451a5b

Olive, J., Makar, K., Hoyos, with V., Kor, L. K., Kosheleva, O., & Sträßer, R. (2010). Mathematical knowledge and practices resulting from access to digital technologies. In C. Hoyles & J. Lagrange (Eds.), *Mathematics education and technology – Rethinking the terrain. The 17th ICMI Study* (pp. 133-177). New York: Springer.

Pierce, R., & Stacey, K. (2010). Mapping pedagogical opportunities provided by mathematics analysis software. *International Journal of Computers for Mathematical Learning, 15*(1), 20.

Wolfram, C. (2010, July). Conrad Wolfram: Teaching kids real math with computers. Retrieved from https://www.ted.com/talks/conrad_wolfram_teaching_kids_real_math_with_computers

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Science

Making Scientific Inquiry Activities Accessible to Students with Autism

Alonna Ackerman

Abstract: In light of the major trend within science education of focusing on inquiry-based activities, students with autism may face difficulties in the classroom due to barriers such as problems with communication, social situations, and desire for routine. Though research regarding inquiry-based science education for students with autism is scarce, explicit instruction appears to be a promising option for elementary students. Additionally, Applied Behavior Analysis and Self-Regulated Strategy Development have proven useful in other content areas. Extrapolating from this data, the author discusses how these strategies could be applied in inquiry-focused science classrooms and suggests that researchers use these strategies as starting points for future research.

Introduction

Mrs. Baker notices early on in her first year of teaching that Dawson, who has autism, is an extremely bright student. He studies, stays on task, and if he is asked a question, his answers clearly demonstrate his knowledge of chemistry. Still, he is relatively quiet, a little uncomfortable during group work, and it sometimes seems like he needs time to put his answers together. He also appears to struggle with short-answer questions and writing laboratory reports. It seems to Mrs. Baker that Dawson has trouble transferring his ideas to paper, which could be a problem given that in this class, students often design their own laboratory procedures or draw conclusions based on their data. Mrs. Baker does her best to help, talking with Dawson about long written responses before he is asked to write them down and making sure to always group him with students with whom he is comfortable, both of which seem to help. Mrs. Baker worries, however, that the strategies she is using may not necessarily be based in research and may not work for every student. Furthermore, she is frustrated because she knows that not much research exists on helping students with autism access an inquiry- based science curriculum.

Mrs. Baker's use of scientific inquiry activities in the classroom represents a scenario familiar to many science educators, as the use of inquiry represents a major goal in the field of science education centered on helping students to develop their scientific literacy skills (AAAS, 1989). In general, inquiry involves generating questions that students can attempt to answer through experimentation, data analysis, and communication of results (Knight, Smith, Spooner, & Browder, 2012). Although inquiry has been deemed useful for students with exceptionalities, implementing inquiry-centered learning environments can be challenging for teachers working with this population of students (Knight et al., 2012; NSTA, 2017). While some students with autism demonstrate high levels of performance in the general education classroom, their communication styles, along with various other types of barriers, may not allow them to adequately demonstrate what they know without intervention (NSTA, 2017). Furthermore, in light of the accepted understanding that curriculum materials need to be appropriate and accessible for students of all learning styles, the need to provide research-based interventions for students with autism becomes abundantly clear (NSTA, 2017).

Despite this pressing need, few, if any, studies specifically address interventions for students with autism in an inquiry-based science classroom. A similar scarcity of research was noted by Knight and colleagues (2012) regarding science and students with developmental disabilities, in general. Given this lack of research, this author has sought to develop her own model. She hypothesizes that teaching strategies developed for a range of other content areas may be effective when applied to the scientific inquiry environment, as well. Following a description of barriers faced by students with autism in the classroom, the literature on research-based teaching strategies to aid these students will be examined in terms of how such techniques could be adapted for scientific inquiry. Overall, the aim of this paper is to provide researchers with a starting point to develop content-specific teaching strategies for students with autism within the inquiry-focused learning environment.

Autism and Barriers to Student Learning

What is Autism? Usually diagnosed by age three, autism spectrum disorder (ASD) can cause difficulties with social skill development, interests, and ability to communicate; however, a range of disorders with variable severity fall within the ASD classification. This means that different students can present with different symptoms of the disorder. In terms of prevalence and etiology, by age eight, one in 150 children have been diagnosed. No known cause for the disorder has been identified (Ryan, Hughes, Katsiyannis, McDaniel, & Sprinkle, 2011).

Barriers in the Classroom

In terms of the effects of autism on the classroom experience, trouble with communication of information has been noted by several researchers (Hedges et al., 2014; Ryan et al., 2011). Such struggles can manifest in the science classroom, as scientific inquiry involves communication of results (Knight et al., 2012). For example, students might have difficulty writing laboratory reports or participating in a class discussion. In addition to communication, navigating the social environment may be an additional barrier faced by students with autism (Casey, Williamson, Black, & Casey, 2014; Friedlander, 2009; Hedges et al., 2014; Ryan et al., 2011). As noted in a focus group conducted by Hedges and colleagues, secondary students may face social anxiety as their difficulty in social situations becomes clearer to them (Hedges et al., 2014). In turn, it makes sense that difficulty interacting with peers can cause students to become uncomfortable in group work situations (Hedges et al., 2014). Students with autism may also crave routine and consistency, which can lead to difficulty adjusting to several different teachers and changes in the bell schedule (Friedlander, 2009; Hedges et al., 2014; Ryan et al. 2011). This could be a potential source of stress for students participating in scientific inquiry activities, as no two experimental procedures are exactly alike (Hedges et al., 2014). Focus on small details and trouble generalizing concepts also may present barriers in the classroom (Casey et al., 2014; Knight et al. 2012). Because scientific inquiry involves data analysis, students must be able to organize and make sense of how what they observed can be placed into the bigger picture (AAAS 1989; Knight et al., 2012). Other issues may include sensory issues or repetitive behaviors (Friedlander, 2009; Hedges et al., 2014; Ryan et al., 2011).

Teaching Strategies for Students with Autism

Strategies for Inquiry Learning

Given the challenges outlined above, it makes sense that research-based teaching strategies should be developed in an effort to overcome them. Knight et al. (2012) studied the use of explicit instruction with three elementary school students with ASD in order to test its efficacy for teaching students how to describe objects in general and in an inquiry laboratory setting. Using a strategy called model-lead-test, researchers followed three steps: show students an adjective and the objects it applies to, guide students in identifying objects, and ask students to identify objects on their own. Finally, students attempted to use these adjectives in an inquiry-lab setting with typically developing peers. While the instruction was effective for teaching the words, the results did not transfer as well to the inquiry setting. Knight et al. speculate that teaching the words during the actual inquiry lesson by giving examples prior to lab or using a response board during lab could yield greater improvements.

Applying this research to high school students, the results suggest that explicit instruction could be effective in science classrooms (Knight et al., 2012). In the context of inquiry, students would be carrying out experiments that require them to note observations. Using these techniques to make sure that students are familiar with the vocabulary that will be used, then, may be a way to help them communicate with other peers and their instructors.

Strategies from Other Content Areas

Looking at the research conducted with students with ASD in other content areas points educators to Applied Behavior Analysis (ABA) ABA has been recommended in general and for physical education (Ryan et al., 2011; Szapacs, 2006). In the physical education setting, ABA breaks down behaviors into what caused the behavior, what the behavior was, and what type of reinforcement resulted from the behavior (Szapacs, 2006). In terms of a gym class, a larger goal, such as correctly kicking a soccer ball, can be broken down into individual steps using visual cues. A pre-test is given first to help develop the steps, and then the cues can be slowly reduced or removed over time until they are no longer needed. Ryan and colleagues (2011), too, found that providing reinforcement helped to promote positive behavior.

For the sciences, ABA could be used in order to help students explain what their data mean. If a student struggles to write a laboratory report or describe a procedure, for example, the teacher could break the process into smaller steps and allow the student to gradually reach independence with the task. In addition to helping students complete and write about a laboratory experience, the development of steps could help address the lack of routine that some authors have noted may be stressful (Friedlander et al., 2009; Hedges et al., 2014; Ryan et al., 2011).

A research-based strategy called Self-Regulated Strategy Development (SSRD) has been proven useful for students with autism who struggle with writing (Casey et al., 2014). SSRD is a 6-stage technique that uses acronyms to help students through the writing process. Acronyms and tools such as "POW" (pick ideas, organize notes, write more), and "WWW," which guides students through 7 smaller questions, have proven helpful for students with ASD. Although the "WWW" strategy seems to work better for creative writing, it seems plausible that a similar approach could be used for writing laboratory reports. For example, students could answer "What was my question?", "How did I figure it out?", "What did I see?", "What does it mean?" Similarly, a process could be developed for thinking about how to write a laboratory procedure. Again, the presence of a strategy to follow could improve communication, as well as addressing the desire for routine (Friedlander, 2009; Hedges et al., 2014; Ryan et al., 2011).

General Recommendations

Apart from studies for specific content areas, general strategies have been developed that work for multiple areas. Among these, the use of social stories can help to alleviate social issues by providing a depiction of how to navigate social situations (Friedlander, 2009; Ryan et al., 2011). Such stories could be used for expectations such as laboratory safety or working with others. A system called Treatment and Education of Autistic and Communication Handicapped Children (TEACCH) also recommends keeping an area organized, providing a schedule, and giving visual prompts on the task and how to navigate the work area. This organization helps students to be clear about expectations and gives them a sense of routine (Friedlander, 2009; Hedges et al., 2014; Ryan et al., 2011). Friedlander and colleagues (2009) also suggest providing some sort of outlet for sensory problems. For writing, Casey and colleagues (2014) suggest explaining both verbally and visually, allowing extra time and individual attention, and shortening tasks. Finally, Hedges and colleagues (2014) say that care should be taken to help students form relationships with other students and that the use visual cues and good communication among staff may be helpful (Hedges et al., 2014).

Limitations and Recommendations

Although some of the strategies listed above have been proven effective, the current research is limited. First and foremost, only one of the above strategies specifically discusses implementation in an inquiry-based science environment (Knight et al., 2012). Additionally, the study by Knight and colleagues, as well as the study by Scapacz (2006), only assessed teaching strategies at the elementary level. Further he study by Knight and colleagues only had three participants, all from the same school district, so results may not generalize to other students. Most importantly, despite success in other content areas or with other age groups, it cannot be guaranteed that the strategies discussed above will work well in the specific setting of inquiry-based science education until further research is implemented. That being said, this publication has reviewed strategies that have been successful over several different content areas and given a few general recommendations; however, the assertions described above represent hypotheses about what may work. Further research is desperately needed in order to determine how we can best serve students with autism in this type of environment. It is the hope of this author that the hypotheses outlined above will serve as starting points to spark future research.

Conclusion

While inquiry activities are essential to the teaching and learning of science, students with autism may face barriers in the classroom which make it difficult to access and communicate the information learned. Among these barriers are communication and social skill difficulties, a need for a routine, a tendency to focus on small details, and the prevalence of sensory issues, generalization issues, and repetitive behaviors (Casey et al, 2014; Friedlander, 2009; Hedges et al., 2014; Knight et al., 2012; Ryan et al., 2011). Although strategies such as ABA, TEACCH, explicit instruction, and SSRD have been successful in other settings, only explicit instruction has been examined during a scientific inquiry lesson, and most strategies have only been attempted with elementary, rather than secondary students (Casey et. al. 2014; Knight et al., 2012; Ryan et al., 2011; Szapacs, 2006). Yet given their success in other content areas, it is reasonable to believe that such strategies, as well as the general recommendations noted above would be viable in the high school, inquiry-based science classroom; however, such claims cannot be substantiated without empirical evidence. The lack of research on autism and science inquiry specifically presents a major hole in what is known and points to a need to study this topic in a more in-depth way to gain more answers. Studies should be conducted that follow students with autism through science classes in order to test whether similar interventions will work for inquiry activities. If this research proves fruitful, very positive changes in the classroom could result.

References

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans*. Washington D.C.: AAAS.

Casey, L. B., Williamson, R. L., Black, T., & Casey, C. (2014). Teaching written expression in the inclusive high school classroom: Strategies to assist students with disabilities. *National Forum of Applied Educational Research Journal, 27*(1/2), 45-56.

Friedlander, D. (2009). Sam comes to school: Including students with autism in your classroom. *Clearing House, 82*(3), 141-144.

Hedges, S. H., Kirby, A. V., Sreckovic, M. A., Kucharczyk, S., Hume, K., & Pace, S. (2014)."Falling through the cracks": Challenges for high school students with autism spectrum disorder. *High School Journal, 98*(1), 64- 82.

Knight, V. F., Smith, B. R., Spooner, F., & Browder, D. (2012). Using explicit instruction to teach science descriptors to students with autism spectrum disorder. *Journal of Autism And Developmental Disorders, 42*(3), 378-389. doi:10.1007/s10803-011-1258-1

National Science Teachers Association (NSTA). (2017). NSTA position statement: Students with exceptionalities. Accessed at http://www.nsta.org/about/positions/exceptionalities.aspx

Ryan, J. B., Hughes, E. M., Katsiyannis, A., McDaniel, M., & Sprinkle, C. (2011). Research based educational practices for students with autism spectrum disorders. *Teaching Exceptional Children, 43*(3), 56-64.

Szapacs, C. (2006). Applied behavior analysis. *Teaching Elementary Physical Education, 17*(6), 12-15.

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Project-based Learning as an Alternative to the Pedagogy of Poverty in Low-income Schools

Shannon N. Giesige

Abstract: The pedagogy of poverty is a phrase coined by Haberman in 1991 to describe the didactic teacher-centered learning that takes place in most urban, low-income schools. This form of teaching is based on assumptions that teachers, administrators, and parents make about the students they are teaching and the students' goals, aims and capabilities. This manuscript discusses why teachers turn to the pedagogy of poverty and how project-based learning offers a workable alternative in a low-income, urban environment. It examines how project-based learning can improve student self-efficacy and academic performance, as well as exploring what this method asks of teachers.

Introduction

I stood nervously in front of my seventh grade classroom about to teach for the very first time. I had spent hours carefully gluing pictures on little cardboard boxes preparing an activity called "The Incredible Journey" (Project Wet). I would ask my students to role-play as rain drops working their way through the water cycle. They would role the cardboard dice and it would tell them which station to go to. Afterward, I would ask them about their journeys. Where did you go? When were you a liquid? Did you get stuck anywhere? Why? As my students walked into the classroom, I worried about so many things. Would they be able to do the activity? Would they fight with each other? Would they care?

What does learning look like? When you think of a k-12 science classroom, what do you see? Are students sitting quietly at their desks reading, taking notes, listening to the teacher lecture? Are the students bored? If your imagination is vivid, perhaps there is one student in the back with their head down, taking a nap. Maybe you've seen this image of school on television or maybe this was your own school experience, but is this image the best way that students learn? Is this the best way that you learn?

Imagine a different sort of classroom. One where students are working together to create something or to solve a problem. Perhaps it is loud. Maybe the students are debating in small groups, intent on accomplishing their work. Papers are scattered everywhere. Where is the teacher in this classroom? She is not standing in the front of the room, lecturing. Instead, she is moving from group to group, asking questions rather than answering them, prodding the students to make new discoveries. Is anyone sleeping in this classroom? Does it look like learning is taking place? If you walked into this classroom with idea of the quiet, teacher-centered environment that was first described, what would you think?

As I explained the rules of the "Incredible Journey" activity to my students on that first day, they seemed interested. They stood up and went to their first stations. They rolled the dice and recorded where they went as raindrops. When it was over and I began asking them questions, they were excited to tell me where they had been. They shared the frustrations of getting stuck in a glacier and when I asked them when they were a liquid, a solid, or a gas, they were thoughtful. They asked questions and were engaged. They said that they liked getting up and walking around. They wanted to do more activities like that.

As we enter into our own classrooms, we must make a choice about what learning looks like. Will our students be asked to sit quietly in rows, taking notes and listening to us lecture? Or will we challenge our students to figure things out on their own, to interact with the world on their own terms? Will we ask our students to be repositories for the knowledge we teachers choose to bestow on them or will we challenge them to construct their own meanings and explore in ways we can't always predict?

The Pedagogy of Poverty

In 1991, Haberman coined the term "pedagogy of poverty" to describe the didactic, teacher-centered form of teaching that is often found in low-income urban schools. This format of teaching runs counter to modern teaching practices, which place more emphasis on student-centered, inquiry based learning.

Four assumptions describe the Pedagogy of Poverty:

> (1) Teaching is what teachers do, learning is what students do. Therefore, students and teachers are engaged in different activities...
>
> (2) Teachers are in charge and responsible. Students are those who still need to develop appropriate behavior…
>
> (3) Students represent a wide range of individual differences… therefore ranking of some sort is inevitable.
>
> (4) Basic skills are a prerequisite for learning and living and students are not necessarily interested in these basic skills. Therefore, directive pedagogy must be used (Haberman, 1991, p. 83)

According to Haberman this pedagogy, while outmoded, appeals to many groups of people. It appeals to parents who did not do well in school themselves and believe they could have done better if only someone had forced them to learn. It appeals to those who rely on "common sense" and view freer teaching as "permissiveness" or weakness. It appeals to those who fear minorities and the poor and feel a need to exercise control. It appeals to those who have low expectations for these students. Finally, it appeals to those who do not know the full range of pedagogical options available.

Why was I so worried about my students' behavior as I stood in front of my seventh grade class? Why did I think that they wouldn't care about the lesson? I had been placed at a Title I school. All my students qualified for free or reduced lunches. I had seen my students struggle with meeting classroom expectations for behavior. As I continued in my placement, I would be told time and time again that I needed to get a handle on my classroom management. My mentor teacher never once commented on my lesson plans or their adherence to the curriculum. The teachers, the administrators, and the parents of the students had all bought in to the four assumptions. When I observed my classroom, my mentor teacher stood in the front and gave the students vocabulary to record or chapters to read. The focus of the classroom was on displaying classroom-appropriate behavior first, learning second and the expectations for these learners and their abilities were low.

Project-Based Learning

Compare this kind of environment to one using project-based learning. Project-based learning (PBL) is a method based on constructivism and the ways in which students make meaning. As Lou and colleages (2011) described, it is an approach that gives students the opportunity to design, solve problems, and make decisions based on a challenging question. It gives students opportunities to independently accomplish related tasks and present their results. PBL is learner-centered, encourages teamwork and cooperative learning, allows student to continuously improve their work or outcomes, involves students actively discovering instead of learning related knowledge, includes students producing work, reports, or results and is challenging and depends upon high-level skills. From the teacher's perspective, PBL focuses on authentic content, purposes, and evaluations, and has specific educational goals. Teachers are defined as helpers rather than direct instructors, and it also allows teachers to be learners.

Self-Efficacy

Imagine being that student sitting in the teacher-centered class. After six hours of notes and lectures, what are you thinking? Are you excited about anything that you have learned? Do you think you'll remember any of the lessons in a year? In a month? Tomorrow? Has being in this classroom affected your outlook on yourself, on your community, or on your science abilities?

Now imagine that you are one of the students in a study conducted by Hiller and Kitsantas (2014). Students in this study spent a day conducting fieldwork on horseshoe crabs. These students went to the beach and were taught by experts how to collect data by taking measurements on horseshoe crabs. Hiller and Kitsantas analyzed data from pre- and post-tests on and found that the treatment group outperformed the comparison group in not only academic achievement, but measures of self-efficacy, science observation skills, task interest, and career interest in science. This example of PBL allowed students to see themselves as scientists and gain confidence in their own scientific abilities.

In contrast, the pedagogy of poverty focuses on encouraging students to behave appropriately rather than encouraging them to think scientifically. Varelas, Kane, and Wylie (2011) performed a study on how low-income African American first, second, and third grade students construct their identities in the frame of science and scientists. In this study, science teachers worked with researchers to develop instruction that was interactive, participatory and dialogic. Researchers found that the children had developed complex relationships that fused the concepts of "doing science" and "doing school." Many students defined "smartness" and being a "good scientist" in relation to behaving appropriately in class. What our students know about doing science is only what we can teach them in our classrooms. If we become so focused on student behaviors rather than student abilities, we risk them losing the skills that make truly great scientists, including curiosity, willingness to take intellectual risks, and the ability to collaborate with others to create something new. By labeling students who are loud, energetic, or willing to take risks in their work and their answers as "bad" or "problem" students, we ironically teach them that these are not the skills that a scientist needs. In contrast, PBL encourages these skills. It rewards students who take risks and communicate well with others, 21st century skills that will serve students in any career path they may take.

Academic Performance

Educators want to engage their students, but feel immense pressure to meet academic standards and for your students to succeed on standardized tests. Can these standards be met with project-based learning? Out of five studies that compared project-based learning to didactic teacher-centered learning, three studies showed better results for those using project-based learning and the remaining two showed no statistical difference between the control and treatment groups. No group showed worse academic outcomes for the students engaged in project-based learning (Chen, Hernandez & Dong, 2015; Han, Capraro & Capraro, 2015; Hiller & Kitsantas, 2014; Horak & Galluzzo, 2017; Scogin, Kruger, Jekkals & Steinfeldt, 2017).

What PBL Asks of Teachers

When properly implemented, PBL has been shown to be as effective as or more effective than teacher-centered teaching. However, PBL relies heavily on the pedagogical knowledge and engagement of the instructor. One study by Kanter and Konstantopoulos (2010) specifically studied teachers as they implemented a PBL curriculum for the first time. Nine sixth- through eighth-grade science teachers were given extensive professional development to help them implement the program, meeting for three hours per week for ten weeks. Researchers used essay descriptions that the teachers wrote of their lessons to determine the pedagogical content knowledge of the teachers using a rubric scored from one to seven. They determined that teachers needed to score at least a three on their rubrics to effectively teacher using PBL. This shows that PBL

Teachers must also decide what their goals for their students are. A collective case study by Rogers, Cross, Gresalfi, Trauth-Nare, and Buck (2011) looked at the first-year implementation of PBL by three separate teachers. One of the teachers had a main goal to teach his students 21st century skills. Another teacher wanted to implement PBL to engage students and improve test scores. A third teacher wanted both to teach his students 21st century skills and improve their test scores. The goals of PBL aligned best with the goals of the first teacher in implementing 21st century skills. Thus, he was very happy with his curriculum and completed the entire year using PBL instruction. The second teacher whose focus was largely to improve test scores was uncomfortable with PBL. He felt that without his direct instruction, students would be unable to learn the concepts they needed to do well on the standardized tests they would be taking later that year. As a result, he reverted to his traditional teaching method about halfway through the school year. The third teacher, who wanted to strike a balance between teaching 21st-century skills and improving test scores, implemented a modified version of PBL that included some teacher-centered instruction intermittent with projects.

Conclusion

In The Widening Gap

Unequal Distribution of Resources for K-12 Science Instruction, Smith, Trygstad and Banilower (2016) used data from the 2012 National Survey of Science and Mathematics Education to discuss how three kinds of resources – well-prepared teachers, material resources, and instruction itself – are allocated to classes that are grouped by prior achievement level. This study found that certain groups are more likely to be viewed as low-achieving than others and that minority students, males, and low-income students were over-represented in these classrooms. They found that students in these low-achieving classrooms were much less likely to have access to hands-on laboratory activities and that teachers used much more didactic teaching practices in these classrooms.

When approaching a low-income school, we owe it to our students to rethink what learning looks like. There will always be pressure to conform to a vision of the classroom that does not match what research shows us is best for our students. There will always be those who find reasons to teach students to sit quietly, to take notes, and to recognize the teacher as the sole authority. It is our job as educators to carefully examine these reasons and then dispose of those that aren't backed up by research. We must do what will truly help our students become better thinkers, learners, and scientists.

Students who take part in project based learning have more positive images of science and their abilities to perform science. They see future careers in science as a possibility that is open for them. We need not worry that they will not learn the information they need to do well on tests without us standing in front of them asking them to copy down notes and definitions, because the research shows that they do just as well, if not better, when they are given the chance to engage in a meaningful way. As we enter our classrooms, we must cast away the four assumptions that lead us into the pedagogy of poverty. We must re-evaluate the reasons we hold for teaching in ways that do not do justice for our students. In doing so, we can create a learning environment that is better for both our students and ourselves.

References

Chen, P., Hernandez, A., & Dong, J. (2015). Impact of collaborative project-based learning on self-efficacy of urban minority students in engineering. Journal of Urban Learning Teaching and Research, 11, 26-39.

Haberman, M. (1991) Pedagogy of poverty versus good teaching. Phi Delta Kappan, 73 (4), 290-294 doi:10.1177/003172171009200223

Han, S. S., Capraro, R., & Capraro, M. (2015). How science, technology, engineering, and mathematics (STEM) project-based learning (PBL) affects high, middle, and low achievers differently: The impact of student factors on achievement. International Journal of Science & Mathematics Education, 13(5), 1089-1113. doi:10.1007/s10763-014-9526-0

Hiller, S. E., & Kitsantas, A. (2014). The effect of a horseshoe crab citizen science program on middle school student science performance and STEM career motivation. School Science and Mathematics, 114 (6), 302-311. doi:10.1111/ssm.12081

Horak, A. K., & Galluzzo, G. R. (2017). Gifted middle school students' achievement and perceptions of science classroom quality during problem-based learning. Journal of Advanced Academics, 28 (1), 28-50. doi:10.1177/1932202X16683424

Kanter, D. E., & Konstantopoulos, S. (2010). The impact of a project-based science curriculum on minority student achievement, attitudes, and careers: The effects of teacher content and pedagogical content knowledge and inquiry-based practices. Science Education, 94 (5), 855887. doi:10.1002/sce.20391

Lou, S. J., Liu, Y. H., Shih, R. C., & Tseng, K. H. (2011). The senior high school students' learning behavioral model of STEM in PBL. International Journal of Technology and Design Education, 21 (2), 161-183. doi:10.1007/s10798-010-9112-x

Project Wet. (n.d.). Discover the incredible journey of water through the water cycle. Retrieved June 16, 2017, from http://www.projectwet.org/resources/materials/discover-incredible-journey-water-through-water-cycle

Rogers, M. M., Cross, D. I., Gresalfi, M. S., Trauth-Nare, A. E., & Buck, G. A. (2011). First-year implementation of a project-based learning approach: The need for addressing teachers' orientations in the era of reform. International Journal of Science & Mathematics Education, 9 (4), 893-917. doi:10.1007/s10763-010-9248-x

Scogin, S. S., Kruger, C. J., Jekkals, R. E., & Steinfeldt, C. (2017). Learning by experience in a standardized testing culture: Investigation of a middle school experiential learning program. Journal of Experiential Education, 40 (1), 39-57. doi:10.1177/1053825916685737

Smith, P. S., Trygstad, P. J., & Banilower, E. R. (2016). Widening the gap: Unequal distribution of resources for K-12 science instruction. Education Policy Analysis Archives, 24 (8). doi:10.14507/epaa.24.2207

Varelas, M., Kane, J. M., & Wylie, C. D. (2011). Young African-American children's representations of self, science, and school: Making sense of difference. Science Education, 95 (5), 824-851. doi:10.1002/sce.20447

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Scientific Inquiry and the Impact on Classroom Environment

Heather K. Leckie

Abstract: Scientific inquiry is an instructional strategy that requires students to engage in scientific problem solving by identifying a problem, designing an investigation, and supporting conclusions with evidence. The demand for the use of inquiry in the classroom is shown by the number of national and state standards that include inquiry as a requirement. Depending on the topic, inquiry in the classroom can range from structured to open. A classroom that engages in scientific inquiry creates an environment where students feel confident taking risks, collaborating, supporting conclusions with evidence and considering different positions. This article examines the foundations of scientific inquiry and the benefits to learners who are in a classroom where it is used.

Introduction

Austin, a high school sophomore, signed up for biology because his guidance counselor told him that he needed to pass the course to graduate from high school. Austin works at a local fast-food restaurant after school for about 20 hours a week. Both of his parents work full time, in fact, his dad works two jobs so he does not get to spend much time with him. Austin's mom works a job where her shifts vary, so sometimes she is not home at night and Austin has to help take care of his little brother.

Austin has never liked science very much because it seems like a collection of random facts to memorize. In all his other science classes, the teacher had given him notes, handed out a worksheet, and then given a test on Friday. Sometimes they did labs, but these always involved simply following directions, step-by-step, and he rarely the connection to what he was learning in class. He had never really done well in his other science classes – in fact, he had to attend summer school to pass his freshman science class. There did not seem to be much about science that related to his life, so he felt disconnected from the content and was indifferent to the learning. Austin was not looking forward to taking biology; honestly, he was hoping it would be the last science class he would ever have to take.

However, once he began biology, he knew this class would be different. This year, his teacher did not spend the entire class period lecturing and handing out worksheets. Instead, she asked what he wanted to know about the topics he was learning about. She had him come up with questions that he wanted answered and had him find the answers. He finally got a chance to research and explore ideas that he wanted to, for example how DNA is used in solving crimes. And he finally saw a connection between the labs and activities that he did in class and how the learning related to his life. For the first time, he actually looked forward to going to science class. In fact, he even made some new friends!

One of his favorite activities was during the unit on DNA technology and genetically *modified organisms (GMOs). His teacher asked the students in his class to research GMOs more and take a stance on if they supported their use or not. Once they took a side, they had to construct a product (it was their choice – a presentation, a video, a poster, or another visual aid) that showed their position and the evidence they found. They had a day in class where they had a debate and they had to consider the other side's findings and evidence. It was one of the first times that Austin felt like he was walking away from science class with information he could use in the real world.*

The National Research Council (NRC) (2000) has pointed out that "traditional" science education, which treats science more as a set of facts to memorize rather than a way of learning, fails to prepare students for experiences in the real world because its lack of connection to their lives. This seems to be the approach in many science classes. The use of scientific inquiry to guide classroom instruction is a more student-centered approach. For many students, using scientific inquiry in the classroom sparks new interests and awakens a natural curiosity about scientific phenomena not felt before. The foundations of inquiry require opportunities for students to engage in exploration to construct and communicate understandings of scientific ideas.

Scientific inquiry helps students to develop an evidence-based opinions about socio-scientific issues, such as genetically modified organisms (GMOs). These are the same issues that current high school students will have to make decisions about as adults. And using scientific inquiry works to even the playing field for students and can create a healthy classroom environment where students work together to develop scientific explanations. For inquiry-centered learning to succeed it is vital that the classroom be a place where students feel comfortable communicating and working with both the teacher and their peers. In turn, a classroom that engages in scientific inquiry creates an environment where students feel confident taking risks, collaborating, supporting conclusions with evidence and considering different positions.

Cornerstones of Scientific Inquiry

The use of scientific inquiry in the classroom is reinforced by several education standards. The Next Generation Science Standards (NGSS) (2013) and Ohio's Revised Science Standards (2011) each include specific sections of the value of scientific inquiry in science education. In an official position statement, the National Science Teachers Association (NSTA) (2004) encourages science teachers at all levels to incorporate scientific inquiry as a regular activity in their classroom. The NRC (2000) released an entire book, Inquiry and the National Science Education Standards: A Guide for Teaching and Learning, to help teachers bring inquiry into their classrooms. The national push for inquiry has encouraged many teachers to embrace the power of inquiry within their classroom.

Scientific inquiry has been defined by the National Science Education Standards "as a pedagogical method that models scientific practice and encourages students to gain content knowledge" (as cited in Banjeree, 2010, p.1). According to the NGSS (2013), students need to be able to engage in the following practices in order to use scientific inquiry:

1. Asking questions.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations.
7. Engaging in argument from advice.
8. Obtaining, evaluating, and communicating information. (Appendix F, p. 1)

Inquiry incorporates the nature and process of science so that students learn to think in the same way that a scientist in the field would to seek answer to a question (NRC, 2000). Although the steps presented appear sequential, it is important to point out that not every investigation needs to follow each step in a specific order (NSTA, 2004). Some investigations will require more revision than others and perhaps even repeat steps. Throughout the course of their educational career, students should have the opportunity to explore and improve these skills to prepare them for their next step in scientific discovery.

What Can Teachers Do?

Inquiry can take on many forms in the classroom based on the level of direction presented by the teacher. For inquiry to be considered "open," the students must dictate the direction of the investigation. They define questions, develop investigations, and determine materials (NRC, 2000). In these types of investigations, teachers take a much more supportive, facilitating role to allow students to construct and communicate explanations. In this case, students can arrive at the same conclusion through many different approaches – and therefore get to choose the path of their explorations. On the other end of the spectrum is guided inquiry. Guided inquiry allows teachers more control over questions students explore – teachers often determine materials and sometimes procedures for guided inquiry (NRC, 2000). In this case, the teachers might have a specific conclusion in mind so activities are geared towards helping students discover this. Teachers can also decide to use a mixture of these methods as students participate in student inquiry. For example, a teacher may determine the question (such as "Are GMOs safe to use?"), but allow the students to determine the materials and procedures they will use to find a conclusion. Teachers can also allow students more freedom in the questions asked and procedures utilized, but the teachers must then require that communication of discoveries be in a specific format – such as a lab report.

Inquiry allows for teachers to inspire curiosity in students while still maintaining some control of classroom activities and course pacing. In their official position statement on inquiry, the NSTA (2004) lists many recommendations for teachers on how they can help students to understand inquiry such as understanding that not all questions can be answered by the same type of investigation. The most important thing that teachers can do when using inquiry is to ensure that students are active participants in their learning and that they are forming their own conclusions supported by evidence they accumulate during their investigation.

Benefits to Learners

Classroom Environment

A classroom that supports inquiry is a place where students feel confident taking risks because teachers place importance on student ideas and findings. In classrooms where inquiry takes place, teachers understand that students come with prior knowledge and experiences, and because the focus is on the learner, these experiences are valued (NRC, 2000). Perhaps the most significant impact that inquiry has on a classroom is the development of a community. In his poignant discussion of emotional ecology, Zembylas (2007) points out that "teachers and students create the environment that shapes how they are emotionally connected and engaged in learning together" (p. 357). Using inquiry can help to form these bonds between teachers, students, and content. In a classroom where inquiry is practiced, students understand that they can not only learn from the teacher, but from each other as well (NRC, 2000). The NSTA (2004) recommends that teachers "design and manage learning environments that provide students with the time, space, and resources needed for scientific inquiry" (p. 2). Such inquiry helps to develop a classroom where students feel safe interacting with each other as well as the teacher.

Collaboration

One of the most valuable and important results of using inquiry in the classroom is that students learn ways to communicate ideas with others during collaboration. In order for this to happen, the classroom needs to be a place where students feel comfortable presenting new ideas and taking risks, as well as asking questions and participating in dialogue and discussions: "Inquiry requires students to be positively interdependent, so that the benefit to one student benefits the whole group" (as cited in Wolf & Fraser, 2007, p. 324). This resonates with the idea of Zembylas (2007) that learning occurs when teachers and students work together. The community that is created from inquiry recognizes that communication and collaboration with others is a requirement to reach a deeper understanding of material.

Supporting Conclusions with Evidence

One of the cornerstones of inquiry is that students must support and defend conclusions with evidence. "It is not the K-12 teachers goal to create philosophers of science. The goal is to develop informed citizens so decisions can be made concerning personal and societal issues that are scientifically based" (Lederman, Antik, & Bartos, 2014, p. 291). A variety of issues that students will face in adulthood are controversial: for example, genetic engineering and climate change. Students will have to make decisions about these issues and these decisions will require evidence.

The NSTA's official position statement Teaching Science in the Context of Societal and Personal Issues (2016) offers several declarations for what students should learn about these complex issues facing the world today. The last statement sums up the importance of evidence-based approaches: "Prepare students to become future citizens who understand science and engineering and are willing to engage in making responsible and informed decisions" (p. 2). As students work through the process of inquiry, they develop a greater understanding of science by supporting their ideas with results from investigations. This one of the most important skills that inquiry helps develop because it allows students to be well versed in using evidence when making decisions.

Considering Other Positions

Over the course of the inquiry process, there will be times in which students disagree with each other and have to reach a resolution. If the environment of the classroom is one of respect, students will learn to work with others who have differing ideas. For a student like Austin who has never used inquiry, this experience will probably be new. Teachers have to ensure that students are provided opportunities to revise their own thoughts and ideas while considering differing viewpoints. This could be a simple activity such as reflecting on learning and sharing these ideas with others or a more detailed exercise involving an audience. Either way, this revision of ideas with collaboration will allow students to continue the dialogue and consider new or previous ideas as solutions to problems. As students participate in inquiry, they also learn to ask questions about what is considered valuable information that should be further considered (Banjeree, 2010). Often, this decision is not one that is made as individual – students must work together to decide what is valuable. Joseph Massaquoi points out that science education is "concerned with the sharing of science content and process within the community." This is a vital part of the scientific process and exemplifies the fact that "doing" science relies on others' ideas (2009, p. 64).

Conclusion

Successfully incorporating scientific inquiry into regular classroom practice is a daunting task for educators: it takes time, practice, and the revision of learning materials to refine lessons to truly allow students to participate in inquiry. There is no doubt, however, that it is time well spent. Students who truly understand science are those who learn using the skills required for inquiry. "Research indicates that learners benefit from opportunities to articulate their ideas to others, challenge each others' ideas, and, in doing so, reconstruct their ideas" (Roseberry et al. as cited in NRC, 2000, p. 119). For many students, the use of inquiry could change their entire outlook on science. This process helps students to make connections to the real world that they may not have seen before. Inquiry also helps students to develop problem-solving skills that prepare them to be informed citizens. While the intellectual skills that students learn from inquiry are important, the interpersonal skills that students develop may benefit students in much more dynamic and far-reaching ways. Students who are part of an inquiry community learn to interact with others to develop ideas and understandings, so they must together create a learning community of thought, process, and understanding where communication and collaboration are vital. Inquiry encourages acceptance of others and their ideals along with a willingness to find ways to work together to create a deeper understanding of science. Throughout their lifetime, these skills will be invaluable tools as students enter into to the greater societal community.

References

Banjeree, A, (2010). Teaching science using guided inquiry as the central theme: A professional model for high school science teachers. *Science Educator, 19*(2), 1-9.

Lederman, N.G, Antik, A., & Bartos, S. (2014). Nature of science, scientific inquiry, and socio-scientific issues arising from genetics: a pathway to developing a scientifically literate citizenry. *Science & Education, 23,* 285-302.

Massaquoi, J.G.M. (2009). Strengthening peacebuilding through science and technology education. *Science Education International, 20*(1/2), 5-24.

National Research Council. (2000). *Inquiry and the national science Education Standards: A guide for teaching and learning*. Washington, DC: The National Academies Press. https://doi.org/10.17226/9596.

NGSS Lead States. (2013). Next Generation Science Standards: For states, by states. Retrieved from http://epsc.wustl.edu/seismology/book/presentations/2014_Promotion/NGSS_2013.pdf

National Science Teachers Association. (2004). NSTA position statement: Scientific inquiry. Retrieved from: http://www.nsta.org/about/positions/inquiry.aspx

National Science Teachers Association. (2016). NSTA position statement: teaching in the context of societal and personal issues. Retrieved from http://www.nsta.org/about/positions/societalpersonalissues.aspx

Wolf, S.J. & Fraser, B.J. (2007). Learning environment, attitudes, and achievement among middle-school science students using inquiry-based laboratory activities. *Research in Science Education, 38*, 321-341.

Zembylas, M. (2007). Emotional ecology: The intersection of emotional knowledge and pedagogical content knowledge in teaching. *Teaching and Teacher Education, 23*, 355-367.

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Argumentation in the High School Science Classroom
Underutilized and Misunderstood

Jillian R. Richmond

Abstract: Argumentation is a crucial part of discourse in the scientific field, but is rarely found in the science classroom. This raises the questions of why teachers are not using argumentation, as well as what benefits argumentation provides in the science classroom. Argumentation is not widely used in the science education field due to lack of teacher knowledge about integration techniques and teachers' fear of unruly class discussions. However, research shows that students benefit in many ways from argumentation based learning by allowing students to work through real world problems to develop higher level thinking skills. This paper discusses the importance of argumentation in science learning, ways to increase argumentation in the science education field, and specific techniques of argumentation that can be implemented in the science classroom.

Introduction

Jack plops down on his couch after a long day of work and turns on the news. The newscasters are debating a new law that would require the labelling of GMOs. One newscaster is practically yelling that GMOs cause cancer, while the other stands firm in their belief that GMOs are harmless. Jack thinks back to his high school biology class, and remembers that GMO stands for Genetically Modified Organism. He can't remember much past the definition, so he pulls out his laptop and starts to Google. "GMOs Will be the Death of Us All" one article blares. "10 Reasons Why GMOs are Crucial for the Future" declares another. As he scrolls through the articles, he thinks to himself, "How can anyone know which side to believe when there is so much information out there?" As Jack continues to scroll, he becomes frustrated and feels his education has failed him. He knows that mitochondria are the powerhouse of the cell and can list off Newton's Laws of Motion, but he has no idea what his opinion on GMOs should be or how to start developing one. He thinks of the science issues he sees debated everywhere from his television to Twitter: climate change, oil pipelines, renewable energy, water quality, ecosystem degradation, fertilizer use, and a variety of others. He knows that these topics were discussed in the science classroom, but he has no idea what information to believe in the vast abyss that is the internet. He closes his computer and changes the channel, and decides that the rest of the voting public can figure out what the right option is for this GMO law without him.

Where Science and Politics Intersect

Jack is not alone in his inability to discern which sources of information are scientifically valid and which are not. In the information age we live in, many people don't know what to believe, while others simply trust the first source they read. In the current political climate, there are a variety of scientific issues on the ballots that require citizens to do their own research and form their own opinions. As science educators, it is our duty to make sure that students who come into our classrooms not only learn the science content, but also learn how to find scientifically accurate information, process that information, and form their own opinions. Luckily for science teachers everywhere, argumentation can be used in the classroom not only to teach science content, but also to help students develop higher level thinking skills and form opinions based on scientific evidence, rather than depending on the first news source they see.

Scientific Discourse and Argumentation

Scientific discourse is how scientists interact with each other and exchange information. In the science classroom, it is important that students learn different forms of scientific discourse so they can interact with each other and with the scientific content. Argumentation is a form of scientific discourse that is only occasionally used in the science classroom, but is widely used in the field of science. The basis of scientific argumentation is reasoning scientifically based on information in order to create a position, to present a new idea, or to refute an existing position or idea. Argumentation is important in education because it allows students to work through scientific knowledge by using higher order thinking skills, such as the synthesis and evaluation levels in Blooms Taxonomy. In fact, using argumentation as an educational tool is not a new idea and was used for teaching as far back as Plato and Aristotle (Eduran, 2006).

How is Argumentation Used In Science?

Scientists in the field use argumentation often. Initially, when scientists start out with an idea for an experiment or a procedure for how to conduct an experiment, it is generally critiqued through argumentation-based processes. Scientists must talk to their peers to determine if their hypotheses and experiments are valid and relevant to the field and to decide whether they make sense from a scientific perspective. Once a scientist has finished conducting their experiment, they typically attempt to publish the findings. These scientists generally write scholarly articles, which must be critiqued by other scientists many times in an argumentation-based process before the articles are published. Similarly, Master's and PhD students in the sciences generally write a thesis or dissertation which must be critiqued and approved by a panel of scientists and professors. These students sit in with a panel of experts and defend their thesis by answering critical questions. Since argumentation is an integral part of the scientific process, most science educators think that it should be an integral part of the science classroom.

Why Is Argumentation Important in the Classroom?

To truly understand science, students need to know how evidence is used in science to construct explanations, and how arguments form links between data and theories that science has already constructed. Thus, in their article "Establishing the Norms of Scientific Argumentation in Classrooms" Driver, Newton, and Osborne (2000), argued that current science classrooms are organized around reading and experimentation when they should revolve around socially-constructed science. The idea of integrating more argumentation into the science classroom has been around for a long time, yet modern day science classrooms generally offer little to no argumentation in their curriculum. Newton and Osborne make the case that factual recall and memorization is not the basis of science, and that these skills are not very useful in the scientific community. The article claims that although modern day science classrooms teach you the "what" (meaning what a scientific term is), they don't cover the most important bases. They argue that argumentation in the classroom would help teach students the "how's" and the "whys" as well. Argumentation can help teach students how a phenomenon works, how it relates to other phenomena, and why it works the way it does. If a student only learns one "how," "what," or "why," they are missing the big picture that can be mastered through argumentation. For example, turning back to Jack and the political issue of GMOs, it is clear that Jack had only learned what a GMO was, but had missed out on learning the "hows" and "whys" of GMOS. If Jack had been taught through multifaceted argumentation, he would likely have had an idea of what GMOs are, how they work, and why they are pertinent to society, which would allow him to have or create a logical and scientifically-based opinion on the issue.

Jack's case illustrates Newton and Osborne's (2000) final points about why argumentation should be used in the science classroom. First, there are many issues that the public has control over such as those related to air quality, water quality, the destruction of ecosystems, GMOs, and the use fertilizers in agriculture. These issues are complicated and there is rarely a simple "right" or "wrong" side. Due to the complexity of these scientific issues, it is important that the public be able to evaluate them and to be informed on what they are voting for or against. As seen in Jack's case, the lack of a deeper understanding of the issue of GMOS, combined with a deficiency in the skills needed to form an opinion, led him to back away from current political issues. Secondly, it is important that the public understand what science really is and what scientists do. A large part of the population doesn't understand how the scientific community works or why argumentation is integral to the scientific process. Newton and Osborne claim that if we want a scientifically educated population, we must teach students the ability to know how to become scientifically educated on a topic.

Research shows that teachers can be taught to use argumentation in the science classroom. Demiriglu and Ucar (2012) performed a study that shows the positive effects of argumentation in the science classroom. This study evaluated the effects of Argument Driven Inquiry (ADI) laboratory activities with pre-service teachers. An ADI lab is essentially a science lab that allows experimenters to decide how to run their experiments, for example deciding what steps to take, by using argumentation with the group. In their study they worked with 63 pre-service teachers, and dividing them into a control group which completed a standard lab with a predetermined procedure, and an intervention group that completed an ADI lab. The group that completed the ADI lab controlled how they experimented and used argumentation to figure out the best way to do so. Afterwards, the control group and the test group took a test that was identical to the pretest they had taken before they did the experiment. Although there were no differences in the content scores between the two groups, the positivity scores on the experiment from the test group were much better than the control group, indicating that that those who were able to develop and test their own experiments felt much more positively about the experience, and about science than those who had performed the a pre-made experiment. For this reason Demiriglu and Ucar believe that those in the test group would be likely to use ADI in their own classrooms, leading to similarly increased engagement on the part of their students.

Why Is Argumentation Underutilized?

Many scholars argue that the reason argumentation is not commonly used in the science classroom is the lack of pre-service teacher instruction on how to implement argumentation-based teaching in the classroom (Duschl, 2002). As Demiriglu and Ucar (2002) showed when teachers learn how to use argumentation as pre-service teachers, they are more likely to use argumentation in their own classrooms. Generally though, teachers struggle with implementing classroom procedures that they have not learned how to used or with which they have not yet gained experience in their own education. As with other education techniques, practice makes perfect, and when teachers start to use argumentative practices in the classroom, they only get better at doing so.

How to Use Argumentation in the High School Science Classroom

A lot of research supports the idea that argumentation is important to the classroom and to the scientific community, but discerning what argumentation techniques are best for use in the classroom is a topic still in its infancy. Although argumentation has been used historically in science and in the classroom, studies of its implementation have fallen to the wayside.

The most common argumentation technique used in the classroom is debate. This involves having students pick sides or assigning students sides of a particular issue, and having them engage in a structured debate. In my experience, many teachers feel uncomfortable with the idea of debates in their classrooms for two reasons: the time commitment and the lack of control. It is important for teachers to note that debates can last for as little as one class period, and that when there are structured debates in the classroom, they can still be a moderator who controls the flow of the debate without taking away students' freedom. Jack's situation may have been very different not only if he would have understood GMOs in a multifaceted way, but more importantly if he had the skills to develop an opinion by doing his own scientifically accurate research. When students enact argumentation-based debates in the classroom, it allows them to examine an issue from many different angles. Finally, through debate, students learn how to research an issue and form an opinion using higher-level thinking skills as opposed to just reading and regurgitating information.

There are many other ways to use argumentation in the classroom. One argumentation technique is facilitating students as they constructively critique each other's work. This can be done by allowing students to look at each other's experiments, projects, or papers and directing them to use constructive criticism techniques to help improve their work. Another method is to have guided discussions in class, which can be done by asking questions with no definitive answer and allowing students to discuss possible answers. Such guided discussion can take place in a whole class setting or in small groups in which students discuss among themselves. Another common argumentation technique the can be used in the classroom is assigning argumentative papers, where students either pick or are assigned a certain side of a scientific issue and are expected to validate it through writing.

Argumentation can also be brought into the classroom by allowing students to create their own experiments for various science topics. Another way teachers can use argumentation is by having students make predictions that strengthen their explanations. This is done by having students predict the results of an experiment by using their previous logic from another experiment or scientific explanation. Teachers can also ask students to reconcile competing explanations, meaning that students must find a common understanding or explanation between two results or findings that may seem to contradict each other. Lastly, teachers can have students build a consensus from multiple contributions. This requires students to compare and contrast different sources to form a larger consensus of data from multiple sources. If it involves students looking at an issue from multiple view points and taking a stance, it is argumentation.

Many science classrooms follow a model in which teachers relay facts or truths to students, as opposed to using argumentation to explain a topic. Osborne (2010) explains the difference:

> An argument, in contrast, is an attempt to establish truth and commonly consists of a claim that may be supported by either data, warrants (that relate the data to the claim), backings (the premises of the warrant), or qualifiers (the limits of the claim). (p. 464)

Argumentation can also be used with students to teach them about different topics, and allow them to see topics as multidimensional, as opposed to being given only one viewpoint on a topic and being expected to memorize facts. In Jack's case, his teacher had probably focused on relaying facts about GMOs, such as the definition of GMOs and examples of them, instead of diving into the arguments made by pro- and anti-GMO proponents and allowing students to formulate their own opinions.

Eduran (2006) conducted a study on argumentation and his research revealed two important things: first, that teachers can learn how to integrate argumentation into the classroom, and second, that students' argumentation skills improve with practice. One of the high school chemistry teachers involved in the study conducted an argumentation lesson on the periodic table. She had the students use argumentation to arrange a periodic table and determine to what class (Metals, Non-Metals, Metalloids) various elements belonged. Students helped to critique other students' evidence arguing whether a particular element was a metal or non-metal. Another high school chemistry teacher who participated in the study, taught a similar lesson, but only posed a single question: Was mercury a metal or non-metal? Students researched both sides of the issue and used argumentation to come up with a final answer. This research shows that something as simple as determination of what class an element belongs to can be taught using argumentation. When students are told that certain elements belong to certain classes, and given the reasons why, there is a chance they will remember what they have been taught. However, when students must use higher-level thinking skills to discern for themselves what class an element belongs to, it is much more likely they will internalize that information. Knowing that students improve the more they practice makes argumentation even more worthwhile in classrooms. If Jack had practiced argumentation on other science classroom topics that were not GMO related, he might have built the higher-level thinking skills required to conduct his own research and make scientifically informed decisions long after he left the classroom.

Conclusion

When students exit classrooms and step into the real world, they will be faced with many decisions. These choices range from which career path to go down to which way to vote on various issues. It is a school's responsibility to make sure that students are educated enough to make good choices without the guidance of a teacher, counselor, or parent. Schools and teachers can prepare a generation of students who are socio-scientifically educated, and who are able to research various issues without just regurgitating what they see on TV or online. In a society which is inundated with such controversial issues as climate change, GMOs, and the use of renewable energy, students should be able to use argumentation to evaluate an issue from multiple sides and to form an educated opinion.

Luckily for teachers, students typically get better and better each time they practice argumentation (Eduran, 2006). Because of this, students at any age can learn how to be more argumentative in their thinking. The science education community needs to put more research into what types of classroom environments best nurture argumentation if they want teachers to use more specific practices in their classrooms. The pre-service science education community needs to integrate more argumentation techniques into their curriculum to help teachers to learn to help students. Duschl and Osborne (2002) claim that "[l]earning to argue is learning to think," and by that logic, teachers have an obligation to teach students how to argue.

References

Demircioğlu, T., & Uçar, S. (2012). The effect of argument-driven inquiry on pre-service science teachers' attitudes and argumentation skills. *Procedia - Social and Behavioral Sciences, 46*, 5035-5039.

Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education, 84*(3), 287-312.

Duschl, R. A., & Osborne, J. (2002). Supporting and promoting argumentation discourse in science education. *Studies in Science Education, 38*(1), 39-72.

Erduran, S., & Msimanga, A. (2014). Science curriculum reform in South Africa: Lessons for professional development from research on argumentation in science education. *Education as Change, 18*(Sup1), S33-S46.

Mork, S. (2005). Argumentation in science lessons: Focusing on the teacher's role. *Nordina, 1*(1), 17-30.

Osborne, J. (2010). Arguing to learn in science: The role of collaborative, critical discourse. *Science, 328*(5977), 463-466.

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A Progression of Discourse in the Science Classroom

Jennifer Wiesen

Abstract: The framework of the NGSS requires the development of skills central to the field of science. Scientific discourse is necessary for developing these skills, but the use of discourse is absent from many science classrooms. Possible reasons for this could be that teachers do not know how to incorporate methods into their classroom. This manuscript addresses methods that can be used to develop the discursive skills necessary for students to participate in activities central to science. Methods are described in a progression from introductory vocabulary use and explanation of ideas, discussion skills, and finally, the integration of skills to perform complex tasks such as inquiry and argumentation.

Introduction

The introduction of more rigorous science standards has placed a greater emphasis on improving student language use in science classrooms. Many students are not familiar with this form of language use, and associate speaking and writing requirements with language arts classes. The use of scientific discourse in the classroom is a skill that must be taught to ensure students are successful when using higher level skills (e.g., inquiry and argumentation) necessary for successfully meeting current standards. This manuscript discusses a framework, or progression of discourse, for teaching students foundational science language skills and guiding them to more advanced language skills in the science classroom.

What is Discourse?

It can be a struggle at times to fully understand what is meant when referring to the word discourse. It involves language, but if discourse was just language, we would call it simply that: language. Discourse is more than just spoken language; it makes up who a person is. Gee (1996) defines discourses as, "ways of being in the world, or forms of life which integrate words, acts, values, beliefs, attitudes, social identities, as well as gestures, glances, body positions and clothes" (p. 142). Thus the use of discourse depends on the context of how one lives such as one's culture, occupation, education, and religion. According to Gee, there are different forms of discourse. Big "D" Discourse reflects one's identity in society and little "d" discourse is language use in general (p. 142). Little "d" discourse is simply the use of language, and is included in big "D" discourse. Big "D" Discourse, as stated before, consists of one's identity, which determines the ways in one uses language. For example, a scientist will speak and write differently than a historian because the language of each field differs. A student may speak and write at home in a manner different compared to how they speak or write in school. Through education students can develop different Discourses. Some may be social or cultural, while others may be educational.

Discourse in Science

Engaging scientific discourse requires the use of language specific to the science community. Language use can include reading publications, analyzing data, presenting results, collaborating with colleagues, etc. The use of language in science is unique because it is the language of observation, discovery, and explanation of the natural world. To truly understand science, one must become fluent in its language, just as to truly understand a conversation with a person from Venice, one must become fluent in Italian. When learning any new language, there is a progression. First one focuses on learning the basic terminology, followed by applying basic language to make simple statements, then, finally, fully integrating use of the language. To teach students the language of science, a similar progression can be applied. First, vocabulary and terminology are learned, followed by practice with speaking the language, with the end goal being full incorporation of language use in the context of science.

Progression of Discourse in the Science Classroom

There are many methods for increasing the use of student discourse in the science classroom. Students do not necessarily enter the classroom with the appropriate skills to participate in an inquiry or argumentation activity; these skills must be taught and students must be provided with scaffolding to help them successfully reach that point. Figure 1 illustrates the progression needed for students to reach higher level skills such as inquiry and argumentation. Development of these skills depends on a student's ability to understand the language of the subject matter and use language to participate in meaningful discussions related to subject matter. In science education, language use can take many forms: stating hypotheses, describing measurement and collecting data, analyzing data, and collaborating with peers to name a few. How are students to be led on the path to these different forms of scientific discourse? As depicted in Figure 1, the path begins with a solid foundation constructed with the teacher's careful guidance. The various methods for assisting students with developing scientific discourse will be examined as a progression; discussion of these methods will follow.

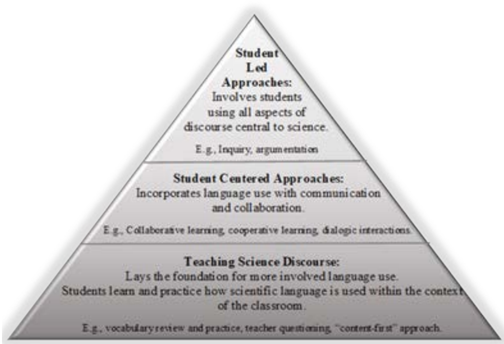

Figure 1: Explanation and methods for the progression of teaching scientific discourse in the science classroom.

Teaching Science Discourse

Teachers shape the path students will travel to successfully communicate in the science classroom; they structure and model the language use expected. To begin students on their journey of learning the use of scientific discourse, knowledge of background vocabulary is essential. Teaching vocabulary is often thought of requiring the memorization of words and definitions. When placed in the context of developing student discourse, students should be using vocabulary words within the context of the concept being mastered, in order to develop more complex modes of communication like language use and presentation of data (Dawes, 2015). The significance of teaching vocabulary in this manner is illustrated by a study of middle school students conducted by Crosson, Lawrence, Pare´-Blagoev, & Snow (2015). A limited number of vocabulary words were selected each week for students to learn. Given a topic, students read, talked, and wrote about the topic using the vocabulary words for the week. The results showed an increase in the quality of classroom discussion. This method of vocabulary instruction involves students using new vocabulary in an appropriate context and illustrates for students how the word is used within the subject. Using this method helps students make connections between vocabulary and its usage.

Another method for vocabulary incorporation, as described by Brown and Ryoo (2008), is the "content-first" approach to teaching science. This vocabulary teaching strategy involves teaching students a scientific concept using everyday language before introducing scientific vocabulary. To illustrate, students initially learn about photosynthesis through statements like, "This is the inside of an energy pouch where plants make their own food. There are many green pigments inside of an energy pouch" (p. 540). After the concept is introduced, students are presented with the statement again but with appropriate scientific language, "This is the inside of a chloroplast where plants make glucose. There are many chlorophylls (green pigments) inside of a chloroplast" (p. 540). This method is useful because it supports students in making connections between everyday language and scientific language. Another benefit to this method is it improves student's ability to use scientific language when communicating in the classroom.

While both of the above methods focus on the use of vocabulary, they both impact the quality of discussion. Thinking of discourse as a framework or progression, classroom discussions are aimed at building skills that will lead students to an endpoint where they will acquire critical thinking and analysis skills. For students to reach this endpoint and build a solid foundation, the types of discussion questions to be posed must be carefully planned by the teacher. When students are asked higher-order questions they are given the opportunity to explain and justify their opinion (Smart & Marshall, 2013). Higher-order questions are open-ended and do not have one right answer, so they allow students to think and communicate, and respond to their peers. Typically, when first introducing this method of questioning, a scaffold is needed. Referred to as the "cognitive ladder," as described by Chin (as cited in Smart & Marshal, 2013, p. 251), questions progress from lower-order to higher-order as students become more confident with the material. For example, a lower-order question is "What is density?" and a higher-order question is "How would you find the density of this nail?" The first question involves a simple definition, where the second question requires understanding of the definition but, more importantly, creates the opportunity for discussion. This method of discussion and questioning helps students develop a deep conceptual understanding of scientific concepts.

The teacher-led methods discussed above assist students in developing their conceptual understanding and skills necessary to explain and justify their opinions; they lay the foundation depicted in Figure 1. Students must obtain these skills before progressing to the next level of scientific discourse; collaboration and communication with peers.

Student-Centered Approaches

Collaboration and communication with peers is a use of discourse central to science and the scientific community. Therefore the next phase in the progression of science discourse is to promote interactions between students. A way to introduce communication that is student-centered is through dialogic teaching. Dialogic teaching is a type a teacher-led discussion. The teacher poses a meaningful question followed by a rotation that allows students to explain what they know or do not know, while the teacher connects the students' responses together in a meaningful way (Dawes, 2015). Although it is teacher-led, dialogic teaching conducted in this way can be considered student-centered because it is most successful when students participate in interactions with peers while preparing their thoughts about the proposed question (Aguiar, 2015). Dialogic interactions involve the production of student ideas, not the teachers. The teacher may mediate the discussions and provide background information when necessary but it is the students that create the dialogue. This method is successful for increasing communication between students while also introducing argumentation skills that may be used for future purposes (Reznitskaya, 2009).

Dialogic interactions assist students in becoming familiar with communicating in the classroom. Students begin by simply stating what they know or think. Collaboration is the next step in this progression. Collaborative learning involves discussion between students to solve a problem posed by the teacher. Discussion guides the learning. When students are given the opportunity to discuss a question or problem, they increase their conceptual knowledge. A study by Barth-Cohen et al. (2015), illustrates the success of collaborative learning. Students were asked questions and responded using a clicker system. After their initial answer, students collaborated with their peers. Together, they answered the same question again followed by a separate question that was different but covering the same concept. The results showed that more students answered correctly on their second attempt answering the first question. More importantly, the number of correct responses on the follow-up question were much higher compared to responses on the first before the students had collaborated. The increased scores were a result of better conceptual understanding gained from the discussion rather than simply being told the correct answer. This is the basis of collaborative learning: students discuss problems to gain conceptual knowledge.

Cooperative learning is similar to collaborative learning, but cooperative learning involves more student communication because it requires students to work together toward a common goal (Murphy, 2015). According to Murphy, there are five elements essential to cooperative learning; groups should be interdependent, there should be face-to face interaction between students, all students are accountable, social skills are necessary, and the group should self-evaluate. Cooperative learning opportunities usually involve the production of a product (model, presentation, etc.) and require student communication using scientific discourse combined with adequate content knowledge.

The methods discussed in this phase of progression involve giving students opportunities to become comfortable communicating with their peers while promoting deeper conceptual understanding. The skills gained by students from the first two phases of progression can now be transferred to more complex activities that immerse students in scientific discourse like inquiry activities and argumentation.

Student-Led Approaches

The final step in the progression of science discourse is for students to participate in activities that resemble the work of scientists in the field. Inquiry-based learning is a method where students explore the answer to a question that is of interest to them. Skills necessary to perform inquiry have become the framework for many present science standards. The National Research Council has outlined the processes critical to science as:

1. Asking questions
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information (as cited in Melville, 2015, p. 507)

The processes listed above require the use of scientific discourse. Students cannot successfully participate in inquiry activities if they do not have sufficient content knowledge and communication skills. The progression of scientific discourse that has been laid out supports and prepares students for introduction into inquiry-based learning. Even with such preparation, inquiry activities can be intimidating for students. To ease the intimidating nature of inquiry activities, skills such as formulating hypotheses, observing, measuring, collecting data, and interpreting data can be broken down and taught in manageable pieces until students become more comfortable with the processes (Russel, 2015).

Inquiry-based learning is, as it seems, the future of science education. Inquiry develops critical thinking skills and independence by integrating science discourse in the classroom within the context of the scientific community. Hand in hand with inquiry goes argumentation. Argumentation is another important skill in the scientific community. While argumentation is related to inquiry, the focus in argumentation follows "a claim, evidence, reasoning, and rebuttal framework" (Krajcik, 2015, p. 286). The argumentation framework, like inquiry, requires various uses of scientific discourse. Students are required to make clear statements, to analyze text or data for evidence, to discuss and explain their viewpoints, and to listen to and take into consideration the viewpoints of others. The topics used in argumentation should be relevant and meaningful issues that are related to scientific concepts. Like inquiry, argumentation can seem intimidating to students, so breaking down the process and guiding students through the steps will be beneficial when first introducing this method.

Inquiry and argumentation involve the use of skills and processes that are central to science. At the center of these processes lies the one thing that supports the whole structure: Discourse. The language and the processes involving the use of language are what creates the field of science. Science education is not only about the content or the facts, but also about the process of science: giving students the skills they need to observe and understand the world around them.

Conclusion

Understanding science means understanding the corresponding discourse associated with it. Practice and guidance in using scientific discourse assists students along their journey to understanding science as a way of knowing. This progression takes into consideration the fact that many students do not have experience with the discourse skills needed for inquiry and argumentation. It involves creating a gradual path that introduces students to the various methods that constitute scientific discourse. Beginning with vocabulary, students become familiar with terminology, enabling them to explain scientific phenomena. Students then begin to incorporate their explanations into the group setting where they communicate ideas to their peers. Both the vocabulary and communication phases deepen student conceptual understanding of topics which is necessary for the final step of the progression: inquiry and argumentation. Inquiry-based learning and argumentation build on previously learned skills like providing explanations, communicating ideas, and collaboration with peers and incorporates them into the larger context of science.

References

Aguiar Jr., O. G. (2015). Dialogic teaching and learning. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 310-315). New York, NY: Springer Netherlands.

Barth-Cohen, L. A., Capps, D. K., Lewin, J. D., Shemwell, J. T., Smith, M. K., & Stetzer, M. R. (2015). What are middle school students talking about during clicker questions? Characterizing small-group conversations mediated by classroom response systems. *Journal of Science Education and Technology, 25*(1), 50-61. DOI 10.1007/s10956-015-9576-2

Brown, B. A., & Ryoo, K. (2008). Teaching science as a language: A "content-first" approach to science teaching. *Journal of Research in Science Teaching, 45*(5), 529-553.

Crosson, A. C., Lawrence, J. F., Pare-Blagoev, J. E., & Snow, C. E. (2015). Word generation randomized trial: Discussion mediates the impact of program treatment on academic word learning. *American Educational Research Journal, 52*(4), 750-786. DOI: 10.3102/000283121557948

Dawes, L. (2015). Discussion and science learning. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 340-346). New York, NY: Springer Netherlands. DOI 10.1007/978-94-007-2150-0

Gee, J. P. (1996). S*ocial linguistics and literacies: Ideology in discourses, critical perspectives on literacy and education* (2nd ed.). Bristol, PA: Taylor & Francis.

Krajcik, J., & McNeill, K. L. (2015). Designing and assessing scientific explanation tasks. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 285-290). New York, NY: Springer Netherlands. DOI 10.1007/978-94-007-2150-0

Melville, W. (2015). Inquiry as a teaching strategy. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 507-509). New York, NY: Springer Netherlands. DOI 10.1007/978-94-007-2150-0

Murphy, C. (2015). Cooperative learning. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (p. 236). New York, NY: Springer Netherlands. DOI 10.1007/978-94-007-2150-0

Reznitskaya, A., Kuo, L., Clark, A., Miller, B., Jadallah, M., Anderson, R. C., & Nguyen-Jahiel, K. (2009). Collaborative reasoning: A dialogic approach to group discussions. *Cambridge Journal Of Education, 39*(1), 29-48.

Russell, T. (2015). Developmental perspectives on learning. In R. Gunstone (Ed.), *Encyclopedia of Science Education* (pp. 297-300). New York, NY: Springer Netherlands. DOI 10.1007/978-94-007-2150-0

Smart, J. B., & Marshall, J. C. (2013). Interactions between classroom discourse, teacher questioning, and student cognitive engagement in middle school science. *Journal of Science Teacher Education, 24*(2), 249-67.

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Social Studies

Historical Empathy
Judging the People of the Past in a Secondary Social Studies Classroom

Thomas D. Ellenwood Jr.

Abstract: Historical empathy is a structural element of the study of history that needs to be taught in every secondary history classroom. It is important not only for the sake of accuracy in our studies, but also because helping students develop historical empathy has been proven to help improve their historical understanding and increase their interest in the study of history. Instructional strategies like reading and interpreting primary sources, role-playing, and engaging in writing that requires empathetic understanding have been found to be the most beneficial in fostering historical empathy in the classroom. It is also imperative to teach students how to engage in historical empathy in order that they can more accurately interpret history and judge the people of the past more fairly.

Introduction

"You never really know a man until you understand things from his point of view, until you climb into his skin and walk around in it," (Lee, 1960, p. 30).

Passing judgment on others is an interesting thing, because we do it almost immediately unless we have been very well trained not to. We judge others through our own perspectives, according to our own standards, using our own experiences, often without sharing the standards and criteria for which we apply judgment. Reading this, it seems unfair, right? As a society we fight against it, reminding our fellow citizens not to judge others until they understand the other person well, a feat we generally consider nearly impossible. Yet, we quickly judge historical people and events in history without considering their emotions, experiences, knowledge, or context. This is unfair both to the historical figures and likewise to learners of history, who are judging them. In order to prevent this rush to judgment, history and social studies teachers must help their students develop historical empathy.

Consider a classroom where historical empathy is missing. You may have a hard time thinking of what that looks like because it does not change the physical classroom. In fact, even the most appealing classroom with active discussion and hands on activities can be missing historical empathy entirely. Historical empathy happens within our minds, and without it, we begin learning history the wrong way. When historical empathy is absent from study, history dries up into an un-relatable subject; it becomes the unintelligible past, filled with people that made bad decisions, and sometimes were nearly evil, considering some of the things they did When we forget to consider the context surrounding those events, our vision of past may be skewed.

Defining historical empathy poses a problem, as experts do not have one agreed upon definition. One useful definition comes from Endacott and Brooks (2013), who described historical empathy as "the process of students' cognitive and affective engagement with historical figures to better understand and contextualize their lived experiences, decisions, or actions," (p. 41). Historical empathy, much like psychological empathy, allows a person to connect with another person in order to understand the emotions and actions of the other person. The major difference between the two has to do with the time and context. In psychological empathy, we relate to each other in the present period, and often share a common context. To feel historical empathy, students must think about the difference between present and past, and consider the context of the past instead of their own present context. This is unquestionably a challenging task for students. Nevertheless, the concept of historical empathy is important in history education because without utilizing it, we generate judgment and interpretation of historical events and people based on our own present context and not on the historical context that should be used, resulting in false interpretation and unfair judgments.

The Importance of Teaching Historical Empathy

Go into a classroom and talk about the founding fathers. You can mention all the great things they did, the great ideas they had, and the impact they had on this country. Then mention that many of them owned slaves; students become confused about why such revered people did something we consider so obviously wrong. Nowadays there is widespread agreement that slavery is bad and should be banned, yet many of the founders of the United States were slave owners; this may seem incongruous to students. Fostering historical empathy allows students to consider the "why" in the situation, taking on the perspective of the founders.

"Empathy is central to history, one might say structural, in that without it history cannot begin," (Lee, 1983, as cited in Cunningham, 2009, p. 40). According to Lee, history is the "story of us" and we have to be able to connect to the people of the past in order to fully understand what history is. Historical empathy allows us to connect to the people of the past and using it when studying history is important because it allows us to arrive at accurate and fair interpretations of why people behaved as they did, how they made their decisions, and why events occurred in a particular manner. The "why" of history is the essential component in history education if we are to take anything from the study of the past other than names, dates, and facts. With historical empathy, students of history will more accurately interpret historical events without interpreting and jumping to judgments based on their own context and emotions.

Historical empathy is not only taught for the sake of understanding history in context, although that is a good enough reason as any. According to Brooks (2011), engaging students in using historical empathy in the classroom has been shown to increase the amount of care students have for the subject. This is because students find connections to the past, which in turn triggers emotional reactions and interest. When students care more about history, because they can relate to it better, they tend to take more interest in the subject and work harder, which means that fostering historical empathy is also a way to improve student performance in your classroom.

Requirements for Historical Empathy

Historical empathy means more, though, than just recognizing the difference between the present and the past and then trying to assume the perspective of the figure in study. It relies on three different factors that must work together in order for one to achieve meaningful historical empathy. According to Endacott and Brooks (2013), historical empathy relies on three interconnected factors. The first is historical contextualization: recognizing the time difference and understanding of the norms of the time period in study. The second is perspective taking: understanding another's experiences, attitudes, and beliefs and how these things affect their decisions. The third is affective connection: consideration of the emotional reaction of the person being studied and similar responses in one's self (p. 43). Each of these are powerful tools in the Social Studies classroom individually but fail to reach the full potential of historical empathy when used separately.

As an example, when studying the Great Depression, a topic that is commonly taught is the New Deal, and more specifically, teachers usually cover the Works Progress Administration program. Historically, the New Deal was President Franklin D. Roosevelt's economic solution to the Great Depression. It consisted of significant spending on government projects, such as the Works Progress Administration, in order to get money to the people of the United States; this was expected to increase demand for goods, stimulating the economy. Currently in the U.S., some argue the New Deal was a waste of money and did not contribute to the ending of the Great Depression. Without getting into the arguments about the success of the New Deal, we can still use it as an example of how to foster historical empathy in terms of the three requirements.

In order to help students empathize those taking part in historical events, we must identify the three interrelated factors and how they apply to the event. Using the Works Progress Administration, a sub-topic of the New Deal, as the example, it is necessary for students to engage in historical contextualization and recognize the difference in time period between the present and the time of the Great Depression. They must know what the Great Depression was, what life was like before and during the time period, what events transpired prior to the establishment of the Works Progress Administration, and understand many other historical events and facts that give us our basis for understanding. Secondly, with perspective taking, students can take the perspective of individuals including the President, the chief policymaker of the period, and begin to investigate the position that he was in, stepping into his role and assuming his mindset. For example, President Roosevelt wanted to help the people by reviving the economy, and he had previous success with a similar program as governor of New York. Further, Roosevelt was under a great deal of pressure to fix the economy, pressure that came from his own political party as well as the American people. Students could also take the perspective of a Works Progress Administration worker. Students could look at the life of the worker and make a decision on whether or not the program was a solution for the worker's issues. Finally, through an affective connection, students begin to build an emotional connection between themselves and Roosevelt or other people from the time. They should think about how they would feel if in those positions. Students should have to face emotional questions such as how would it feel to have the power to fix the problems your people are dealing with or how it would feel to be a worker and find out that you get to go back to work. Stress, sympathy, and relief would be first in the emotional reactions and are something the learners can relate to. When engagement with all three factors is successful, students are likely to develop historical empathy.

This example only applies to one aspect of historical empathy through the perspective of Roosevelt or the workers. Historical empathy can further be fostered between students and other people taking part in events. This example is meant to begin answering the question, "what can I do in the classroom to foster historical empathy?"

Instructional Strategies to Foster Historical Empathy

Primary Sources

One instructional strategy that is of focus in history education is the use of primary sources in the classroom. Interpreting primary sources begins being taught early in history education and rightfully so. Primary sources are sources from the time period that historians use to come to conclusions about history. Getting such information in front of the students is helpful in completing the goals of history education, as well as meeting state and national standards. Moreover, in respect to historical empathy, Yeager, Foster, Maley, Anderson, and Morris (1998), found that exposure to primary sources yields the most gain in terms of developing historical empathy skills.

Yeager et al. (1998), contrated primary sources with textbooks to investigate the use of historical empathy in students. Their goal was to explore whether the development of historical empathy is an active process that is part of historical study (p.8). The results indicated that primary sources fostered historical empathy more than textbooks. To analyze the results, they read open-ended question to students, and found that students who had read the textbook restated the information from the textbook, and did not consider other perspectives or challenge the decisions that had been made in the relevant time period. In contrast, the primary source readers got to read various documents, all from different points of view. This led the students to open their thought process to interpretations from multiple perspectives and options the historical figure had and why they chose the one they did.

This is convenient for teachers because the use of primary sources is commonly part of the history education standards and these sources should therefore already be present in the classroom. Thus, few materials or resources would have to be added to the classroom in order to start purposefully developing historical empathy. The goal is not to discredit secondary sources, but throughout the research, primary sources tend to yield more favorable results in terms of historical empathy (Yeager et al., 1998; Endacott & Brooks, 2013).

Role-plays

Primary sources are great to use for literacy purposes, they provide raw information from the source. However, some students will learn better from hands-on strategies rather than literacy strategies. Endacott and Pelekanos (2015) conducted a case study in a seventh-grade classroom in which the teacher taught a unit on Ancient Greece and Athens. After learning about the Athenian government and culture, students were given a role and organized into the Athenian Senate, charged with making important decisions for the country. The teacher found that assigning students roles of actual people and making them research those individuals led student to be more engaged in class and to display more historical empathy on the assessment after the role-play was complete. Accordingly, this study suggests that history teachers can utilize role-playing as an instructional strategy for any period in history, and that role-playing is yet another useful strategy to foster historical empathy.

Writing

Writing is regarded as the most beneficial and easiest way to both develop and measure skills in historical empathy (Yeager et al., 1998; Downey, 1994, as cited in Brooks, 2008). Yeager et al. conducted a study in which the teacher gave one group of students multiple primary sources with varying perspectives and another group of students a popular high school social studies textbook, all with the topic of the end of World War II. After the students read their assigned readings, they were given open-ended questions to answer, such as "What forces affected Truman's decision?", and application questions such as, "You are charged with designing an exhibit over the bombings in Japan, what the exhibit would include?" (p. 4). Responses to the prompts showed positive results empathetic for those using primary sources, which they explained contributed to the student's ability to explain their thinking instead of feeling locked into a specific answer dictated by history textbooks. Because empathetic reactions are individual, in terms of historical empathy, giving students specific responses could block them in and limit their emotional reaction.

In order to foster historical empathy, question and prompts must therefore be tailored to activate an empathetic response by students. Such questions are usually open-ended allowing the student to develop their own answer without much restriction. Endacott and Brooks (2013), provide sample questions that teachers have used to foster historical empathy. The examples include questions that activate moral judgment like, "how do we determine what was right or wrong in the past?" or ask students to compare and contrast time periods (p. 54). Reflective questions are also asked to engage students in historical empathy. Another question asked, "how has our view of this historical situation changed over time?" (p. 54).

Conclusion

Historical empathy is a powerful skill in historical study and should be fostered in the classroom in order to increase historical understanding and engagement. Historical empathy may seem like something that develops naturally, but without teacher facilitation and the use of the proper resources, such as those mentioned above, students will not engage in historical empathy and will accordingly judge history from their current perspective and context (Yeager et al., 1998). To support historical empathy in their students, teachers can follow the model by Endacott and

Brooks (2013) which outlines the three requirements for historical empathy: historical contextualization, perspective taking, affective connection.

The development of historical empathy is shown to increase interest in historical topics and in return, increased grades that students achieved (Brooks, 2011). Without a focus on developing historical empathy, students are more likely to restate facts or copy direct quotes from the textbook instead of developing their own interpretations. Teaching skills in historical empathy and utilizing them in the study of history leads to a deep understanding of history and more fair judgments about historical figures, as well as more insightful understanding of historical events in the times and places in which they occurred.

References

Brooks, S. (2008). Displaying historical empathy: What impact can a writing assignment have? *Social Studies Research & Practice, 3*(2), 130-146.

Brooks, S. (2011). Historical empathy as perspective recognition and care in one secondary social studies classroom. *Theory & Research in Social Education, 39*(2), 166-202.

Cunningham, D. L. (2009). An empirical framework for understanding how teachers conceptualize and cultivate historical empathy in students. *Journal of Curriculum Studies, 41*(5): 679-709. doi: 10.1080/00220270902947376

Endacott, J., Brooks, S. (2013). An updated theoretical and practical model for promoting historical empathy. *Social Studies Research and Practice, 8*(1), 41-57.

Endacott, J., & Pelekanos, C. (2015). Slaves, women, and war! Engaging middle school students in historical empathy for enduring understanding. *Social Studies, 106*(1), 1-7. doi: 10.1080/00377996.2014.957378

Lee, H. (1960). *To kill a mockingbird.* Philadelphia: Lippincott.

Yeager, E. A., Foster, S. J., Maley, S. D., Anderson, T., & Morris, J. W. (1998). Why people in the past acted as they did: an exploratory study in historical empathy. *International Journal of Social Education, 13*(1), 8-24.

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Learning to Teach

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