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Learning to Teach

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

Editors in Chief
Jenny Denyer, Ph.D.
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A publication of the Department of Teacher Education
Jenny Denyer, Ph.D., Interim Chair | University of Toledo

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

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Section on Language Arts

Section on Mathematics

Section on Science

Section on Social Studies

Language Arts

Music and Literacy

Prioritizing Instrumental Music Education at the Middle School Level

Melissa Brown

Abstract: This paper explores the relationship between instrumental music training and literacy. Research shows that instrumental music training (such as band) has a positive impact on literacy rates and on learning in general. This relationship was not seen for choral studies but specifically for instrumental music education. When implemented correctly, music training supports the learning of students and boosts their reading levels. The quality of the music instruction also affects the outcomes. Through an exploration of these studies and their results, this paper argues that quality instrumental music training (i.e., quality band programs) leads to higher literacy rates, as measured by state test scores.

Introduction

While in Southeast Asia on a study abroad trip, I had the opportunity to attempt communication with many non-English speakers. In a music store in Vietnam, I encountered a young man who spoke no English. Since I spoke no Vietnamese, we attempted to communicate with a language we were both familiar with—music. The young man began playing a familiar American tune on a flute from the shop, and a connection was made. It is very easy to discount the importance of music until that is the only common language that you share with another person. In this situation, the dialogue was with someone who spoke a foreign language. Likewise, in conversations between teachers and students it can sometimes feel as though two different worlds are being bridged and two different languages are being spoken. Music can serve as that bridge between worlds.

As an educator in the field of language arts, one of the issues I face is the low reading levels of my students. Unfortunately, this issue is not limited to students within my school, nor is it limited to students living within my district. Poor literacy skills are a common problem across the country. Low literacy levels can affect students in every subject area and can lead to student frustration in school, as students who cannot read struggle to catch up to their peers. As a result, according to Hernandez (2011), "One in six children who are not reading proficiently in third grade do not graduate from high school on time, a rate four times greater than that for proficient readers" (p. 3). Not only do those reading below the level of proficient have trouble graduating on time, but as Hernandez states, "The rates are highest for the low, below-basic readers: 23 percent of these children drop out or fail to finish high school on time, compared to 9 percent of children with basic reading skills and 4 percent of proficient readers" (p. 3). The importance of literacy is clear: Students with low literacy levels are less likely to graduate from high school.

With all the content that language arts educators are required to teach, if other educators can reinforce or assist in teaching reading skills or closing the gap between

those reading below proficient levels and those who are not, this burden can be lessened. Music education may have the answer. According to Weidner (2013), "literacy has become less about the actual act of reading and more about the constituent skills that are required to be a literate individual" (p. 55). It is important to examine the implications of that statement relating to various disciplines outside of English language arts (ELA). If literacy includes skills that can be taught in fine arts, for example, this can ease the strain on language arts educators and can give struggling readers an opportunity to catch up to their peers.

Additionally, educators strive to tailor their lessons and classroom activities to fit the interests of their students. Resources like Flocabulary exist to appeal to students' appreciation of rap music as well as to create catchy rhymes with which students acquire new vocabulary. Music motivates students to learn, and it can motivate them to become better readers. Not only will this motivate students, but also studies, such as that done by Johnson and Memmott (2006), have demonstrated the link between instrumental music training (such as in band or orchestra programs) and increased test scores at the middle school level. Instrumental music study over time has been linked to changes in the brain that can impact reading (Hansen & Milligan, 2012). Instrumental music training leads to higher test scores and changes to the brain that cannot be ignored by educators. Band and orchestra programs should be a priority in both elementary and music education.

Music and the Brain

In order to address the connections between music education and literacy, it makes sense to begin by examining the connections between how the brain processes music and how it processes language. For early readers, spoken language is extremely important to the development of literacy. "Children who enter school with weaker verbal abilities are much more likely to experience difficulties learning literacy skills than those who do not" (Roth, Paul & Pierotti, 2006, para 2). This means that without these fundamental language skills, children will already be at a disadvantage. According to the studies that cited below, instrumental music training impacts the brain in a positive way, leading toward higher benefits in core subjects.

Hansen and Milligan (2012) explained, "Music training influences auditory discrimination, the ability to discern nuance in sound" (p.76). They stated that the brain changes as a result of music training, which in turn affects language development. The authors referenced a study completed by Schlaug, Norton, Overy, and Winner, who looked at the differences in overall brain development after instrumental music training. In this study, the researchers were attempting to determine if differences in brain development seen in adult instrumental musicians were something that developed "as a result of musical training during sensitive periods of brain development" or if this existed prior to music training (Schlaug, Norton, Overy, and Winner, 2005, p. 222). To determine if these brain changes were a result of music training, the researchers completed various ability tests as well as brain scans on children aged five to seven years. After one year of music training, the researchers reported that children in the experimental group showed higher scores on some of the behavioral tests—fine motor and auditory discrimination skills—and other tests showed

"trends in the anticipated direction" (p. 224). In addition, brain data did show some changes in the experimental group that were not present in the control group.

Because their study showed only "trends," Schlaug, Norton, Overy, and Winner (2005) also added a second age group to their study to determine if these trends would continue. In this second study, the same tests were completed on students aged nine to eleven who had already undergone four years of instrumental music training. They compared their behavioral test results and brain changes to a control group of students who never received music training. Overall, the study showed that the trends seen in the initial study with young children increased with age. The connection between instrumental music training and the effect on the brain was apparent. As Hansen and Milligan (2012) also stated, there was a link between this part of the brain and how it processes sound as well as how it processes language.

Music and Phonological Awareness

In addition to research on the influence of music in language development and its effects on the brain, it is important to examine the link between music and phonological awareness. This relates to how we break down the individual sounds we hear when learning a language. Hansen and Milligan (2012) state that, "internalizing and discriminating sound is a process that is common and foundational to both" music and reading (p. 76). For young children, a lack of phonological awareness can greatly affect their ability to decode or "sound out" words. Hansen and Milligan explained the connections between music and language learning, specifically relating to phonological awareness in early readers. Both music and language, they propose, are connected to listening: young children are involved in the early reading process prior to beginning to decode words. Additionally, "while researchers cannot determine exactly what aspects of musical training cause these advantages for musicians, they encourage musical training in schools with opportunities for auditory training for people with and without speech-encoding deficits" (p. 77).

Since research has solidified the connection between music training and reading, some educators have worked to combine the two to enhance the learning of students. Standley and Hughes (1997) worked to create a specialized music and pre-reading/pre-writing program to be used as an intervention for four and five-year-old children with disabilities. The music sessions included in this curriculum were successful in improving the reading and writing of the students involved. The program was then adapted for a study done in Quebec. Bolduc (2009) sought to confirm other studies that found links between phonological awareness and music by implementing a music curriculum from Standley and Hughes' program (1997) that was adapted to fit the kindergarteners in the study. Over the course of 15 weeks, 104 children with similar backgrounds were put into either the adaptation of Standley and Hughes' music program (experimental group) or followed curriculum issued by the Quebec Ministry of Education (control group). According to Bolduc (2009), this had some similarities in the music instruction to Standley and Hughes' program, but Standley and Hughes' music program (1997) was specifically tailored to aid with pre-reading and pre-writing skills in children. The results showed a significant difference in the growth of phonological awareness--the experimental group showed

higher improvement in this area. The data demonstrated that this music education program benefitted students learning to read and write.

Music and Older Students

At the middle and high school levels, reading standards focus on reading comprehension and texts that are more complex that are age-appropriate. In order to fully examine how music education impacts literacy, research done with older students should be examined. The issue then becomes more complex because general music classes are not always required for middle and high school students. Instead, students often have the option to enroll in band/orchestra, choir, or discontinue their study of music. In addition, research conducted with older students regarding literacy is also primarily focused on state test scores, as these are readily available and consistent across state borders in the United States. Johnson and Memmott (2006) and Kinney (2008) looked at the connections between these state test scores and involvement in music programs. Kinney looked at achievement test scores for middle schoolers at a Midwest metropolitan area to determine if band or choral participation impacted these scores. Participants in the study included students in grades six (273 students) and eight (215 students) from two schools labeled "in need of improvement." The study found two things. First, students who participated in the choral program did not demonstrate a difference in achievement when compared to students who did not participate in a music program, and second, students in the band program showed greater improvement in achievement scores overall. However, Kinney cautioned that "higher test scores before students' enrollment [in the band program] indicates that band may attract higher achieving students from the outset" (p. 8). Despite the suggestion that higher achieving students may be attracted to band or orchestra programs, the evidence that instrumental music training creates changes in the brain implies otherwise.

Examining over 4,000 older elementary and middle school students, Johnson and Memmott (2006) looked at the relationships between state test scores (math and English) for students across the country and the quality of the music programs at their schools. Music education professors at universities located in each respective region of the country identified which schools had "exemplary" and which had "less than ideal" or "deficient" music education programs. At the elementary level, 1,119 third and fourth grade students were put into two groups that were based on the quality of the music program at their schools. The researchers then compared this data to students' state test scores for the 2004-2005 school year. At the elementary level, the researchers found that, although the West coast region generally had lower English test scores for schools with a higher-quality music program, the overall results for all regions indicated that schools with better music programs had 22% better English test scores than schools with lower quality music programs.

At the middle school level, Johnson and Memmott (2006) examined other variables in addition to the quality of their school's music program. All students were either coded as "instrumental," "choral," or "non-music" students. Furthermore, some of the schools selected had high-quality band programs but lower-quality choral programs, so additional categories were added for this difference. With 3,620 eighth and ninth grade students involved, the data showed:

> Students at schools with excellent music programs generally performed better on standardized tests than students at schools with lower-quality music offerings. Students at schools with poorer instrumental programs outscored the students who had no music at all, and the students who participated in poor choral programs scored the worst in every region. (para 23).

The findings suggest that music programs at the elementary and middle school levels influence students' reading test scores, but choral programs do not follow the same trends as instrumental music programs.

Conclusion

Due to the existing connections between instrumental music education and language learning, phonological awareness, and increased test scores, instrumental music education should be prioritized at the middle school level. For language arts educators who are struggling to teach students who are reading below grade level and do not have additional instruction time to help these students, music education may be part of the answer. Bolduc (2009) suggested that improvement in reading is demonstrated by young children in music education programs, but for those students who have not had the same music instruction and are now older, there may still be a benefit to studying music. If students can be encouraged to study music over time, particularly by learning to play an instrument, this may improve their overall reading and writing skills. Additionally, using music programs that are tailored to reading and writing like that used by Standly and Hughes (1997) can offer those benefits while not sacrificing music as a fine art content area.

With a focus on quality music education at a young age, particularly on programs designed to include reading and writing, language arts educators are likely to see an improvement in literacy. Schools should be encouraged to make instrumental music a bigger part of their core academics at the middle school level, and higher quality instrumental music programs should be prioritized. Not only do music programs providing students a creative outlet, but they also make them better overall students with stronger literacy skills. Learning is the goal educators have for their students, and quality instrumental music programs may be a valuable support.

References

Bolduc, J. (2009). Effects of a music programme on kindergartners' phonological awareness skills. *International Journal of Music Education, 27*(1), 37-47.

Hansen, D., & Milligan, S. (2012). Aural skills: At the juncture of research in early reading and music literacy. *Music Educators Journal, 99*(2), 75-80.

Hernandez, D. J. (2011, April 01). Double jeopardy: How third-grade reading skills and poverty influence high school graduation. The Annie E. Casey Foundation. Retrieved April 5, 2019, from https://www.aecf.org/resources/double-jeopardy/

Johnson, C. M., & Memmott, J. E. (2006). Examination of relationships between participation in school music programs of differing quality and standardized test results. *Journal of Research in Music Education, 54*(4), 293–307.

Kinney, D. W. (2008). Selected demographic variables, school music participation, and achievement test scores of urban middle school students. *Journal of Research in Music Education, 56*(2), 145–161

Roth, F. P., Paul, D. R., & Pierotti, A. (2006). Emergent literacy: Early reading and writing development. Retrieved from https://www.asha.org/public/speech/emergent literacy.htm

Schlaug, G., Norton, A., Overy, K., & Winner, E. (2005). Effects of music training on the child's brain and cognitive development. *Annals of the New York Academy of Sciences, 1060*(1), 219-230.

Standley, J. M., & Hughes, J. E. (1997). Evaluation of an early intervention music curriculum for enhancing prereading/writing skills. *Music Therapy Perspectives, 15*(2), 79–85.

Weidner, B. (2013). Supporting common core reading literacy in the music performance classroom. *Illinois Music Educator, 73,* 55-59.

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Melissa Brown currently teaches middle school English language arts and drama in the Toledo area. She graduated from the University of Michigan-Dearborn with a Bachelor of Science in political science then went on to complete her teaching licensure through the LAMP (Licensure and Master's Program) program at the University of Toledo.

Culturally Relevant Pedagogy in the English Language Arts Classroom

Rebecca Cook

Abstract: Teachers of all subjects face one common problem: student engagement. Because students need to be engaged to effectively learn, teachers need to know the best way to engage students in learning. In the English Language Arts classroom, teachers are faced with the problem of engaging students in reading texts that are sometimes not interesting or relevant to their lives. These teachers are tasked with finding ways to make these texts more engaging, or deciding to use more culturally relevant texts. Research has found that culturally relevant texts and teaching methods engage and therefore more effectively teach students. How can teachers make canon texts more culturally relevant to students and how can teachers use culturally relevant texts to teach their students?

Introduction

Throughout the school year, there are approximately 180 days teachers have with students to teach them their content. During these 180 days, students have roughly an hour a day to study English Language Arts. Considering the limited amount of time teachers have with their students, it is important to carefully choose which texts best fit the curriculum and will make the most impact on the students. So, what kinds of texts do teachers need to use in order to engage students effectively? Often, teachers stick to canonical literature because it is what is most commonly taught. However, research has shown this may not always be the most effective way to teach literature, because such texts may not be relevant or engaging for their students. Another way that teachers can instruct on literacy is by introducing culturally relevant literature and pedagogy into the English language arts classroom. This particular methodology has many benefits for student engagement and success.

Culturally Relevant Pedagogy

Research suggests that the best way to engage students is through culturally relevant pedagogy. Gloria Ladson Billings (1995) describes culturally relevant pedagogy as "a theoretical model that not only addresses student achievement but also helps students to accept and affirm their cultural identity while developing critical perspectives that challenge inequities that schools (and other institutions) perpetuate" (p. 469). The use of culturally relevant pedagogy in the classroom helps increase engagement, and therefore increase the effectiveness of teaching; it has been shown to be linked to greater student engagement as well as improved standardized test scores (Harbour, Evanovich, Sweigart & Hughes, 2015). Harbour and colleagues found that when teachers effectively engage students, they have a higher level of achievement and are more successful. This means students need to be engaged in order to learn. Because students are more engaged when being taught with work

that is relevant to them, a culturally relevant approach offers a more effective way to teach.

Culturally Relevant Literature

Culturally relevant pedagogy can be taught with either culturally relevant literature or canonical literature. Researchers Tanya Christ and Sue Ann Sharma's (2018) work on culturally relevant practices found that culturally relevant pedagogy supports "students' motivation, engagement, literacy outcomes, and positive identity formation" (p. 55). They specifically studied this in regards to literature instruction. They looked at knowledge of the students' cultures, attention to text selection, and the use of culturally relevant texts and pedagogy combined. They evaluated lesson plans, reader responses and reflections to measure whether or not the students were learning the material more effectively. They found that culturally relevant pedagogical practices improve student learning "because they help students anchor to their identities and personal experiences via a specific subset of prior knowledge" (p. 58). Using culturally relevant pedagogy to guide teaching instruction helps improve motivation, engagement, and student outcomes.

One specific successful practice that was studied was the selection of culturally relevant texts. Teachers used students' self-reflections to improve their ability to engage in culturally relevant pedagogy and to select culturally relevant texts (p. 66). They found that by doing so the teachers learned more about their students' cultures and came to recognize that cultural relevance is an important aspect to consider when instructing students. This is an important insight because of the importance of student engagement; by choosing culturally relevant texts for them to read, the teachers increased their engagement and the students were therefore more likely to learn the content that the text and teacher are trying to teach.

For example, one teacher in this study chose the book "Maniac Monkeys on Magnolia Street" by Angela Johnson. She selected this book for an African American student. She did this by considering several dimensions of her student's culture and identity (including race, dialect, and age) in relation to those of the character in the book, as well as considering the situations the characters were going through. She also asked the student questions about herself to determine the story's relevance (p. 66). The teacher found that her student was able to connect with the literature and was able to successfully respond to multiple dimensions of the novel because of the cultural relevance to the student (p. 67). This anecdote and the larger study suggest that culturally relevant pedagogy and culturally relevant texts both need to be present in the English Language Arts classroom in order for students to achieve at high levels. This conclusion is supported by the sixteen other preservice teachers in the study who had similar outcomes with their students when they implemented culturally relevant pedagogy into their classrooms.

Culturally relevant literature is a way to get students engaged in literacy learning. A study conducted by Clark (2017) also looked at the impact of culturally relevant literature on African-American struggling readers. This study examined the achievement of these children for ten weeks in an after-school reading program. This program presented tested three different types of text usage: the first used culturally relevant texts, the second non-culturally-relevant texts, and the third used culturally

relevant texts intermittently. The purpose of this study was to examine how reading comprehension might be improved or worsened by the use of culturally relevant texts.

Clark (2017) found that the students who had read culturally relevant texts demonstrated significantly greater comprehension than the students who read the non-culturally-relevant texts, or those who read them intermittently. Clark also found that the students who read culturally relevant texts improved their word recognition skills at much higher rates than those in the other groups. Overall, this study supports the theory that culturally relevant teaching is beneficial to student learning and helps improve comprehension. This study also shows that culturally relevant texts can promote higher achievement for African-American children and strongly suggests the importance of considering student culture when teaching literature.

Canonical Literature

It is also worth looking at how to make canonical texts more culturally relevant for students. Because some canonical novels cannot be replaced, whether due to budget constraints, standards, or district practices, teachers need to know how to implement culturally relevant teaching practices while teaching canonical literature to students. Even though research has shown that culturally-relevant texts are better at engaging students, canonical literature can be taught using culturally- relevant pedagogical practices to ensure that students are being taught in the most engaging way possible.

Borsheim-Black, Macaluso, and Petrone (2014) describe canonical literature as a group of texts that may evolve over time but it is widely and commonly taught. They argue that canonical texts "perpetuate ideologies that are also dominant—about Whiteness, masculinity, heterosexuality, Christianity, and physical and mental ability" and that these types of ideologies are often left unquestioned and unexamined when these works are taught, which has the effect of privileging some while marginalizing others. Because canonical literature is so widely taught, and because the traditional ways of teaching this literature can support these problematic ideologies, it is important for ELA teachers to incorporate culturally relevant practices while teaching these works of literature.

Bright (2011) studied how to use canonical literature in different ways, and in particular how to use intertextuality to generate interest in the literature. Bright quotes Gallo (2001) "Typically, books classified as canonized literature are recommended for use in high school curricula, fulfilling an expectation that teens read what is considered to be "great" literature. The reality is that "for the most part, canonized novels deemed suitable for adolescents and young adults by teachers and curricula are not relevant or interesting to young readers" (p. 39). Bright suggests that an intertextual approach to teaching canonical literature can help surmount this problem. She defines intertextuality as incorporating one or more texts for the students to read before reading the canonical literature to better prepare the students for the canon literature they will encounter. Her research suggests that if a teacher is going to teach canonical literature, they need to consider using parallel texts to introduce the themes in order to generate interest in the novel before reading. Otherwise, as Harbour, Evanovich, Sweigart and Hughes (2015) found in their research,

students will likely not be engaged, and therefore will not effectively learn very much from reading the literature.

Since the question, "which texts are more effective to teach between canon literature and culturally relevant literature" seems to lean towards culturally relevant teaching, my follow up question is "how to teach canon literature in a culturally relevant way." Research done by Simon (2008) offers another approach to teaching canonical literature. She suggests scaffolding student experiences with canonical texts. Simon begins by showing the need for such scaffolding. In an interview with a student, the student was asked about her experiences with canonical literature. The student stated that she never connected with Great Expectations by Charles Dickens, a popular canonical novel. Because of the disconnect, she ended up failing the class and felt discouraged from reading other literature. This implies that there are detrimental consequences from requiring students to read canon literature without first scaffolding and providing more authentic and engaging learning opportunities.

Simon researched student's comprehension and engagement using the text The House of Mirth by Edith Wharton. She had them read the first scene and asked them to note the sensory details, and found the students' responses unenthusiastic. She asked students to reflect on what they had read, and received feedback including "what a drag it was to open that book," and "the cover alone turned me off" (p. 136). Simon surmised that their lack of enthusiasm was because the book did not reflect their experiences. She then introduced activities like role-playing and activities to build background knowledge as part of her students' pre-reading. After engaging in these activities, students showed an understanding of the topic and characters, and an interest in reading the book. They also noted that it made the text more real. One student was quoted saying, "I was eager to read the story to find out which of the characters symbolized the roles we played." Students initially had not engaged with the story because of their lack of knowledge about how this text might be relevant to their own experiences of poverty, race, religion, and class. After implementing culturally relevant teaching practices, students were able to identify points of contact with the text. Where earlier the students had missed key points of the story, after the culturally relevant activities, students reported that they felt as if they had entered into the story and were able to see the story instead of just reading it. As one student stated, "It made me see the character's view… Before I had only seen them from my own readings and my own understanding of the book."

At the end of her teaching of the novel, Simon (2008) asked students to complete a final reflection. In this reflection, the students' responses were more positive. Simon saw these responses as a demonstration of how role-playing can be used to engage students to learn about canonical literature. This research goes to prove that providing engaging activities to go along with canonical literature is more effective than having the students cold-read such literature.

How to Use Canonical Literature as a Historical, Cultural, and Social Teaching Tool

Another way to engage students in reading canonical literature while also incorporating cultural relevance is explored by Maher (2013). Maher presents a method of teaching the canonical novel To Kill a Mockingbird as a resource for teaching about

the school-to-prison pipeline. The goal is to not only understand To Kill a Mockingbird, but to also understand a larger issue and to make the students more culturally, socially, and historically aware. Maher's approach engaged four different aspects of culture, which she explored through linkages to the novel: single parent homes, lynching and racial discrimination, the criminal justice system, and poverty. To gauge student engagement, Maher observed her students and had them complete reader response journals. For each subject, Maher worked to generate interest and provoke thought about that aspect of culture. For example, to engage the subject of single fathers raising children, Maher showed clips from Finding Nemo, The Pursuit of Happyness, and from the film version of To Kill a Mockingbird. This method involved the students in understanding a real problem in the country and made them more culturally and socially aware. The subject of prisons and incarceration was connected to racial discrimination, which allowed the students to become more historically aware of America's past in relation to racial discrimination, incarceration and lynching. The responses of Maher's students showed the strong feelings and engagement this approach generated, "Our world is so messed up! I don't know why God lets things like this happen," wrote one student, while another wondered "Who could possibly have that much hatred in their heart, killing human beings like that!" (p. 48). These responses show that the students were deeply engaged and affected by what they read and discussed. Maher also connected this topic to schools' zero-tolerance policies, which disproportionately affect African-American students (p. 48). Again, this brought real-world cultural relevance into the classroom.

Maher (2013) found that such an approach led students to be more engaged in classroom activities and to be able to write insightfully about the literature because of the cultural approach to the novel. Using canonical literature in a cultural, historical, and social way led them to think more deeply about the world around them.

Conclusion

Culturally relevant pedagogy is important for teachers to practice to be more effective and engaging educators. Whether they are practicing this pedagogy by using culturally relevant texts or canonical texts, it is important to keep in mind their students' backgrounds, cultures, religions, etc. By doing this, teachers can more effectively teach their students in meaningful ways and increase the success of their students.

References

Borsheim-Black C., Macaluso, M., & Petrone, R. (2014). Critical literature pedagogy: Teaching canonical literature for critical literacy. *Journal of Adolescent & Adult Literacy. 58*(2), 123-133.

Bright, A. (2011). Writing Homer, reading Riordan: Intertextual study in contemporary adolescent literature. *Journal of Children's Literature, 37*(1), 38-47.

Christ, T. & Sharma, S. A. (2018). Searching for mirrors: Preservice teachers' journey toward more culturally relevant pedagogy. *Reading Horizons, 57*(1), 55-73.

Clark, K. (2017). Investigating the effects of culturally relevant texts on African American struggling readers' progress. *Teachers College Record, 119*(6), 1-30.

Harbour, K., Evanovich, L., Sweigart, C. & Hughes, L. (2015). A brief review of effective teaching practices that maximize student engagement. *Preventing School Failure, 59*(1), 5–13.

Ladson-Billings, G. (1995a). Toward a theory of culturally relevant pedagogy. *American Educational Research Journal, 32*(3), 465-491.

Maher, S. C. (2013). Using "To Kill a Mockingbird" as a conduit for teaching about the school-to-prison pipeline. *English Journal, 102*(4), 45-52.

About the Author

Rebecca Cook recently earned her master's degree in middle childhood education from the University of Toledo focusing in English language arts and social studies. She received her Bachelor of Arts with a major in history from the University of Toledo as well.

The Benefits of Bilingualism

Rachel Farhan

Abstract: More people are becoming bilingual and the research suggests that it is worth the time and effort to do so. Neurological and academic research suggests that being bilingual has many benefits, including supporting a sense of community and accomplishment. Research has shown that bilingualism at an early age has neurological and academic benefits. Neurological benefits include contributing to the plasticity of the brain and to an increase in brain activity and offering cognitive advantages. Academic benefits include contributing to a larger capacity for short-term memory and advantages linked to literacy. The earlier a second language is learned, the earlier these benefits manifest; thus, learning another language has lasting effects that can carry on throughout a child's education and life.

The Benefits of Bilingualism

Imagine going to a country in Europe, such as Italy, and taking part in the way of life there, being immersed in the culture, the community, and the language of the people, feeling a part of it and enjoying yourself there. That's what being bilingual can do for you. Bilingualism is fluency in two or more languages. Being bilingual can be rewarding and useful, and it's good for the brain. Researchers have found that globally, more people are bilingual than monolingual (Marian & Shook, 2012). Marian and Shook report that "even in the United States, which is widely considered monolingual, one-fifth of those over the age of five reported speaking a language other than English at home in 2007" and that "millions of Americans use a language other than English in their everyday lives outside the home, when they are at work or in the classroom" (p. 1). Despite the increasing numbers of those who are bilingual, learning a new language takes time and effort, and sometimes isn't prioritized by parents or by schools. Yet, developing another language should not be put off until the later grades, it can begin in elementary school. Bilingualism at an early age has neurological benefits and can help with academics as well as with personal development in the classroom.

Learning a Language Early

The earlier a child learns another language, the greater the benefits (Burlacu, 2018; Marsh, 2000). Children have an enthusiasm for learning and they can learn languages faster and more easily than adults. Teachers can use a child's first language to help with the learning of a second language. Learning a second language early allows children to develop greater fluency as well as a smooth, natural accent. As they master a new language, they also gain confidence and a feeling of accomplishment. Along with this, bilingualism opens up job opportunities and is a selling point for colleges making it a great addition to a resume or college application. An early start allows for longer second-language education, which increases the likelihood of an individual becoming fluent in a second language (McLaughlin, 1992).

According to research, learning becomes more difficult with age, so learning early results in the most benefits. One large-scale study conducted with approximately 670,000 participants found that the critical period for learning a language is by age 10; after this period, it gets harder. Those under 18 were also able to learn a second language well, although not as easily as those under 10. Those who began learning a second language after the age of 18 were much less likely to reach proficiency (Andrei, 2018; Burlacu, 2018; Gander, 2018). Further research has supported this finding; research using brain scans has also found that the capacity to learn a language decreases over time. Sousa (2011) has also argued that the best time to learn a second language is early in life. Children can still learn languages during adolescence, but as Sousa (2011) explained:

> the window of opportunity for acquiring language within the language-specific areas of the brain diminishes during the middle years of adolescence. Obviously, one can still acquire a new language after this period, but it takes more effort because learning the L2 recruits brain regions not generally involved in native language acquisition. Furthermore, PET scans show that when children grow up learning two languages, all language activity is found in the same areas of the brain. But those who learn a second language at a later age show that the two language areas are spatially separated (p. 31).

The factors affecting such learning have not yet all been determined; for example, it may be that younger brains have more flexibility to learn a second language (McLaughlin, 1992), but it has been hypothesized that it is easier for children to learn a second language because they have more time and effort to learn (Schmid, 2016).

Benefits of Bilingualism

Neurological Benefits

Knowing more than one language has positive effects on the brain (Espinosa, 2018; Jasinska & Petitto, 2018; Marsh, 2000). Bilingualism has been tied to competency in speaking, reading, and writing in both languages. It carries linguistic and cognitive advantages and is valuable in later school years and life. Learning another language helps develop thought processes in the brain, and also support learning more broadly. Research has shown that bilingual learners have cognitive advantages over monolingual learners in terms of both verbal and nonverbal reasoning, as well as greater cognitive flexibility (Jasinska & Petitto, 2018).

Bilingual learners' brains have been shown to have better attention-focusing and task-switching abilities. Bilingual learners can easily switch between their first and second languages and speakers can rapidly adjust to changes in language situations (Marian & Shook, 2012). For example, a Spanish-speaking student learning English can speak Spanish on the playground with friends yet switch with ease to English with in the classroom. Using brain scans, researchers have found that bilingualism is associated with improved executive function, such as attention-focusing and the inhibition of inappropriate behavior (Kovelman, Baker, & Petitto, 2008;

Marian & Shook, 2012). In addition, using functional Magnetic Resonance Imaging (fMRI) to see which brain regions are active when completing tasks that require switching between the two languages, these researchers found that bilingual learners had stronger cognitive abilities; bilingualism was associated with broad effects on neurological functions, such as control mechanisms and sensory processes, along with improved metalinguistic awareness, memory, and creativity.

Another study found that early and proficient bilingual learners had larger inferior parietal cortexes, which are linked not only to language learning but also to mathematical ability and the ability to read emotions, perhaps due to overlapping and similar neural activations across the two languages (Kovelman, Baker, & Petitto, 2008). Additionally, fMRI showed activation in the right temporal and parietal lobe regions of the brain, suggesting that bilingual learners learn languages at the same time and can switch back and forth between the two; thus focusing on learning a second language does not interfere with learning one's first language (Sousa, 2011).

fMRIs have also showed that the brains of bilingual and monolingual learners processed language in similar ways. In both groups the language areas of the left hemisphere activated when language was spoken. In addition, both monolingual and bilingual learners had a similar increase in brain activity in the left hemisphere when speaking one language. However, when bilingual learners used both languages, they showed increased brain activity in both left and right hemispheres (Sousa, 2011). Based on this research Sousa has argued that bilingualism builds neural networks and cognitive control, and that bilingual leaners can easily transfer learning from one language to another.

Academic Benefits

Beyond neurological benefits, bilingualism can have positive effects on academic achievement and personal growth and development. Cook (2001) argues that for bilingual learners, the two languages are blended in the mind in all areas: vocabulary, syntax, phonology, and pragmatics. As a result, bilingual learners are more flexible in their thinking and can code-switch in both languages at the same time; easily moving from one language to the other another. As Cook explained, "code-switching is a highly skilled activity" (p. 10), one which helps individuals rapidly switch between discourses beyond language (for example, from learning English to learning math). For this reason, Cook argues that being bilingual can improve a mind cognitively, emotionally, and socially.

Many researchers have explored the positive academic effects of bilingualism (Espinosa, 2018; Marsh, 2000; McLaughlin, 1992). They have found that for students studying a second language, the first language acts as a bridge to improved learning in the second language, and that such students typically have more positive attitudes toward school. Early exposure to a second language related to better language skills in that second language. Moreover, bilingual learning enabled children to avoid falling behind and improved academic outcomes in school. Research has also shown that often bilingual learners outperform monolingual learners (Jasinska & Petitto, 2018; Marian & Shook, 2012). As Jasinska & Petitttto (2018) have described,

> Early exposed bilingual children showed better performance on measures of phonological awareness relative to monolingual children, their increased pho-

> nological skills were the strongest predictor of reading skill, and they outperformed their monolingual peers on reading tasks. The bilingual child has exposure to phonological systems in two languages and must differentiate between those two languages from an early age. This dual language experience may support the bilingual child's perceptual learning of phonological categories and ability to discriminate phonemes (p. 326).

Further, they argued that their linguistic exposure provided a literacy advantage. Bilingual learners also tended to perform better on tasks that required conflict management, suggesting that the benefits of bilingualism extend beyond the academic into the social realm.

Beyond this, researchers found an association between the range of a bilingual learner's first language (Spanish) vocabulary and the second language (English) fluency of those individuals (Proctor, Carlo, August, & Snow, 2006). Students who were the fastest readers in English seemed to benefit from possessing a broad Spanish vocabulary.

Both Sousa (2011) and Teale (2009) have found that bilingual learners' knowledge of their first language helps them when learning to read English and contributes to their academic achievement. Teale found that for bilingual learners, literacy skills like phonological awareness and decoding developed quite fully (to mastery) in relatively short periods, and that this typically happened at an early age. Thus, their research suggests that when a second language is spoken regularly, it has lasting effects on the mastery of grammar and phonology in one's first language. Supporting this, Gil & Bardack (2010) found that students in bilingual programs outperformed those in monolingual programs in academic achievement across curriculum after four to seven years of dual language instruction. Research on students studying in dual-language programs has also shown that for those students English is learned at the same time as for those students enrolled in English-only programs and that dual-language students demonstrated a higher level of academic achievement.

Additional research supports these findings. For example, in a study conducted at York University in Canada suggested that bilingual learner's second language knowledge gave them an advantage in learning to read (Helen Doron English, 2013). Neurologically, bilingualism flexes brain muscles and builds them up. It promotes greater density of gray matter in the brain, which is responsible for processing information, including memory, speech, and sensory perception. A final positive example of bilingualism is higher test scores; bilingual learners were found to perform better than monolingual learners on many standardized tests, such as the SAT (Helen Doron English, 2013).

Next Steps

Given the many positive effects of bilingualism, what can be done to help bring bilingual learning into the classroom? One important implication is that the first language of students enrolled in ESL programs should be seen as a strength rather than as a weakness, and that these students should be taught in ways which encourage them to develop true bilingualism. For example, Cook (2001) suggested the importance of using students' first languages positively, such as for testing and for

translation, or the use of one language for part of the day and the other language for the other part of the day. Other researchers have suggested the importance of intentionally use both languages to promote proficiency (Espinosa, 2018; Marsh, 2000). To do this, teachers should pay attention to the exposure and quality of teaching in each language. Teachers can learn strategies to help second-language learners comprehend, develop oral language, and progress in English language development. It is important to bridge the two languages by using visual aids and multi media to help with comprehension and to give these students the chance to get instruction and real-life situations to help them master both their languages. The greater the proficiency in the first language, the better the chance of acquisition and proficiency in a second language (Sousa, 2011). There is broad agreement among researchers that if skills in one's first language are strong it offers a strong foundation to build second language acquisition, and this should be made clear to all of those working within education, from administrators to teachers to pre-service teachers (Pufahl, Rhodes, & Christian, 2001).

Conclusion

Research has shown that bilingual learning at an early age has neurological benefits and can help with academic learning and personal growth and development. Schools should offer second language education from an early age, and should encourage bilingual and ESL learners to use both of their languages for better academic achievement. The earlier the exposure to and acquisition of a second language, the longer lasting positive effects it can yield. In addition, ESL students should be offered education in both their first and second languages; the research shows that supporting them in this way encourages bilingual learning with all of its benefits.

References

Andrei, M. (2018, May 01). Science shows what's the best time to learn a foreign language. *ZMEScience*. Retrieved from https://www.zmescience.com/medicine/mind-and-brain/when-learn-foreign-language-01052018/

Burlacu, A. (2018, May 02). What's the best age for learning a new language? *Techtimes*. Retrieved from https://www.techtimes.com/articles/226621/20180502/whats-the-best-age-for-learning-a-new-language.htm

Cook, V. (2001). Using the first language in the classroom. *Canadian Modern Language Review, 57*(3), 402-423. doi:10.3138/cmlr.57.3.402

Espinosa, L. M. (2018). Encouraging the development and achievement of dual language learners in early childhood. *American Educator, 42*(3), 10-12.

Gander, K. (2018, May 02). Scientists have pinpointed the best age to learn a second language. *Newsweek*. Retrieved from https://www.newsweek.com/scientists-pinpoint-best-age-learn-second-language-907505

Gil, L., & Bardack, S. (2010). Common assumptions vs. the evidence: English language learners in the United States: A reference guide. *PsycEXTRA Dataset*. doi:10.1037/e537552012-001

Jasinska, K. K., & Petitto, L. (2017). Age of bilingual exposure is related to the contribution of phonological and semantic knowledge to successful reading development. *Child Development,89*(1), 310-331. doi:10.1111/cdev.12745

Kovelman, I., Baker, S. A., & Petitto, L. (2008). Bilingual and monolingual brains compared: a functional magnetic resonance imaging investigation of syntactic processing and a possible "neural signature" of bilingualism. *Journal of Cognitive Neuroscience, 20*(1), 153-169. doi:10.1162/jocn.2008.20.1.153

Marian, V., & Shook, A. (2012). The cognitive benefits of being bilingual. Cerebrum: *The Dana Forum on Brain Science, 2012*, 13. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3583091/

Marsh, D. (2000). *Using languages to learn and learning to use languages: An introduction to content and language integrated learning for parents and young people*. Jvyäskylä: University of Jvyäskylä.

McLaughlin, B. (1992). *Myths and misconceptions about second language learning: What every teacher needs to unlearn*. Santa Cruz, CA: National Center for Research on Cultural Diversity and Second Language Learning.

Proctor, C. P., August, D., Carlo, M. S., & Snow, C. (2006). The intriguing role of Spanish language vocabulary knowledge in predicting English reading comprehension. *Journal of Educational Psychology, 98*(1), 159-169. doi:10.1037/0022-0663.98.1.159

Pufahl, I., Rhodes, N. C., & Christian, D. (2001). What we can learn from foreign language teaching in other countries. *ERIC Digest*. Retrieved from https://www.ericdigests.org/2002-2/countries.htm

Schmid, M. (2018, September 11). At what age is it easiest to learn a second language? *The Conversation*. Retrieved from http://theconversation.com/at-what-age-is-it-easiest-to-learn-a-second-language-53840

Sousa, D. (2011). *How the ELL brain learns*. Thousand Oaks, CA: SAGE Publications.

Teale, W. H. (2009). Students learning English and their literacy instruction in urban schools. *The Reading Teacher, 62*(8), 699-703.

Helen Doron English. (2013, January 27). Top 10 benefits of early second language learning [Web log post]. Retrieved from https://www.helendoron.com/learning-a-second-language-top-10-benefits-of-early-language-learning/

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Instructional strategies that will promote literacy in an early childhood classroom for struggling readers

Kara Henck

Abstract: This article focuses on an issue that many teachers face with students who are learning to read. At some point, perhaps very often, teachers in an early childhood setting will encounter students who struggle with reading. The focus of this article is to discuss strategies that will help and encourage struggling readers and assist in closing learning gaps in reading. The strategies discussed in this article are repeated readings, Reader's Theatre, songs, and poems.

Introduction

As a teacher, it can be frustrating and disheartening to see students be promoted to the next grade with minimal knowledge of the basic concepts of reading. The farther behind they get, the harder the teacher has to work to get them caught up. It seems next to impossible to help a student who is struggling when they are so far behind. "Reading requires readers to accomplish at least two critical tasks—they must decode the words and comprehend the text. Given the limited amount of attentional resources available to any reader, attention that is given to the decoding requirement cannot be used for comprehension" (Griffith and Rasinski, 2004, pg. 1). Year after year teachers will encounter struggling readers. It may be just one or it could be half of the class. Whatever the case, teachers must have a variety of strategies that are engaging and fun in order to assist struggling readers in their journey to becoming fluent readers. "In order for students to learn to construct meaning from text, it is necessary for teachers to apply instructional strategies that will help readers transition from simple decoding of words to fluent word identification" (Mraz, Nichols, Caldwell, Beisley, Sargent, and Rupley, 2013, pg. 165).

Rasinski, Zimmerman and Bagert (2015) state:

> Many children who struggle in reading do not view reading as fun…Early experiences tend to shape long-term attitudes. Reading material that fails to engage young imaginations can trap children in failure; it can make children "hate" to read and become a near insurmountable obstacle to the development of age appropriate levels of reading achievement (pg. 5).

Teaching goes beyond the curriculum or the materials that are supplied to teachers. Strategies are the materials, delivery methods, and so much more that go into supporting a struggling reader. This manuscript will explore several different strategies that engage students in their reading and promote fluency and to provide teachers with several different ideas that can easily be implemented into the classroom. By utilizing one or more of these strategies in the classroom, gaps in reading achievement can decrease. Consequently, the number of struggling readers will become smaller.

Repeated Reading

Reading a passage more than once has many benefits. "Rereading the same passage repeatedly has been found to have a positive impact on both fluency and comprehension" (Mraz et al, 2013, pg. 165). When students reread, they become more familiar with not only the words in the passage but the meaning behind those words.

> Studies have found that repeated readings leads to improved student word recognition accuracy, reading rate (a measure of automaticity), expressive and meaningful reading, reading comprehension, and confidence in reading, not only on the passages the students have practiced but also on new never-before-seen texts (Rasinski, Rupley, Paige and Nichols, 2016, pg. 169).

If repetition of a task can benefit people in a multitude of ways, then the same should prove to be true for reading. Rasinski et al, (2016) uses the following example as a way to portray the importance of repeated reading:

> A music student, for example, will practice a piece under the guidance of an instructor who models and provides feedback to the student. The student will practice the repeated selection until he can hit all the notes automatically and begin to think about phrasing, emphasis, and other interpretive features of playing. The improvement from practicing the one piece will also carry over to improve playing on subsequent pieces never played previously by the student. (pg. 167)

This example shows the role of the teacher and student in a scenario of repetition. This can also work in the classroom, where the teacher is scaffolding through the lessons and providing feedback for improvement. Through continued practice, the student becomes more fluent and confident in decoding and comprehension. The positive effects of this practice continue as the student becomes a more independent reader and utilizes the strategies as self-directed.

Repeated readings can benefit struggling readers in many ways. "Reading the same passage repeatedly has been shown to significantly increase reading rate and accuracy, comprehension, and the benefits are carried over to unpracticed texts" (Mraz et al, 2013, pg. 165). However, the mode of implementing these readings is still an issue.

> In many fluency programs, students engage in rote and somewhat mindless oral repetitions of texts for the primary purpose of increasing reading speed. We find students, especially students who struggle or are already unmotivated to read, often lose interest in such approaches (Rasinski et al, 2016, pg.169).

By using a variation of texts and strategies, readers will become engaged and reading for fluency will take place.

Performance based selections, where the students present or act out a selection that needs to be read repeatedly and rehearsed, are one possibility to use in order to combine repeated reading with a sense of purpose and enjoyment. "An action research study by Neumann, Ross, and Slaboch (2008) found that students respond best toward activities that include performances and repeated readings" (Clementi, 2010, pg. 87). There are many different performance-based texts that can be used, a popular choice being Reader's Theatre.

Reader's Theatre

One way to instill a sense of purpose for reading is to put on a performance that involves the students interacting with one another in front of their peers. When students are able to perform, their attitudes toward a task become more serious and a purpose for reading is conveyed. "In addition to improving fluency and comprehension, Readers Theatre also engages readers and serves as a motivational tool for students. For struggling readers, motivation may be the key to their success in using this strategy" (Mraz et al, 2013, pg. 169).

Reader's Theatre is a fun alternative to reading as it allows students to interact with a text in a way that is not sitting in their seats listening to someone read or rereading the passages themselves. Clementi (2010) states that students have specific parts to read, instead of memorizing lines, students read from scripts so they can focus on their reading. The wonderful part about Reader's Theatre is the amount of resources available for all reading levels. Not only can premade scripts be found, but also books and texts can easily be adapted into scripts as well. "Readers Theater can be easily adapted for use with all kinds of students in all grades and reading levels" (Clementi, 2010, pg. 85).

Introducing a Reader's Theatre strategy into a classroom is very flexible; there is no right or wrong way to do it. Clementi (2010) provides the following information:

> Students should practice reading their scripts about 15 to 20 times. This typically occurs over three to four days and includes silent reading, paired reading, and group reading. Rereading the script is a crucial part of Readers Theater because this is when students develop their oral reading fluency. As students practice, their accuracy and speed increases, so they can focus on expression. (pg. 85)

Students can benefit greatly from reading a passage multiple times. Below is an example of a weekly routine for implementation in the classroom.

Pre-Day 1

- *Teacher and/or students select story.*
- *Teacher and/or students prepare or write script.*

Day 1

- *Teacher reads aloud the story.*
- *Students read script independently, in small groups, or as a whole class multiple times.*
- *Teacher and students discuss story.*
- *Students take home unmarked scripts for practice.*

Day 2, 3, and 4

- *Students practice script in small and large groups, taking turns with different parts until later in the week when permanent parts are chosen.*

- *Students give each other compliments and suggestions.*
- *Teachers provide mini-lessons or coaching that explicitly teaches an aspect of fluency or prosody.*
- *Students highlight parts for specific characters.*
- *Students select permanent parts.*
- *Students take highlighted scripts home for practice.*

Day 5

- *Performance*

Reader's Theatre allows for repetition and reading for a purpose. Student motivation is increased, their fluency is improving and it allows the teacher the opportunity to provide feedback to students based on their assigned reading. This is a tremendous way for a teacher to foster growth and improvement with struggling readers.

It is difficult to ignore the success of this strategy. "In their study of second-grade, Title I students use of Readers Theatre, Millin and Rinehart (1999) observed increases in both oral reading fluency and reading achievement that transferred to other reading materials" (Mraz et al, 2013, pg. 169). Using a strategy that is fun and engaging for students is a great way to boost fluency and seeing the positive effects of such a strategy can be an amazing and satisfying feeling as a teacher.

Poetry and Song

Another great strategy to promote fluency in the classroom is through poetry and song. "Thus, we feel that songs and poetry are naturals for promoting reading fluency, and that rhyming poetry has a strong potential for developing both competency in both phonics and fluency" (Rasinski et al, 2016, pg. 170). The use of poetry and song as a reading strategy can also be performance based, thus engaging the students in their reading and allowing for more fun.

When teachers use poetry as a strategy, Mraz et al (2016) suggest using a three-step approach. The initial step involves introducing word families as words in a list. Using word families boosts fluency as readers begin to start recognizing patterns in words. The ability to recognize patterns is a tool that is used by fluenct readers. The second step moves from these words families in isolation to using them in a text. The final step would then be to take the word family words and put them into writing, creating their own rhyming poem.

Rasinski et al, (2015) state that perhaps the most immediate reason for bringing poetry into the classroom is that it is specifically identified as a text for instruction in the Common Core State Standards in Literacy (Common Core State Standards Initiative, 2014). Indeed, poetry is included in the reading standards at every grade level from kindergarten through grade 12. When reading is made fun for students, their attention and engagement in activities are boosted. The very nature of poetry itself, the rhyme and rhythm embedded in poetry for young children, make poems

fun to read. Rasinski et al, (2015) explains that rhyme, rhythm, and repetition of children's poems invite multiple readings that have the propensity to increase comprehension, fluency, word recognition, and vocabulary of the reader. As it applies to phonemic awareness, by focusing on poetry's rhyme, alliteration, and assonance, young and struggling readers are attracted to the tempo, cadence and sound, of the text. Rasinski et al, (2015) also concluded that poetry should be a "matter of passion, not survival," we have found that poetry indeed can be a key to literacy survival for many students who struggle in learning to read.

Along with the idea of poetry and the rhythm that corresponds with it is song. Iwasaki, Rasinski, Yildirium and Zimmerman (2013) point out that a considerable amount of language activity we engage in as adults involves rhythmical words such as songs. Perhaps it is singing in places of worship, or the beginning of a sporting event, or singing along to the radio while driving, or just listening to one's iPod while walking in the neighborhood. If during these singing episodes we were provided with the written lyrics to the songs, we would be reading! For example, Biggs and colleagues (2008) discovered that the regular repeated singing and reading of songs by struggling middle school readers over a nine-week period resulted in reading achievement (seven months gain on average) than a comparison group of students in an alternative intervention. Song lyrics often are embedded with rhyme, assonance, and alliteration. This playing with the sounds of language through song can be a gateway to the development of phonemic awareness. The rhyming nature of most song lyrics also provides teachers with excellent texts for teaching word families (rimes) (Rasinski et al, 2016).

Conclusion

The word "strategies" carries a multitude of meaning when it comes to reading instruction. It is the curriculum and the materials provided by these programs that help support struggling readers in a whole group, small group and one on one setting. Through a multisensory approach to reading, the students are engaged and learning is optimal. When reading is enjoyable, students are engaged and learning is taking place. Through different types of text, struggling readers can gain confidence and an interest in reading. Poems and songs enable students to find their rhythm in reading and language. Poetry has many key features that support early language learners, such as rhyme and repetition. Songs help to promote a rhythm and spark interest that might otherwise be lacking. Consequently, an interested student is motivated to read again. Additionally, evidence shows repeated reading is effective in promoting literacy in the classroom. The use of a performance-based strategy, such as Reader's Theatre, supports repeated readings while keeping the reader actively engaged.

References

Clementi, L. B. (2010). Readers Theater: A motivating method to improve reading fluency. *Phi Delta Kappan, 91*(5), 85-88. doi:10.1177/003172171009100524

Griffith, L. W., & Rasinski, T. V. (2004). A focus on fluency: How one teacher incorporated fluency with her reading curriculum. *The Reading Teacher,58*(2), 126-137. doi:10.1598/rt.58.2.1

Iwasaki, B., Rasinski, T., Yildirim, K., & Zimmerman, B. S. (2013). Let's bring back the magic of song for teaching reading. *The Reading Teacher, 67*(2), 137-141.

Mraz, M., Nichols, W., Caldwell, S., Beasley, R., Sargent, S., & Reply, W. (2013). Improving oral reading fluency through Readers Theatre. *Reading Horizons, 52*(2), 163-180.

Rasinski, T., Zimmerman, B., & Bagert, B. (2015). Poetry as a core reading text for younger and struggling readers. *The NERA Journal,51*(1), 1-5. Retrieved March 23, 2019.

Rasinski, T. V., Rupley, W. H., Paige, D. D., & Nichols, W. D. (2016). Alternative text types to improve reading fluency for competent to struggling readers. *International Journal of Instruction, 9*(1), 163-178. doi:10.12973/iji.2016.9113a

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Reducing Writing Anxiety by Improving Self-Efficacy Beliefs

Katie McGee

Abstract: Writing anxiety is an issue that affects students in all classes, but especially in writing-intensive courses like English language arts classes. However, students with writing anxiety exhibit a wide range of behaviors, which can make it difficult for teachers to diagnose and prevent that anxiety. Research has highlighted several possible solutions; in particular, studies most consistently suggest improving students' writing self-efficacy as a means of reducing writing anxiety. Several research-based strategies, such as the use of peer reviews and the process writing approach, have proven successful in improving self-efficacy beliefs. Teachers should research the best strategies to reduce anxiety in their students, but should ultimately encourage students to believe that they can succeed.

Introduction

Imagine that you are a high school English teacher with over one hundred students, all of whom have varying opinions about the importance of writing and about their writing abilities. It is no surprise that some students do not enjoy writing. Some of your students may audibly moan when you assign writing tasks, so you pay close attention to these students' work. If they perform poorly, do you believe this is a result of lack of effort? What about the students who do not show physical reactions, but instead internalize their dislike of writing? And what if this feeling is not really a general dislike, but rather a fear of inability? This disposition is known as writing anxiety, and it affects students both academically and emotionally.

To further illustrate, imagine that these students are in your classroom:

Student A is a quiet, well-behaved student who excels in most of his classes, including English. When asked to complete group tasks, he often chooses to work alone. You notice that on tests he erases and rewrites his answers before moving onto the next question. He takes nearly twice as long as most students to complete writing tasks and sometimes takes his class work home with him. Despite this, he usually earns A's and B's on assignments, though on the days that major writing assignments are due, Student A is visibly exhausted.

Student B is outgoing and social, but it is difficult to engage her in independent tasks. She is able to articulate ideas during group work and she often raises her hand during whole-class discussions. When working silently on independent writing tasks, however, Student B regularly distracts those around her by starting off-task conversations. When she does engage in independent writing work, it is clear that she rushes through the questions. You can tell by her answers that she is usually on the right track, but often her answers are so brief or unclear that she only receives partial credit.

Student C is barely passing any of his classes. You have noticed that his writing skills are below grade level. You differentiate instruction and work with Student C individu-

ally when possible, but he frequently skips your class, sometimes more than once per week. During independent work, he sometimes complains that he is ill and asks to use the restroom. When you assign writing tasks worth a large portion of the grade, Student C is usually absent on the due date. Sometimes he does not submit any work at all.

All three of these students are affected by writing anxiety, which exhibits itself in very different but equally problematic ways. Student A submits good-quality writing, but his anxiety causes him to procrastinate and to doubt himself. His good behavior may make it less likely for teachers to notice that he is struggling. Student B makes poor behavioral choices, a defense mechanism that might redirect teachers' attention from her writing anxiety to her attitude. Student C struggles in many other areas, both in academics and attendance, so it may be difficult to identify writing anxiety as part of his problem.

How can teachers change these negative dispositions that seem so deeply ingrained in students? Research suggests several strategies, and most of them involve addressing students' self-efficacy beliefs. Because writing is such a personal task and draws on both cognitive and affective processes, students' emotions are often intertwined with their ability or perceived ability to perform on written assignments (Pajares, Johnson & Usher 2007). Imagine if the above students all believed they were capable of succeeding. Student A would not second guess his answers and could come to school well-rested. Student B would not feel insecure when working individually and would be able to focus on her assignments. Student C would not become nauseated at the thought of submitting writing assignments and would likely have fewer absences.

Writing anxiety is a complex issue with more than one possible remedy. However, improving students' self-efficacy beliefs has been shown to reduce writing anxiety for whole classes of students. In order to do so, teachers must first deepen their understanding of writing anxiety, self-efficacy beliefs, and the research-based strategies used to improve students' dispositions.

Trends in Writing Anxiety

Writing apprehension, a term synonymous with writing anxiety, was first defined by Daly (1978) as "a situation and subject-specific individual difference concerned with people's general tendencies to approach or avoid writing" (p. 10). Their research found that students with writing anxiety exhibit avoidance tendencies as depicted in the hypothetical examples above. According to Daly and Miller (1975), students with writing anxiety may have a record of not completing written work or of being frequently absent for in-class writing activities. These students may seldom complete complex written homework assignments or avoid participating in extracurricular activities that require writing. Additionally, students who exhibit writing anxiety tend to choose professions they believe require less writing (Pajares Johnson, & Usher, 2007). Clearly, writing anxiety affects students well beyond high school.

Research also indicates that writing anxiety is influenced by age and gender. Pajares et al. (2007) found that female students experience less writing anxiety than male students. Female students also reported higher self-efficacy beliefs and mastery experiences than male students, which supports the notion that self-efficacy beliefs

and writing anxiety are negatively correlated. Additionally, female students reported receiving better grades in writing than male students, which may help explain why they experience less writing anxiety.

Pajares et al. (2007) found that students of both genders generally have higher self-efficacy beliefs and lower levels of writing anxiety in elementary school. Between elementary and middle school, students' self-efficacy beliefs greatly decrease and generally remain at this lower level throughout high school. This may be due to the increased demand of academic tasks and feelings of inadequacy when approaching them.

Students are not the only ones affected by writing anxiety in the classroom. According to Applebee and Langer (2006), teachers generally feel they are not adequately prepared to address writing anxiety. Furthermore, in a study of college composition professors, Apawu and Anani (2017) found that many teachers are completely unaware of the existence of writing anxiety. Of those teachers who are aware, some do not believe that writing anxiety impacts students' performance at all. This indicates that further professional development is needed to bring awareness to the topic of writing anxiety and to prepare teachers to combat it.

Self-Efficacy Beliefs and Writing Anxiety

Self-efficacy is a person's perception of his or her ability to achieve a goal or master a skill. It is a learned trait that can be influenced by a number of factors including motivation, interest, perceived value of task, and disposition (Troia, Harbaugh, Shankland, Wolbers, and Lawrence 2012). Several studies have found a correlation between self-efficacy and writing anxiety. For example, Berk and Ünal (2013) found that writing disposition is a significant predictor of anxiety: if a student's self-efficacy about writing improves, that student's anxiety about writing decreases.

Motivation and Performance

Improving students' self-efficacy is also helpful in improving writing ability and motivation, both of which influence writing anxiety. Troia et al. (2012) found that students with higher writing self-efficacy approach writing tasks differently than those with lower self-efficacy beliefs. A greater sense of self-efficacy leads students to aim at both mastery and performance goals. Mastery means that students are trying to master a particular task (such as writing a strong thesis statement) while performance means that they are trying to accomplish a particular performance benchmark (such as earning an A). Both goals were associated with greater writing motivation and higher writing scores. In contrast, a lower sense of self-efficacy is leads students to avoid writing, and is associated with moderate-to-low writing motivation and lower writing scores.

The study also found a correlation between self-efficacy and writing performance: students who believed themselves capable of completing a task were more successful at doing so. Students who perceived a writing task to be meaningful also had higher motivation in completing the task and earned higher scores (Troia et al. 2012). Naturally, students who perceive writing tasks in a positive light experience less anxiety when asked to complete them.

Evaluation and Writing Anxiety

Bayat (2014) found that students' writing anxiety often stems from their fear of being evaluated. According to Bayat's study, students with lower writing self-efficacy are apprehensive about engaging in writing tasks because they worry that the grades or feedback they receive will mirror their self-perceived ability. However, it is important to note that the manner in which students receive feedback can influence anxiety. The study showed that students with anxiety who received feedback at the end of the writing process had no change in anxiety levels. However, students who received feedback throughout the writing process had less writing anxiety at the end of the study, even though these students still feared evaluations. This suggests that teachers should use feedback as a tool for improvement rather than solely for assessment. Doing so encourages students to see writing as an area in which they can improve, which promote healthy self-efficacy and reduces anxiety.

Strategies for Reducing Writing Anxiety by Improving Self-Efficacy Beliefs

Purposeful Feedback

As mentioned above, one of the simplest ways teachers can improve students' self-efficacy beliefs is to give thoughtful feedback during the writing process. The aim of such feedback is to promote cognitive growth through affective means – by making students feel better about writing, teachers can help them become stronger writers. Such feedback links directly to self-efficacy because feedback influences how a student perceives his or her ability to successfully complete a task.

Di Loreto and McDonough (2014) studied the types of feedback students found most helpful. Students in the study found instructor feedback particularly helpful in indicating whether their writing was on track while they were working on assignments. Feedback on the organization of their written work was particularly linked to an increase in confidence; the researchers believed that this was because students perceive organization to be within their control. In contrast, feedback on language and word usage caused the most anxiety in students, perhaps because word choice is a difficult and sometimes daunting aspect of writing. Overall, the majority of students reported that instructor feedback was helpful for improving their writing ability. Furthermore, students reported lower anxiety levels on subsequent writing tasks in the study.

The manner in which students receive feedback is also important. Pajares et al. (2007) found that female students generally receive better grades and more positive feedback than male students do, so it is important for teachers to consider how the feedback they offer their male students can be used to promote self-efficacy. Pajares et al. (2007) also note the importance of how feedback is framed: "it pays dividends for a teacher to provide students with feedback focusing on how far they have come rather than how far they have yet to travel" (p. 116). In other words, teachers should make students aware of what they do well while offering suggestions on how to continue growing.

Peer Reviews

Peer reviewing is another method of providing students with feedback on their writing during the writing process. It involves students working collaboratively to workshop one anothers' writing. Fox (1980) analyzed the effectiveness of peer reviews in comparison to traditional instructor-based feedback in relation to writing anxiety and performance and found that such workshops help decrease writing anxiety and increase self-efficacy. Students in the control group worked independently and received feedback solely from the instructor at the end of the writing process. Students in the experimental group worked collaboratively to workshop one anothers' writing at several points throughout the writing process; additionally, the instructor held writing conferences at the end of the process in lieu of assigning grades. The study found that students in the experimental group had significantly lower writing anxiety at the end of the study while students in the control group had no significant change in anxiety. This research suggests that group work and frequent feedback help reduce writing anxiety. The study also implies that teachers can reduce writing anxiety by providing opportunities for students to engage in low-stakes, ungraded writing activities.

Writing Practice

Fischer, Meyers, and Dobelbower (2017) found that a lack of writing practice results in higher anxiety levels and lower self-efficacy beliefs. They studied college students with writing anxiety in a writing-intensive course; many students believed that they had not received enough writing practice in previous courses. Interestingly, despite the complexity of the writing tasks in the course, the students reported a decrease in anxiety levels throughout the semester as a result of having more opportunities to practice writing through assignments and activities.

This unfortunate trend in lack of writing practice is not specific to college. Applebee and Langer (2006) found that over half of the population of eighth grade students they surveyed indicated that 40% or less of ELA class time was devoted to writing instruction per year. The researchers argued that the reason for lack of writing practice in the classroom stems from the increased focus on high-stakes standardized tests, which push teachers to focus more heavily on reading skills. Yet as Graham and Hebert (2010) note, even given the focus on standardized tests, this distinction between reading and writing instruction is not necessary. Their study reported that 93% of students showed improved reading scores when asked to create written responses after reading. Therefore, additional writing practice can improve students' writing self-efficacy and writing scores as well as their reading scores.

Process vs. Product

Studies have shown that product-based writing evaluations, which focus solely on the end goal of an assignment, do not improve students' writing skills (Bayat, 2014). On the other hand, a process-writing approach encourages students to see writing as a process rather than focusing solely on a final product. That is, students should understand that writing involves a series of small steps, including prewriting and revising, and not just the rapid production of a final result. In his study on the pro-

cess approach, Bayat (2014) found that a process-writing strategy not only reduced anxiety, but also improved students' writing quality in terms of grammar, rhetorical structure, content, and creativity. Additionally, Applebee and Langer (2006) argued that this approach to writing instruction offers a new perspective to students who may believe writing skills are inherited traits.

Conclusion

Writing anxiety is multi-faceted with numerous causes and effects. Overall, though, research has shown that it is a learned trait. Because of this, teachers have the ability to implement strategies and create learning environments to reduce writing anxiety. Working to improve students' self-efficacy beliefs is a good starting point to do so.

Because students' writing self-efficacy beliefs generally decreases between elementary and middle school, teachers should seek ways to encourage students in these transitional years and build their confidence throughout high school. To do so, teachers should focus on engagement, collaboration, and feedback. Feedback should be purposeful, specific, be couched in praise, and should be linked to the writing process; it should also be given frequently and should be equally positive for both male and female students. Additionally, teachers should provide students with ample writing practice in formal and informal tasks. This practice should include breaking the writing process down into smaller, manageable parts.

Reducing students' writing anxiety may seem daunting, but it is a worthy cause. Encouraging students to believe that they can succeed in writing tasks will promote students' academic and emotional success. Teachers should start by understanding the issue, its causes and effects, and the available research-based strategies to reduce anxiety. The above strategies are just a sample of successful approaches. Ultimately, it is up to teachers to consider which strategies will be most beneficial for their students.

References

Apawu, D. & Anani, G. (2017). From diagnosis to prognosis: What instructors know about their students' writing apprehension. *Journal of Education and Practice, 8*, 91-96.

Applebee, A. & Langer, J. (2006). *The state of writing instruction in America's schools: What existing data tell us*. Albany, NY. Center on English Learning and Achievement.

Bayat, N. (2014). The effect of the process writing approach on writing success and anxiety. *Educational Sciences: Theory & Practice, 14*(3), 1133-1141. doi:10.12738/estp.2014.3.1720

Berk, R. R., & Ünal, E. (2017). Comparison of writing anxiety and writing dispositions of sixth, seventh and eighth grade students. *International Journal of Instruction, 10*(01), 237-254. doi:10.12973/iji.2017.10115a

Daly, J. (1978). Writing apprehension and writing competency. *Journal of Educational Research, 72*(1), 10-14. doi: 10.1080/00220671.1978.10885110

Daly, J. & Miller, M. (1975). The empirical development of an instrument to measure writing apprehension. *Research in the Teaching of English, 9*(3), 242-249.

Di Loreto, S., & McDonough, K. (2014). The relationship between instructor feedback and ESL student anxiety. *TESL Canada Journal, 31*(1), 20.

Fischer, L., Meyers, C., & Dobelbower, S. (2017). Exploring how pedagogical strategies change student perceptions of writing apprehension. *Journal of Agricultural Education, 58*(4), 254-268. doi:10.5032/jae.2017.04254

Fox, R. (1980). Treatment of writing apprehension and its effects on composition. *Research in the Teaching of English, 14*(1), 39-49.

Graham, S., and Hebert, M. A. (2010). *Writing to read: Evidence for how writing can improve reading.* A Carnegie Corporation Time to Act Report. Washington, DC: Alliance for Excellent Education.

Pajares, F., Johnson, M., & Usher, E. (2007). Sources of writing self-efficacy beliefs of elementary, middle, and high school students. *Research in the Teaching of English, 42*(1), 104-120.

Troia, G., Harbaugh, A., Shankland, R., Wolbers, K., & Lawrence, A. (2012). Relationships between writing motivation, writing activity, and writing performance: Effects of grade, sex, and ability. *Reading and Writing. 26*(1), 17-44. doi: 10.1007/s11145-012-9379-2

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Play and Literacy in Early Childhood Classrooms

Elizabeth Munger

Abstract: Recent research shows that play is being replaced in early childhood classrooms by direct instruction, due to academic accountability and other pressures (Lynch, 2015). This manuscript shares some of the many benefits of play in the classroom on young children. Many recent studies have shown that play is a developmentally appropriate way to teach and practice literacy skills with early childhood students, while helping them to become successful emergent readers. This article will examine different ways that play can be used to instruct and reinforce literacy skills with emergent and at-risk readers.

Introduction

In the past decade, there has been a variety of research conducted that shows the benefits of play in the classroom. Play can be beneficial to children in the five developmental domains: physical, social, emotional, cognitive, and language. Through play children practice empathy and learn the social skills of taking turns and self-regulation. They are able to explore new materials and construct knowledge, and they also further their verbal skills (Pyle, Prioletta, & Poliszczuk, 2018). In addition, play gives children a safe way to experiment with new things (Lynch, 2015).

Although there is a great wealth of research on the benefits of play, there has been a decline in the amount of play in early childhood classrooms (Lynch, 2015). This is partly due to a number of pressures that are put on early childhood educators. There are an increasing number of academic standards and more accountability has been demanded of teachers as a result of government policies (Pyle & DeLuca, 2016). Some administrators, who may not have experience with young children, can be too focused on academic success or testing. There is also an emphasis on meeting reading goals, despite the fact that not all such goals are age appropriate. In addition to these outside pressures, many teachers struggle with balancing academic learning and accountability with developmentally appropriate activities (Pyle et al., 2018). In addition, teachers sometimes feel pressure from parents. For example, some parents believe that their child is not learning if they are not doing pencil and paper work (Lynch, 2015).

Luckily, play has been shown to be both developmentally and age appropriate, while also being a proven tool to teach and reinforce many physical, social, emotional, cognitive, and language skills (Pyle et al., 2018). Play can be used in early childhood classrooms in many different ways. Since play has typically encompassed at least thirty percent of a preschoolers' school day (McLeod, Hardy & Kaiser, 2017), time spent in play is important for reinforcing academic skills. While play can be used to support learning in many content areas, this article looks specifically at ways that play and literacy can be integrated and some of the benefits that follow. It discusses a range of strategies for using play to teach and practice literacy skills with emergent and at-risk readers.

Guided Play and Literacy

Early literacy skills are an important element of early childhood classrooms and should be developed with emergent readers. Emergent readers include students in preschool, kindergarten, and first grade. Literacy in the classroom encompasses components including listening, speaking, reading, writing, and comprehension. Emergent readers can develop these skills in many ways, either while taking an active or passive role. However, when a teacher takes a very active role, it often results in the child taking a passive role, and having students take a passive role may result in inattention and slower progress (Weisberg, Hirsch-Pasek & Golinkkoff, 2013).

Instead of just having an active teacher, both the teacher and the students should take an active role during literacy instruction and the play activities that follow. Guided play, which is half way between direct instruction and free play, should having learning goals, be child-centered, and allow for the teacher to provide support and scaffolding (Weisberg et al., 2013). Educational psychologist Lev Vygotsky's beliefs support these practices. He believed that children should interact with more knowledgeable people in order to learn (Pyle et al., 2018). Many studies have shown that reading and writing skills can be taught through guided play. This is a developmentally appropriate way to teach literacy skills, is enjoyable for young students, and can produce positive results.

Vocabulary Development

Working with Emergent Readers

Reading books out loud is a common activity in preschool, kindergarten, and first grade classrooms. Read alouds were also used as a literacy strategy in many of the studies discussed in this article. The children's books can be either fiction or non-fiction. Following an active learning approach, however, suggests that reading a story to students and simply asking them questions should not be the extent to which books are used in the classroom. Allowing time to play after reading as a way to extend the story has additional benefits (Massey, 2012). This play can be organized to help students practice a number of literacy skills, including vocabulary development.

For example, one way to develop students' pre-reading skills is to expose students to new vocabulary intentionally during a story. While reading high quality literature, the teacher can make connections to students' lives, analyze word meaning, or ask students to make predictions (Massey, 2012). After reading, the teacher can provide play activities that connect to the story and the new vocabulary words.

If the teacher is present during play, he or she can scaffold the language and encourage the use of the new words (Massey, 2012). Wasik and Jacobi-Vessels (2017) argues that "when book reading, which targets specific vocabulary words, is accompanied by opportunities for children to play and use the words in center activities, word learning increases" (p. 772). The teacher should be present during those play opportunities to ask questions that encourage students to use the vocabulary. In this situation, both the teacher and student take an active role.

Working With At-Risk Readers

Children who are at-risk and need a lot of language support at school can be helped by being provided with books that focus on targeted vocabulary words (McLeod et al., 2017). Vocabulary development is a valuable skill to work on because in early childhood it "is strongly predictive of later reading and academic skills" (McLeod et al., 2017, p. 147).

In a study done by McLeod, Hardy, and Kaiser (2017) with at-risk preschoolers, children were read picture books that included focused-on vocabulary words. After listening to the stories read aloud, the children were given a chance to play with toys that went along with the words used in the books. While allowing the children to direct the play, the adult was present to provide prompts and to ask open-ended questions that promoted the use of the new words. After a number of follow up sessions with the same toys, the children used several of the words during play without prompting by the teacher. Their vocabulary had grown. This study shows another way that reading stories and play can be tied together.

Strategies

Play Using Props

Another way to engage children during a read aloud is by using props. The teacher can use puppets or other props while reading, especially with fictional stories. After reading a story, children can be given an opportunity to play with the props to reenact the story, portray characters, sequence events, discuss the story, or retell the story in their own way. Having a teacher present during this play time allows the teacher to model retelling skills or ask prompting questions (Massey, 2012). The teacher should focus on to guiding the children during playtime, rather than directing the play.

Using props during play can help develop a child's vocabulary and oral language. The children can use both pretend and non-pretend talk. Non-pretend talk includes naming, counting, or labeling objects. It can be used when a child asks another student for a puppet, crown, or magic wand, for example. Pretend talk involves giving an inanimate object thoughts or feelings, or having one object represent another (Massey, 2012). This is done frequently when children play pretend. This opportunity to talk about stories through play is valuable to a child's future successes because "literacy success relies heavily on early language development that can be developed through play" (Moedt & Holmes, 2018, p. 2).

Allowing children to play with retelling props has useful effects on students' comprehension, sequencing, and language skills. It also helps them to better remember information about characters and the setting (Moedt & Holmes, 2018). Moedt and Holmes's study of forty-two kindergarteners split the class into two groups. Both groups of children were read the same story and later asked to draw a picture about the story and retell some information. Half of the students had a chance to play with story props between listening to the book and completing the assessment. The children who had time to play before drawing performed much better on the

assessment than the students who did not have the opportunity to play with retelling props.

Figure 1. Props taht can be used to retell a story during play.

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Dramatic Play

Emergent readers also have the opportunity to learn early reading and writing skills through dramatic play. Early childhood classrooms can include a number of pretend settings such as a veterinarian's office, a flower shop, an apple stand, or a restaurant. These play settings allow children to take orders and write them down on a notepad, to reference informational books about animals, to order from menus that include words and pictures, to ask customers to pay for items, or to use other writing tools and resources (Pyle, 2018). These fun settings give many opportunities for literacy development.

To use dramatic play to support literacy, the teacher should be present and active. The teacher should first provide an environment that is print-rich and should also provide materials for the children that help with literacy engagement. This could include providing books that align with current themes, or providing clipboards and pencils, menus with words and pictures, signs, or plastic magnet letters (Pyle et al., 2018). The teacher should also be present to prompt language and conversations. He or she can also encourage self-invented spelling.

Games and Literacy

Students may also benefit from playing games in the classroom that reinforce literacy skills. For example, after teaching a new concept, the teacher can introduce a game that reinforces the concept, such as initial sounds (Cavanaugh, Clemence, Teale, Rule & Montgomery, 2016). Playing a game not only allows for practice of literacy skills, but also for the practice of social skills including turn-taking, teamwork, and rule-following.

Young students can also be given the chance to make up their own literacy games. If students are provided with materials, are supervised, and are encouraged to play their games, they often remain on task, all while having fun. In a study completed by Cavanaugh and colleagues (2016), a group of students were given a chance to create their own literacy game in their classroom, with some guidance from their teacher. The group that created their own game did better on assessments than another group who played a game that had been provided to them. They took owner-

ship of the game and learned more from it as a result. Several of the children even brought their new game and skills into the classroom's free playtime.

Benefits to Oral Language Development

Play does not only support comprehension and vocabulary skills, but also supports a child's language development. Peterson (2017) has shown that "oral communication skills are fundamental to the development of literacy and essential for thinking and learning" (p. 37). Children communicate orally constantly during play. While studying students in a kindergarten and first grade classroom, Peterson identified eighteen ways that children use oral language during play. They ask for help, describe what they are doing, make observations, direct their peers, negotiate, talk to problem solve, as well as many other uses.

Play offers opportunities for children to communicate with each other and also with adults. This especially is true when compared to a classroom where the teacher utilizes direct instruction and one in which the students are passive. Children who have frequent language exchanges with adults have a more developed vocabulary and better language skills. Children who have poor language skills sometimes are rejected by their peers and also tend to have more behavior problems (Wasik & Jacobi-Vessels, 2017). Allowing students to be actively playing, talking, and listening in their classroom is a way to help with this skill.

Conclusion

Play should be a part of every early childhood classroom. If it is used properly, it can be beneficial to both teaching and reinforcing early literacy skills. Play allows both the teacher and the students to take an active role. Students participate in developmentally appropriate and engaging activities. The teacher plans and prepares for the playtime, while also providing support and scaffolding.

There are a variety of methods that a teacher can use to support literacy through play. For example, after listening to a story, children can play with props to strengthen their retelling and comprehension skills. Teachers can provide toys to go with stories that introduce new vocabulary to at-risk students. Dramatic play areas can be provided that allow for imagination, discussions, writing, and socialization skills. Students can make up and play games to practice new skills. By utilizing these

developmentally appropriate activities in the early childhood classroom, teachers can support emergent and at-risk readers in developing and strengthening their literacy skills.

References

Cavanaugh, D. M., Clemence, K. J., Teale, M. M., Rule, A. C., Montgomery, S. E. (2016). Kindergarten scores, storytelling, executive function, and motivation improved through literacy-rich guided play. *Early Childhood Education Journal, 45*, 831-843.

Lynch, M. (2015). More play, please. The perspective of kindergarten teachers on play in the classroom. *American Journal of Play, 7*, 347-370.

Massey, S. (2013). From the reading rug to the play center: Enhancing vocabulary and comprehensive language skills by connecting storybook reading and guided play. *Early Childhood Education Journal, 41,* 125-131.

McLeod, R. H., Hardy, J. K., & Kaiser, A. P. (2017). The effects of play-based intervention on vocabulary acquisition by preschoolers at risk for reading and language delays. *Journal of Early Intervention, 39*, 147-160.

Moedt, K., & Holmes, R. M. (2018). The effects of purposeful play after shared storybook readings on kindergarten children's reading comprehension, creativity, and language skills and abilities. *Early Childhood Development and Care.* Retrieved from https://psycnet.apa.org/record/2018-35901-001

Peterson, S. (2017). Developing a play-based communication assessment through collaborative action research with teachers in northern Canadian indigenous communities. *Literacy, 51*, 36-43.

Pyle, A., & DeLuca, C. (2016). Assessment in play-based kindergarten classrooms: An empirical study of teacher perspective and practices. *The Journal of Educational Research, 110*, 457-466.

Pyle, A., Prioletta, J., & Poliszczuk, D. (2018). The play-literacy interface in full-day kindergarten classrooms. *Early Childhood Education Journal, 46,* 117-127.

Wasik, B. A. & Jacobi-Vessels, J. L. (2017). Word play: Scaffolding language development through child-directed play. *Early Childhood Education Journal, 45*, 769-776.

Weisberg, D. S., Hirsch-Pasek, K., & Golinkkoff, R. M. (2013). Guided play: Where curricular goals meet a playful pedagogy. *Mind, Brain, and Education, 7,* 104-112.

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Increasing Student Engagement with Text
Exploring Student-Centered Activities to Build Literacy Skills

Sarah Preston

Abstract: This article explores an issue faced by many ELA teachers: students' lack of engagement with text. The central idea is to determine the best way to help students become active learners who participate in the classroom and remember the content of what they read. Furthermore, this article stresses the need for all content teachers to regularly seek out and discover new and engaging learning activities that will help connect students to content-area texts. The three activities examined here are sustained silent reading (SSR), interactive notebooks, and literature circles, each of which has the potential to bridge student learning to help develop mastery in English language arts and beyond.

Introduction

Throughout the school year, Ms. Jones has assigned all class readings to be completed outside of the classroom, which results in little to no growth in student scores. She explains to students that it is important to complete the assigned readings because there will be a quiz the following day which accounts for 10% of their quarter grade. The next day, as promised, Ms. Jones asks students to clear their desks and take out a pencil for the quiz. To no surprise, there is a chorus of mumbles and groans about having forgotten about the reading and that the text was too boring to get through. Other students chime in, explaining that they did not understand the reading while another says that they really did read, but because the text was so boring they fell asleep with only two pages to go and can they have a minute before the quiz to review the chapter? The teacher shakes her head, explains that there are no valid excuses for not completing the assignment, and distributes the quiz to the class. Unsurprisingly, the grades display that the students did not do the reading and the teacher is once again entering less than desirable scores into the grade book.

This scenario describes the struggle teachers face to engage students in reading and writing. Content-area reading (English language arts, science, social studies, mathematics, etc.) is regularly assigned as homework so that class time can be utilized for deep thinking questions and discussion of the text. However, for our students to build strong literacy skills, it is vital that teachers in all content areas implement a variety of engaging learning activities that build student engagement with content-area texts.

Implementing Student-Centered Activities

One issue Ms. Jones faces is that she feels there is not enough time during the day for educators to instruct, assess, and still allow students class time to read the assigned text, thus, the reading is reserved for homework. However, we often forget

that many students do not know how to navigate higher-level reading on their own, so that precious class time we are often so worried about is not actually benefiting the students. If more teachers include a rotation of reading activities during class, students might be more inclined to read and thereby gain more knowledge of the content.

Teachers in the English language arts classroom know how important literacy-based skills are and that these skills are part of what drives the educational system, but how do we engage and connect reluctant students to these texts that are the foundation of our curriculum? It's simple; we use strategies that will draw students in and we think outside the box. We talk to our students; have conversations about what we are reading and tell them the good, the bad, and the ugly about our books. We transport them from the brick-and-mortar classrooms to the places that they are reading about by having them create colorful scenarios in their notebooks based on the setting and characters.

Modifying the Approach

The reluctance to read is not reserved solely for the ELA classroom, but is cross-curricular in the fact that students who are reluctant to pick up a book for English class probably aren't too excited about diving into a science book to explore scientific ideas either. For example, McCormick and Segal (2016) explain, "when determined science teachers face reluctant readers, they often choose to teach the content without reading" (p 42), meaning that they drift away from the text and move to more hands-on practices such as labs and exploration rather than assign a chapter reading that will not be completed.

Going deeper into the topic of student engagement, the authors acknowledge that while the labs and experiments in the science classroom help with understanding the content, reading the chapters is still a vital piece of the learning process. In order to complete science experiments thoroughly, students need to "use the language of science, which is innately connected to the reading and writing of the subject," (p. 46) which means exposing them to the text in a meaningful way, and not simply ignoring it (McCormick & Segal, 2016). This is why modifying the approach to the text is so important; students need to read, and by scaffolding that reading with other activities such as labs, group discussions, and writing, we can build strong readers who become immersed in a text.

Literacy-based learning is an important tool for all teachers and is not something that should be negotiated. Reluctant readers may be missing some pieces of the puzzle to reading, no matter the subject area, and therefore need the teacher to fill in the gaps of learning with student-centered activities that pull the students into the learning. It takes practice and patience for a reluctant reader to come around, but by modifying the approach to the text by including hands-on activities as the authors suggest, students may come around to reading beyond just the ELA classroom (McCormick & Segal, 2016).

Instructional Strategies for Reading Engagement

Sustained Silent Reading (SSR)

Sustained Silent Reading (SSR) is time set aside within the classroom routine in which each student participates in "uninterrupted, silent reading" for a set amount of time (Siah & Kwong, 2010, p 168). Many teachers and administrators have transitioned to SSR as a way to promote and encourage independent student reading in response to data indicating that many high school students are not reading at an appropriate level, and thereby unprepared for college-level reading (Siah & Kwong, 2010). The aim of Siha and Kwong's (2010) study was to see if there is a link between students having a specific time to read something that they enjoy and their individual value of reading. The idea was that when a student who does not find value in reading is offered time in class to read something of interest the value placed on reading will change for that student.

The researchers asked students how they would rate their value of reading (Siah & Kwong, 2010). The "value of reading" subscale was adapted from the Motivation to Read Profile (MRP; Gambrell et al. 1996) to assess their [students] value of reading in a way that would indicate whether students have a high or low value of independent reading (Siah & Kwong, 2010,). The questions created a foundation on which to build understanding of how students approached their SSR time in class and data by which to gauge the students' increase in reading. Students were originally categorized into two groups, "high value" (HVR) and "low value"(LVR) reading groups, in which "the results...showed that approximately 89 percent of the students in the HVR group reported that they were self-motivated to read leisure books during SSR, whereas only 71 percent of the students in the LVR group reported self-motivation" (Siah & Kwong, 2010, pp. 171-173). In short, SSR time in class would undoubtedly be beneficial to students who already hold value in reading, and could be encouraging to those students who have less value in reading-related activities as it is one way of helping students foster a deeper respect for reading.

Interactive notebooks

Interactive notebooks create a direct bridge between what a student read during SSR and their comprehension of the material. The cognitive advantage of pairing the two activities is that this encourages student thinking and action immediately after the information has been introduced. Interactive notebooks can be described as consisting of three types of activities (In, Through, and Out) all of which take place in one notebook (Waldman & Crippen, 2009,). As Waldman and Crippen (2009) explain:

> In activities provide a scaffold for class discussion by activating prior knowledge and motivating students immediately as they come into the classroom. Through activities allow the teacher to direct student learning from a fragmented conceptual knowledge to understanding. Out activities emphasize reflection on key concepts at the end of the lesson, before students go out of the classroom. (p. 52)

By incorporating interactive notebooks, students become interested in tackling the reading because there is a structured activity afterwards with a concrete goal. The hesitation is gone and replaced with the motivation to connect with the text on a deeper, more personal level (Mason & Bohl, 2017).

Interactive notebooks can be used to engage students, in any content area, through what Symonette (2018) refers to as Journal Jams and Think Tank activities. These are separate, informal tasks set out by the teacher that require students to be able to think both independently and in a group setting to help create an engaging, diverse discussion based on the text (Symonette, 2018). Journal Jams are a student's individual response to a text through free writing. Students write for a set amount of time based on a particular topic, after which they discuss what they read, "by jamming" with their peers (Symonette, 2018, p. 27). Alternatively, Think Tanks are set up so that students work in groups to discuss textual information they identify with, research the content, and then collaborate to write about the topic (Symonett, 2018,). This is a benefit as it creates engagement by offering students a sense of purpose connected to the text; it values their thoughts and ideas about the reading.

Interactive notebooks are ultimately a cross-curricular tool that will benefit student development throughout their academic career. By integrating active writing and thinking with interactive notebooks, students are on course to develop stronger metacognition. The idea is for students to find patterns in their thinking by having designated areas on each page "to document their thinking and changes in their thinking during the learning process. As a result, the interactive science notebook is an official record of both student thinking (on the left page) and scientific investigations (on the right page)" (Mason & Bohl, 2017, p. 39).

Literature Circles

One way that teachers can modify the reading curriculum in a way that engages students is through literature circles. Not only does this strategy have the ability to draw readers in, it may also improve reading comprehension for students who struggle with understanding during analysis (Brown, 2002). In practice, students are placed in small, temporary groups typically comprised of four to six students where each member of the group is assigned a specific role in which they are reading with a purpose (Herrara & Kidwell, 2018). The idea is that each member of the group has their role, which is assigned prior to the reading, and reads with that particular role in mind. This helps create a "balanced participation and equal opportunities for sharing ideas, expressing interpretations of texts, and responding to the contributions of others in the group" (Herrara & Kidwell, 2018, p. 17). Students read the text individually (during SSR time in class) and then meet up in regular intervals during class to discuss any questions, interests, or topics that are inspired by the reading (Herrara & Kidwell, 2018). This activity is complex because it is student-centered and requires that each group member participate in the reading, but it also relieves some of the pressure for certain students as it defines the purpose of the text in a way that more traditional reading assignments do not. The idea is that the literature circles create a more interesting and engaging way for students to connect with the text while also allowing them to be social and exchange ideas within their groups (Karatay, 2017).

Literature circles also help build engagement by encouraging students to concentrate on a very specific part of the text, thereby diminishing the risk of the student becoming overwhelmed if they have difficulty deciding which part of the text is important to them vs. what is important to the teacher. This strategy takes the guesswork out of reading as it provides direction for each student's goal. They are all reading the same text, but reading with different purposes.

While literature circles are seen as an activity used to build engagement with text in ELA, they do have their place outside of the English classroom. Whittingham (2013) conducted research on the validity of using this method in a science classroom. Not only did Whittingham want to know more about literature circles in other content classrooms, he also wanted to know if they worked while incorporating 21st century skills through online learning. He found that the application of literature circles within a science classroom "helped students internalize big ideas about science while also providing opportunities for critical and inductive thinking", which is a strong proponent of the use of literature circles as a way to draw students into reading no matter the content (p. 54).

Conclusion

Ms. Taylor has implemented SSR time since the beginning of the school year with the first ten minutes of each class period reserved for silent reading of the content-area text. Each day after SSR the teacher assigns a different task for students to complete in their interactive notebook based on that day's reading. One example would be for students to write a one-sentence summary of the pages they have read or creating a chart based on character development and filling in the appropriate boxes as they notice changes in the protagonist's ideas and behaviors. Other days the students are directed to create two questions based on the book; one level-one question and one level-two question in which the students will eventually exchange with their classmates.

Ms. Taylor verifies that her students are engaged in the reading by observing and conferencing with her students as they read. She can easily see which students are making progress and which are struggling based on their answers in their notebook. There is no anxiety about a failing grade, no worry that they won't remember the answer to a question, and no excuses for not reading; there is only student-created material based on the reading that allows the teacher to gauge her students' development toward mastery and understanding in an efficient, equitable way.

While the information presented is not an exhaustive list of resources and strategies teachers can use to motivate reluctant readers, it is enough to prove that there are literacy-based activities that may help build stronger student engagement with text. Students who possess the skill to read, but simply choose not to are not lost to educators, nor are they unteachable, they simply need to be redirected and learn to enjoy reading in an efficient, engaging way that works for them. If more teachers explore various activities to engage students, they are sure to find something that works. If we keep pushing the limits and break free from the textbook and desk formula that the American educational system has become, and allow students to really engage with the curriculum, students might just surprise us.

References

Brown, B. A. (2002). Literature circles in action in the middle school classroom. Retrieved from https://files.eric.ed.gov/fulltext/ED478458.pdf.

Herrara, J. & Kidwell, T. (2018). Literature circles 2.0: Updating a classic strategy for the 21st century. *Multicultural Education, 25*(2), 17-21.

Karatay, H. (2017). The effect of literature circles on text analysis and reading desire. I*nternational Journal of Higher Education, 6*(5), 65–75.

Mason, K., & Bohl, H. (2017). More than data: Using interactive science notebooks to engage students in science and engineering. *Science and Children, 55*(3), 38–43.

McCormick, M. & Segal, P. (2016). Helping reluctant readers: How to make science texts more available. *The Science Teacher,* 41-45.

Siah, P. & Kwong, W. (2010). The value of reading and the effectiveness of sustained silent reading. *Clearing House, 83*(5), 168-174.

Symonett, P. (2018). 21st century communicators: Creating a classroom environment where students are comfortable to speak and write their mind. *Literacy Today, 36*(3), 26–27.

Waldman, C., & Crippen, K. J. (2009). Integrating interactive notebooks. *The Science Teacher, 76*(1), 51–55.

Whittingham, J. (2013). Literature circles: A perfect match for online instruction. *TechTrends, 57*(4), 53-58.

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A Conversation on Literacy
Thinking Outside the Margins

Alison Mejias Santoro

Abstract: How can teachers better engage students in literacy? Disengagement in classrooms is one of the greatest struggles faced across educational institutions. In the English language arts (ELA) field, educators are taking immense strides to adapt their instruction to promote all forms of literacy, including visual and media literacy. Through this, students become aware of all the literacy around them. Fostering literacy engagement for students in the ELA classroom has been an ongoing discussion for educators. A chief insight fostered by such discussions has been the importance of using instruction to fuse the two worlds of the student: the academic world and the world outside of the classroom. To succeed as literacy educators, we must remind students that literacy lives beyond the classroom.

Introduction

Literacy not only lives within the margins of literature, it also transcends the bound pages to encompass visual and media literacy. In the present world, it is as important to become visually literate and to gain media literacy, as it is to be able to decode written texts. ELA is built on the foundation of literacy, and as educators, we must integrate the other forms literacy takes into our classrooms. When we allow students to work in different types of literacies students are better supported to become fluent and avid readers and writers. With the 21st century's technological progress, learning about visual and media literacy has become essential for students because they are surrounded by it at all times through online communication. The relevance of such learning also ensures that literacy skills developed in the classroom are linked to their lives outside of the classroom.

Sociocultural theory, defined by Ivey and Johnston (2013), describes learning as a means of fostering student identity development in a culturally inclusive and collaborative classroom environment. Building on this theory, a crucial element of student engagement in literacy is offering students opportunities to share and to develop their own identities and cultures. Students need to feel valued in the classroom, and this feeling is fostered through the creation of a comfortable learning environment where each student feels like they can add to the class discussion.

From Status Updates to Due Dates
Fostering Student Identity Development through Media Literacy

Multimodal Communication

Engaging students with literacy in the ELA classroom is often challenging because the constant evolution of technology can make literacy and literature seem outmoded. To combat this educators must adapt their instruction to incorporate relevant

media and technology to help students better connect to both literacy and literature. Bailey and Carroll (2010) provide one model for how teachers can do this. As part of their study of high school students, Bailey and Carroll sought to combat stereotypes about literacy. They began by holding a box filled with objects that required the application of literacy skills. These items included a CD player, a movie, and a board game. The students reacted by explaining that reading skills were not needed with those objects; in response the educators explained how reading skills were required to use those items, and helped them understand literacy more broadly, as including both visual and auditory skills. For educators, Bailey and Carroll (2010) also clarify the importance of using multimodal communication in the classroom:

> Multimodal communication and representation, including film, written scripts, comic strips, music, and photography, encourage students to carefully select information… analyze it in ways that they may not if they are merely reporting it in a traditional format… the use of multiple genres pushes students to make connections they might not typically make. (p. 79)

By using multimodal literature, Bailey and Carroll were able to engage students to develop their reading skills with a deeper interest and connection to the material. Sewell and Denton (2011) argue for a similar approach, explaining "it may be possible to draw on students' out-of-school literacies to help them perform better in our classrooms" by helping students understand that their reading skills are not only linked to books they can utilize these skills in other aspects such as video games, movies, social media, music, and etc. (p. 61). As ELA educators, it is our job to make students aware of the vastness of the written word.

Social Media

Engaging students means bringing a little bit of their world outside of the classroom into their academics. It is no surprise that social media looms over our students creating a constant distraction in the classroom. So why do we look at social media as an enemy and not an ally? Social media can serve as a stepping-stone into media literacy and there can be several benefits from its use in the classroom. The use of social media in the classroom allows popular culture to be fused with academic learning, and this gives students opportunity to blend their personal lives with their academics. Educators and researchers advocate for bringing social media into the classroom to remind students that what they learn in school is important and can be applied to online communication, and to show them their literacy skills transcend the classroom and are relevant well beyond their academic years. In addition, through the use of social media in the literacy classroom educators foster student identity development by allowing students the freedom to create their own social media accounts where they can post their own thoughts and ideas about the classroom texts.

As one example of how this can be done, Hunter and Caraway (2014) studied how Twitter can be used to create an authentic literacy experience for students:

> We wanted to offer high school students genuine opportunities to write authentically and frequently for real audiences beyond those found within the high school's walls…Young people using social networking sites are involved in

> fundamental acts of teaching and learning… Twitter could serve as a medium for providing robust literacy learning moments and powerful literature engagement. (p. 77)

Authentic learning is powerful, and Hunter and Caraway (2014) explain how social media transforms students' understanding of what they learn in the English classroom as they came to see that it can be applied to their personal lives. Within Hunter and Caraway's (2014) study, Twitter was used to develop student identity as well as create a foundation for student motivation. Student identity was developed by allowing students to create their own Twitter account for the class where they shared their thoughts about the text using tweets and hashtags. These tweets and hashtags were personalized by the students and allowed the students to have a voice in their learning. This eight-week study on building student literacy skills through Twitter also allowed students to extend their conversations beyond the classroom to after school hours (pp. 76-79).

Through the course of the study Hunter and Caraway (2014) introduced The Giver by Lois Lowry and used Twitter as a supplemental tool where students wrote their interpretations of the chapters. Each day the students were asked to log back on to Twitter and to read the responses generated from their tweets about their chapter interpretations. As a result, these conversations continued outside of the classroom and after school hours. This led to the spotlighting of student tweets.

> [While we] fully recognize that our students will not experience a world completely similar to that found in The Giver, the more enduring themes present in the novel such as choice, deception, nostalgia, responsibility, and suffering will be recurrent throughout the lives of our young people… by identifying the themes using textual evidence and discussing them in sustained and frequent conversations through Twitter, our students were engaged in… Common Core Learning Standards. (p. 79)

Since Twitter's platform only allows 140 characters of text per tweet, it encourages precise writing. This was the focus of a study conducted by Loomis (2018) which found that using Twitter meant students learned the craft of writing concisely. Loomis found that using Twitter contributed to "the development of sharp editing skills, along with creative uses of punctuation and emoji… It develops student editing skills and encourages critical thinking" (p. 6). Hunter and Caraway (2014) also found that having students use Twitter led to more excitement and classroom interaction. Students started to arrive to class on time and attendance improved. Not only were students encouraged to work and enhance their literacy skills through Twitter, they also learned how to translate academic writing into their personal lives. This gave students the opportunity to analyze texts and to engage with different perspectives regarding literature.

Student Identity

The use of Twitter in Hunter and Caraway's (2014) ELA classroom also allowed students to develop their identities and to express their individuality. Students contributed their own voice through hashtags and tweets not just for their peers but also

for the entire online world to see. This also created accountability in student writing by making their writing public. As Hunter and Caraway write,

> Reimagining the social organization of literacy learning and instruction are essential features for producing transformative classroom environments… English Language Arts and literacy educators are poised to bring forth something different, something new, something meaningful that has the capacity to foster 'authentic thinking, thinking that is concerned about reality. (p. 81)

In taking this approach, teachers, like their students must realize that learning literature does not just live within the bound pages of an article or book but also within status updates, twitter posts, and hashtags. With the rise of social media students are reading more than ever without even realizing. So how can educators help students see that they enjoy reading and writing and that they partake in it every day without realizing it?

In the Eye of the Beholder
Visual Literacy through Movies, YouTube, and Video Games

Movie or Book

The question, "Why do we have to read, isn't there a movie about this?" regularly rings in my ears. As an ELA educator you are often faced with challenging questions and sometimes you find yourself agreeing with your students. After one of my students asked this question, I stood there and thought, "why do they have to read the novel when I can show the movie?" In that moment, I realized how much value movies could provide students in terms of building their ELA skills through visual literacy. I decided to have the students continue to read the novel, but after covering key excerpts, I used the movie as a supplemental tool for students to help them visualize the world the author had created: vivid characters, dialogue, imagery, and other literary elements leapt the page to the movie screen. Students are able to see the words from the page come to life, and at the same time, I am able to teach about visual literacy. This gave students the opportunity to see writing in a different light and considering how texts have been converted into a visual medium allows me to help my students develop a new layer of interpretive and analytical skills.

For example, when the students finished reading an excerpt of William Shakespeare's Romeo and Juliet, they then watched the excerpt come to life and I then had the students write about both, comparing and contrasting what they had visualized from their own reading in comparison to how it was portrayed in the movie adaptation. This specific text was written to be performed for the stage. The students had to think critically about the similarities and differences between the movie and book. This writing exercise allowed students to voice and form their own opinions in relation to two forms of literacy, and as a result, the students developed their own critical voice as writers and readers.

YouTube

The integral role technology plays in students' lives and its immediate presence in all our lives means that it offers a layer of additional supplemental learning for student comprehension. For example, Sewell and Denton (2011) had students read a short story entitled "The Boar Hunt." The students did not realize how dangerous such animals were until they were presented with a YouTube clip that showed the true nature of the boar. The video built on student knowledge and gave the students valuable context for the story. In this way technology acts like a virtual footnote for teachers to utilize during reading. YouTube can also be used as a resource to find audiobook clips which can help bring the rich dialogue of a story to life. Supporting this, many of Sewell and Denton's students reported that the narrative from the audiobook reinforced their understanding of the story because they could hear the characters' individual voices stand out better.

Visual Literacy

Building students' visual literacy can also be an excellent tool for strengthening students' traditional literacy. For example, having students visualize literary elements, breaking them down and defining them in a visual representation can support both types of literacy. In my classroom, I have drawn on visual literacy through emoticon stories to promote student comprehension and critical thinking skills. Emoticon stories are news stories told through only emoticons. This mini-lesson was adapted from James Corden's segment "Emoji News" on The Late Late Show with James Corden (Crabbe & Winston, 2019). Students have to use interpretation skills and their understanding of symbolism to derive meaning from these stories. The class was highly engaged with this five-minute exercise, and students were amazed by the concise nature of storytelling through images. When combined with literary interpretation, visual literacy can fuel student understanding of symbolism in literature because it allows students to discover layers of meaning and build on their interpretation skills needed for reading fluency. An example of this was when my students were discussing the imagery and symbols in Shakespeare's Romeo and Juliet. Together we analyzed the moment when Romeo first saw Juliet and how he described her in comparison to how he described the other characters at the Capulets' party. Romeo compares Juliet to a dove, and the students were able to analyze the symbolism of that comparison, and how the use of this image strengthens the audiences' understanding of Juliet. Shakespeare's dialogue is so rich and dense that it was important for us to stop and break down each word and its meaning. I modeled how to look for imagery or symbols in a sentence and then the students were quick to jump in with their interpretations and understanding of the story.

Video Games

The inclusion of video games promotes active and engaged learning in the classroom because of their popularity among student learners. Ellison and Evan (2016) used games in the ELA classroom in order to bridge the gap between their students' online world of gaming and their classroom world of academics. They write that "When we learn to play video games, we are indeed learning a new literacy and

that video games contribute to learning in principled ways… to learn and think cognitively, socially, and morally" (p. 28). Ellison and Evan's framework for incorporating gaming into their classroom connects the idea that the future of education will center around "cooperative and collaborative learning models which focus on knowledge as a social construct" (p. 29). For a while now educational institutions have been focusing on student-centered learning environments where the students become formally immersed into their learning and become explorers or experts in the core content areas. Therefore, teachers are using creative approaches in their teaching to allow collaborative learning into the classroom, and video games such as Minecraft can provide just that (Persson, 2009).

Minecraft's immersive and creative environment has been used to help students explore symbolism and the many layers a symbol or image in literature can hold. Ellison and Evan (2016) utilized Minecraft in this way to support the teaching of canonical literature:

> In order to enhance students' reading comprehension and visualization skills, students can use Minecraft to recreate different settings and scenes from literature they are currently reading and use the game to offer predictions on what might happen in the texts. (p. 34)

As Ellison (2016) suggests, the video games do not become the focal point of the students' learning but rather function as tools to fuel student learning through increasing engagement and relevancy. In this way, video games are able to transform classrooms from teacher-centered spaces into active and student-centered spaces in which students can transfer what they have learned from the literature into a virtual format. This transfer allows students to see the text from the page come to life.

Conclusion

In the field of education, educators must constantly learn new approaches and strategies to integrate relevant ideas and technologies into the classroom and to keep students engaged. By linking literacy to social media, gaming, and movies. Educators can focus on keeping literacy relevant for their students, and can foster connections between literacy and the outside world. To do so educators must be willing to act as a bridge to bring the two worlds of the student together, the academic world and the world outside of the classroom. Doing so can also foster student identity development and individuality, allowing students to feel valued in the classroom and to have their voice heard. This creates a diverse and engaging environment where students can work together to create meaningful knowledge.

References

Bailey, N. M., & Carroll, K. M. (2010). Motivating students' research skills and interests through a multimodal, multigenre, research project. *English Journal, 99*(6), 78-85.

Crabbe, R., & Winston, R. (2019, Jul 23). The late late Show with James Corden: Emoji news [Television series episode] Los Angeles, CA: CBS Entertainment.

Ellison, T., & Evans, J. N. (2016). Minecraft, teachers, parents, and learning: What they need to know and understand. *School Community Journal, 26*(2), 25-43.

Hunter, J. D., & Caraway, H. J. (2014). Urban youth use twitter to transform learning and engagement. *English Journal, 103*(4), 76-82.

Ivey, G., & Johnston, P. H. (2013). Engagement with young adult literature: Outcomes and processes. *Reading Research Quarterly, 48*(3), 255-275.

Loomis, S. (2018). #Twitter: A pedagogical tool in the high school classroom. *Journal of Language and Literacy Education, 14*(1), 1-10.

Persson, M. (2009). Minecraft [Computer software]. Sweden: Mojang.

Sewell, W. C., & Denton, S. (2011). Multimodal literacies in secondary English classroom. *English Journal, 100*(5), 61-65.

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Mathematics

Incorporating Discourse in Secondary Mathematics

Bethany Borton

Abstract: During my teaching experience, I often came across students who could not speak about the mathematics that we were dealing with. There was a disconnect between mathematical concepts and processes. I kept wondering, what do math educators and researchers know about discourse and how do we effectively engage students in it? When the teacher acts as a guide and uses certain strategies such as reflective discourse, funneling, or word walls, students will better conceptually understand the mathematics they are trying to learn. Not only will their conceptual understanding and achievement increase, but also students will reap the important benefit of seeing math as created by communities. This article will share strategies to enhance student discourse in secondary mathematics classrooms.

Introduction

What do we, as math educators, know about discourse in higher education mathematics classrooms? This is a question that came to the forefront of my inquiries during my student teaching experience. Throughout the past year in my geometry classroom, it has become clear that students lack understanding of mathematical vocabulary and the ability to reason and communicate about mathematical ideas and practices. I remember one specific time I asked students, "How do we find the slope of the perpendicular line?" Immediately, a student responded saying, "What does perpendicular mean?" Once they were reminded of what perpendicular meant, they automatically remembered the process of finding its slope. There was a clear disconnect between concepts and procedures. By not knowing the language of mathematics, the student was confused. Math and talk are not normally something that students (or teachers) think go together. In a traditional mathematics classroom students and teachers see mathematics as a process of "doing" and only that. As a math teacher, not only do I want my students to be able to "do" the math, but I also want students that are able to explain and share their reasoning or ideas with others. In the process of doing so it will create well-rounded students and critical thinkers.

The answer to the question, what do we know about discourse, is critical for mathematics teachers (especially new teachers) because mathematical ideas can be more deeply explored when communication and discourse are involved and required. Students who do not have the ability to communicate tend to lack conceptually the basis of the mathematics at hand. Although, many researchers have noted the difficulty of engaging students in productive discourse, they have also shown how effective and important it is for mathematics students. Discourse has become a part of the reform in math education and has made its way to be a part of the National Council of Teachers of Mathematics (NCTM) Standards for Teaching Mathematics (as related to discourse). Their standards provide expectations for both the teacher's role in discourse (standard 2) and the student's role in discourse (standard 3). First, what is effective discourse? As defined by NCTM, "Discourse is the math-

ematical communication that occurs in a classroom. Effective discourse happens when students articulate their own ideas and seriously consider their peers' mathematical perspectives as a way to construct mathematical understandings" (NCTM 2010, 1991). There are many different ways to incorporate discourse into the math classroom. Although it is tough at first, a teacher must take on specific roles when implementing and engaging students in discourse. By engaging students in discourse with different strategies, students' conceptual understanding and achievement will be greater.

Teacher's Role

Cobb, Boufi, McClain, and Whitenack (1997) did an analysis between classroom discourse and mathematical development in order to find possible relationships between the two. This study used two episodes/situations from a first-grade math classroom. This study specifically focused on reflective discourse where mathematical activity is objectified and becomes an explicit topic of conversation. This study differentiated between students' development of mathematical concepts and their development of a general orientation to math activity. Within the analysis and study it addressed the issues of both the teacher's role and the role of symbolization in supporting reflective shifts in discourse. They analyzed two areas of the students' understanding: 1) their construction of specific mathematical conceptions and 2) the general orientation to mathematical activity that participation in the discourse might foster. From this study of the two classroom episodes and two areas of student understanding, it showed that the teacher has specific roles in reflective discourse. The teacher's role should be to guide and as necessary initiate shifts in discourse such that what was previously done in action can become an explicit topic of conversation. Another role that both episodes made apparent is that the teacher must develop the symbolic records of the children's contributions. It is important that the students develop and notice the concepts from their activities and NOT the teacher providing it for them. The teacher needs to practice the "elicit-support-extend" strategy. This study shows that when the teacher takes on these roles it creates effective and positive classroom discourse (Cobb, Boufi, McClain, & Whitenack, 1997). By purposefully choosing to involve discourse in a mathematics room and following the teacher roles there will be many different benefits created in the classroom for the students.

Benefits of Discourse Rich Classrooms

Walshaw and Anthony (2008) completed a study by reviewing and analyzing many research articles involving classrooms where communication about mathematics (discourse) is the central focus. Walshaw and Anthony highlight key themes and assess the kinds of characteristics/strategies that promote mathematical discourse in the classroom that allow students to achieve learning outcomes. For their study, they used the National Research Council's (2001) understanding of mathematics, which included conceptual understanding and adaptive reasoning. Through their review, they found that a number of activities related to pedagogical practice came to the

forefront. These include participating rights and obligations, articulating thinking, fine-tuning mathematical thinking through language, and shaping mathematical argumentation. Together these activities provide insight into definitions of effective domain specific pedagogy for discourse in mathematics. From reviewing classrooms with these activities and focus, Walshaw and Anthony found three main (and huge) benefits of classroom discourse. Valuing and shaping students' mathematical contributions serves these important functions (Walshaw and Anthony, 2008):

1. allowed students to see mathematics as created by communities,

2. supported students' learning by involving them in the creation and validation of ideas, and

3. helped students to become aware or more conceptually advanced forms of math (p. 529-530).

The results of each study reported in their review showed these benefits and the theme that encouraging discourse has to be made a priority by the teacher. I can attest to the value of these benefits. In my internship my students completed a hands-on activity where students found the relationship between a central angle and an inscribed angle (of a circle). Afterwards students were asked to formulate a conjecture about the relationship they saw. Using reflective discourse and prompting students by asking questions such as, "What relationship did you see?" students were able to communicate with each other (and building upon each other) to verbalize the concept that the central angle is two times the size of an inscribed angle. After doing the activity and reflecting upon it as a class the students felt like geniuses because they were able to see this math concept as created with each other and they were involved in the creation of the conjecture (or rule) about what they saw and validated their ideas. During the discourse as the teacher I had to guide and prompt them to use the correct language such as central angle, inscribed angle, and lead them to discuss the relationship between the two (not random facts or what they did in the activity). As the teacher I did NOT say, "Did you see how the central is twice the inscribed?" Asking a question or making a statement telling them the relationship is not going to allow them to reap these benefits or learn socially together through communication in a community, which are the important factors of discourse. In order to create discourse that reaps these benefits there are specific strategies and practices that a teacher can implement into their classroom.

Strategies and Practices

Temple and Doerr (2012) completed a study with the goal of identifying the interactional strategies that one teacher used in a discourse rich tenth-grade classroom to develop her students' facility with the mathematical register. Looking at the mathematical register as multi-semiotic and having a specific grammatical patterning, they used discourse analysis to examine the teacher's initiation and feedback moves that supported students in using symbolic and natural language in mathematical ways during three consecutive lesson episodes. From this study, the findings show that when the goal was to activate prior knowledge or get them to talk about newly

learned concepts the interaction followed a pattern of "funneling" or "leading" the production of accurate and precise language rather than exploration or explanation. However, when the goal was for students to co-construct new knowledge the interaction followed a "focusing" or "probing" pattern that pushed the students to explain their thinking and build on each other's contributions.

To understand what one of these looks like in a classroom we will look at one of the learning episodes that incorporated "funneling" and "leading" questioning techniques by the teacher in this study (Temple and Doerr, 2007, p. 299-300; see https://doi.org/10.1007/s10649-012-9398-6). At the end of each line, they have defined the type of question or feedback move made by the teacher to aid in your reading of the learning episode where T is for the teacher's remarks and S is for a student's remarks.

From this learning episode, we can see that repetition and metalinguistic feedback (turn 59) were two feedback strategies that the teacher used to push the students to correct inaccuracies in their descriptions. Most of the teacher's recasts consisted of her converting well-formed student sentences into symbolic expressions that were variations on the representation constructed by the class during the teaching of new material (turns 61 and 71). It is significant to note that the teacher was not the only source of feedback in this episode; students also gave feedback to each other and to the teacher (turns 66 or 72). The students' feedback turns show that they were actively following the conversation and monitoring their own understanding (which is what we want to happen through discourse). In this episode, the teacher's interactional strategies would be an example of "funneling" students toward predetermined answers. Yet, both the initiation and feedback moves demonstrated by the teacher pushed the students to use the mathematical register to work with newly learned concepts. Importantly, the data from this study shows that students were able to do this with increasing accuracy and fluency throughout the episode (Temple & Doerr p. 300, 2007). From this specific learning episode, we as teachers can learn how to guide our students through specific feedback questioning techniques in order to "funnel" to an answer that we want our students to learn about the mathematical concept at hand.

Similarly, Smith and Stein (2011) present what they believe to be the five practices for orchestrating productive discussions in the classroom. After studying student work from a math teacher's classroom, they have identified an "incorrect" way of having mathematical discussions. The work shows that when a teacher conducts "show and tell" discussions, they cannot be counted on to move the entire class forward mathematically. "A related criticism concerned the fragmented and often incoherent nature of the discuss-and-summarize phases of lessons. In these "show-and-tells," as exemplified in Mr. Crane's classroom, one student presentation would follow another with limited teacher (or student) commentary and no assistance with respect to drawing connections among the methods or tying them to widely shared disciplinary methods and concepts. There was no mathematical or other reason for students to necessarily listen to and try to understand the methods of their classmates" (p.319). From the faultiness that they had noticed in mathematical classrooms and in the generation trying to implement discourse (not so greatly), Smith and Stein created a framework that should be used for discussion facilitation. Their model consists of five practices:

1. anticipating likely student responses to cognitively demanding mathematical tasks,

2. monitoring students' responses to the tasks during the explore phase,

3. selecting particular students to present their mathematical responses during the discuss-and-summarize phase,

4. purposefully sequencing the student responses that will be displayed, and

5. helping the class make mathematical connections between different students' responses and between students' responses and the key ideas (p 321).

With the practices that Smith and Stein integrated together from their observations and other research, they believe it is a model that will help prepare teachers to become facilitators of discussion. The premise underlying this article and their theory is that the identification and use of the five practices (anticipating, monitoring, selecting, sequencing, connections) can make student-centered approaches to mathematics instruction more accessible to and manageable for more teachers (Stein, Engle, Smith, & Hughes, 2008). By incorporating this framework of practices as new teachers, it will be easier to have a mathematics classroom that is rich in discourse by having a model to follow. These strategies and practices are not the only ones in creating mathematical discourse, but they guide and provide many keys and processes for a new teacher wanting to have productive discourse.

Conclusion

So, what does all of this research mean for mathematics teachers? This research shows the importance and how vital discourse and communication is in the classroom for students. By being a guide and using strategies such as reflective discourse, Smith and Stein's model (2008), or feedback moves that funnel or probe, teachers can create positive and productive discourse. By doing so, students' conceptual understanding is going to be heightened and not only will they "do" mathematics, but they will also be able to communicate mathematics. Most importantly, students are going to reap the vital benefits of seeing mathematics as created by a community and being involved in the validation of the ideas they have created together.

References

Cobb, P., Boufi, A., McClain, K., & Whitenack, J. (1997). Reflective discourse and collective reflection. *Journal for Research in Mathematics Education, 28*(3), 258-277.

National Council of Teachers of Mathematics (2010). Discourse. Retrieved from https://www.nctm.org/uploadedFiles/publications/write_review_referee/journals/mtms-call-Discourse.pdf

National Council of Teachers of Mathematics (1991). *Professional standards for teaching mathematics.* Reston, VA: NCTM.

Smith, M. S., & Stein, M. K. (2011). *5 practices for orchestrating productive mathematics discussions.* Reston, VA: NCTM.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and Learning, 10*(4), 313-340.

Temple, C., & Doerr, H. (2012). Developing fluency in the mathematical register through conversation in a tenth-grade classroom. *Educational Studies in Mathematics, 81*(3), 287-306. Doi 10.1007/s10649-012-9398-6

Walshaw, M., & Anthony, G. (2008). The teacher's role in classroom discourse: A review of recent research into mathematics classrooms. *Review of Educational Research, 78*(3), 516-551.

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Project-Based Learning in High School Mathematics

Kimberly D. Kurtz

Abstract: As national mathematics scores continue to decline, it is obvious that the methods we are using to teach mathematics are not working. There is an evident need to find instructional methods that make math relevant and worthwhile. Project-based learning has received attention lately as an instructional technique that engages students in active learning. Research supports that the use of project-based learning activities has a positive influence on student engagement. Additionally, studies have found that students demonstrate a better, deeper understanding of the content through project-based learning activities. By using project-based learning in a high school mathematics classroom, educators can enhance student engagement and motivation, which have a direct impact on student achievement.

Introduction

In 2018, the national average mathematics score on the ACT was 20.5, the lowest average score in 20 years (Gewertz, 2018). Are students, as they often claim, "just not good at math"? A goal of educators is to make mathematical content more relevant and engaging to their students, while creating a deeper understanding of the mathematical concepts. As national mathematics scores continue to decline, it is obvious that the methods we are currently using to teach mathematics are not working, or at the very least, need to be revised. There is an evident need to find different instructional methods that make math relevant and worthwhile to students today.

According to Harrington (2016), international test scores have shown that students in the United States rank below 36 countries or educational systems out of the more than 70 that participated. Mathematics continues to be the subject in which the United States performs the worst (Harrington, 2016). For our youth to be able to compete globally, change is crucial. This change needs to happen in the classroom at an early age and continue throughout a student's post-secondary education. By utilizing a project-based learning (PBL) approach in mathematics, educators can ensure that students will acquire a deeper knowledge of content by actively exploring real-world problems and challenges.

Too often, learning in the mathematics classroom revolves around the rote memorization of basic skills and procedures. This type of learning does not allow for a deeper understanding of the mathematical concepts that students are to learn and be able to apply to authentic situations. Furthermore, rote memorization does not involve active learning. It is neither long lasting, nor is it meaningful to the student. Yet, according to Parker (2015), rote memorization continues in classrooms across the United States. Commonly, teaching that focuses on rote memorization may lead to disengagement and boredom in the classroom. Students have insufficient problem-solving skills and do not perform well when it comes to critical thinking applications. The lack of student understanding in mathematics combined

with boredom in the classroom are critical problems in education today affecting student learning.

According to Grossman, Schoenfeld, and Lee (2005), standards-based curricula were developed following the 1989 issuance of the first NCTM Standards. The curricula focus much more on applications, mathematical contexts, statistics, problem solving, and making connections. Unlike the traditional lecture, practice, and assess approach in a mathematics classroom, project-based learning incorporates real-world applications and problem solving, allowing students to make connections and develop a deeper understanding, retaining the material they have learned. By utilizing a project-based learning curriculum in mathematics, educators can ensure that students will acquire a deeper knowledge of content by actively exploring real-world challenges.

Project-Based Learning

Definition of PBL

For today's students to be college and career ready, there needs to be a drastic change in the way mathematics is taught. "High school students are not gaining a full understanding of the basic principles of science and math, with nearly 30% of U.S. students entering college in the fall of 2000 having to enroll in remedial science and math courses" (Foutz, Navarro, Hill & Thompson, 2011, p. 24). As students' test scores in math continue to decline, new instructional methods need to be implemented. A shift from the traditional classroom and traditional teaching methods needs to occur, making learning more relevant to students. Educators need to limit the use of rote memorization in the classroom and find engaging lessons that stress problem solving and critical thinking.

Project-based learning is a student-centered method of instruction in which students gain deeper knowledge by actively exploring and investigating an authentic, engaging, and complex question, problem or challenge (Buck Institute for Education , 2017). Students are still learning the content and standards that are a part of the curriculum, however, the presentation is different. Rather than memorizing math processes and completing practice exercises after a lesson is taught, students are confronted with an authentic problem or issue which they must solve by engaging in inquiry, collaborating with their peers, making informed decisions based on prior knowledge, reflecting on their choices, self-assessment and peer-assessment, revising, and displaying or presenting their final solution to the challenge.

Benefits of PBL

Project-based learning has received a lot of attention lately as an instructional technique that is student-centered and engages children in active learning. The idea of project-based learning has roots dating back to the progressive education movement in the late 1800's with pioneers of John Dewey and William Heard Kilpatrick. According to Dewey, educators should learn about their students' interests and find unique ways to tie those interests into meaningful learning experiences

(Pieratt, 2010). Education must be regarded as a continuous reorganization of experiences with which to make connections and to allow for a deeper understanding (Pieratt, 2010). As a successor to Dewey, William Heard Kilpatrick was the first to describe a project method of study in the early 1900's. Kilpatrick's method was used to cultivate student motivation by allowing student choice in education (Larmer, Mergendoller & Boss, 2015). Project-based learning made its debut in education in the early 1990's, engaging students in projects that enhanced the learning experience (Foutz et al., 2011).

There are several different ways that students benefit from a project-based learning (PBL) approach to instruction. Students are engaged in inquiry and active learning surrounding a problem which must be explored. Using PBL in the classroom helps to teach the importance of organization. Thorough and careful planning is essential to the flow of the project and the success of the student (Bell, 2010, p. 40). Additionally, PBL enhances students' ability to collaborate with one another because they must actively listen and communicate with their peers. PBL helps students develop twenty-first century skills, such as communication, negotiation, and collaboration (Bell, 2010). Differentiation is essential to PBL, as students have a choice in the method in which they approach a problem. Allowing for student choice often leads to increased motivation. One exciting feature provided by this intrinsic motivation is that students will often reach higher and attempt to read more challenging material to glean the information they seek (Bell, 2010, p. 41). Another benefit of using PBL in the classroom is that students become better problem solvers and increase their higher order thinking skills by making connections to the real world. Finally, Bell (2010) suggests that utilizing PBL in the classroom can have positive effects on how well students are prepared for becoming productive citizens. "By implementing PBL, we are preparing our students to meet the twenty-first century with preparedness and a repertoire of skills they can use successfully (Bell, 2010, p. 43).

Aspects of a Quality PBL Lesson

"The goals and expectations for schooling have changed quite dramatically during the past century, and new goals suggest the need to rethink such questions as what is taught, how it is taught, and how students are assessed" (NRC, 2000, p. 152). Project-based learning is self-directed. The teacher becomes the guide, rather than the focus of the lesson. Students take responsibility and ownership for their learning, making learning more concrete. By adopting these practices in the classroom, student learning becomes more meaningful.

The project-based curriculum requires a multifaceted learning environment. It should be a combination of a learner-centered, knowledge-centered, and assessment-centered environment. As a learner-centered classroom, "a key strategy is to prompt children to explain and develop their knowledge structures by asking them to make predictions about various situations and explain the reasons for their predictions" (NRC, 2000, p. 134). This is a key component of a project-based lesson. Additionally, "knowledge-centered environments intersect with learner-centered environments when instruction begins with a concern for students' initial preconceptions about the subject matter" (NRC, 2000, p. 136). Another key component

of the project-based learning approach is for the students to discuss and analyze a problem with which they have been presented. They rely on prior knowledge and inquiry-based questioning.

There are many aspects of a good project-based learning activity. A good project-based lesson includes a focus related to a larger task or problem. It contains a challenging, yet attainable, problem or question that is both authentic and a real-world issue. Student inquiry involves asking questions, using prior knowledge, utilizing multiple resources, and applying information. Students work collaboratively and have a choice in the methods they will use to explore the problem. Making decisions will allow students to take ownership of the project and their own learning. Reflection is another important feature of project-based learning. Students and educators reflect on the learning and understanding throughout the project. Project-based learning involves both self-assessment and peer-assessment, with feedback to revise and improve results. A final piece of a good project-based learning activity is the presentation of the final project or solution.

PBL and Student Engagement

A study by Beckett, Hemmings, Malthie, Wright, Sherman, and Sersion (2016) investigated the use of hands-on project-based learning activities and the impact it has on student engagement. This study centered on the students at Hughes High School in the Cincinnati Public School district. After some restructuring in the district, Hughes High School reopened in 2008 as a STEM school. The composition of students in Hughes High School was predominantly minority and economically disadvantaged where 90% of the student population was African American; 28% had special needs; and 67% were economically disadvantaged (Beckett et al., 2016). This research supports the use of project-based learning activities as having a positive influence on student engagement in the classroom. Results indicate that emotional and behavioral engagement was significantly increased when students were presented with hands-on investigations of real-world project activities (Beckett et al., 2016).

Another study by Shin (2018) looked at the effects of project-based learning on students' motivation and self-efficacy. The findings were similar to those of Beckett et al. (2016). There were 79 students who participated in this study. Participants were placed into teams of six students. They were to engage in team activities, collaborate on team goals, and produce a team project. Researchers found that the higher the self-efficacy of the student, the higher the self-efficacy of the project-based learning. Moreover, the relationship between the student's self-efficacy and the learning motivation appear to be closely related. The findings of this study show that students learned more content, were more motivated to learn, and had a positive attitude about learning when presented with PBL activities as compared to traditional learning methods (Shin, 2018, p. 107). Motivation is crucial in a student-centered learning environment, such as project-based learning. Self-efficacy is equally important. "Project-based learning can contribute to the development of students' creativity, internal motivation and interest, responsibility, communication skills with others, social skills, cooperation, and problem-solving ability" (Shin, 2018, p. 97).

PBL and Student Achievement

Siswono, Hartono, and Kochar (2018) investigated how implementing project-based learning affected student learning outcomes, student responses, and student activity. This study involved two seventh grade statistics classes at a lower secondary school in Indonesia. One class was taught using PBL activities, while the other class was taught by conventional methods. Student activity and student responses were analyzed. Pretest and post-test data were collected. The study found student learning outcomes and student activity to be higher in the classroom using PBL activities as compared to the students in the conventional classroom. Additionally, students in the PBL class scored higher than the minimum standard score on assessments. This study shows the effectiveness of using a PBL approach in a mathematics class. The findings indicate that the students were passionate about the project and communicated about their work with their classmates (Siswono, Hartono & Kochar, 2018).

Holmes and Hwang (2016) wanted to know the effects of PBL on secondary mathematics students' academic skill development. They researched the impact of project-based learning on secondary mathematics learners; specifically, the effects PBL can have on student learning and student engagement (Holmes & Hwang, 2016). The study involved 8th and 9th grade students at both project-based learning and conventional high schools. The control group consisted of conventional classes which are taught by 70% lecture. This study found that "at-risk and minority students benefited greatly from project-based learning in learning mathematics" (Holmes & Hwang, 2016, p. 449). While an academic performance gap still existed, it diminished significantly with PBL.

> The PBL students became more intrinsically motivated (from 25% to 67%); showed they believed more that they were in control of their own learning (from 75% to 98%); showed an increased appreciation for peer learning (33% to 67%); and learned to regulate their study time and study environment more (from 75% to 88%) (Holmes & Hwang, 2016, p. 458).

Another study by Han, Rosli, Capraro, and Capraro (2016) wanted to know the effectiveness of project-based learning on student achievement in the areas of algebra, geometry, probability, and problem solving. This was an in-depth analysis of two groups of students from 2008 until 2010. The investigation involved students who participated in STEM project-based learning lessons and students in schools where teachers did not incorporate PBL. Participants were a group of diverse students enrolled in six small urban, low socioeconomic high schools. Extensive professional development regarding project-based learning was offered to teachers in three of the high schools. These teachers implemented project-based learning activities in their classes. Teachers in the other three high schools did not have the opportunity to attend the professional development. The findings of this study were that students who demonstrate a deeper understanding through project-based learning activities develop a better understanding of the mathematical content.

Conclusion

For students to be college and career ready, there needs to be a drastic change in the way mathematics is taught in the classroom. As students' test scores in math continue to decline, new instructional techniques need to be implemented. A shift from the traditional classroom needs to occur. Project-based learning makes learning relevant, interesting, and motivating to students. Additionally, project-based learning helps students to develop problem solving skills and critical thinking skills needed today. In short, project-based learning helps students to become better thinkers.

References

Beckett, G. H., Hemmings, A., Maltbie, C., Wright, K., Sherman, M., & Sersion, B. (2016). Urban high school student engagement through CincySTEM iTEST projects. *Journal of Science Education and Technology, 25*, 995-1008.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House, 83*, 39-43.

Buck Institute for Education. (2017). What is project based learning (PBL)? Retrieved from http://www.bie.org

Foutz, T., Navarro, M., Hill, R., & Thompson, S. (2011). Using the discipline of agricultural engineering to integrate math and science. *Journal of STEM Education, 12*, 24-30.

Gewertz, C. (2018). Math scores hit lowest mark in two decades on ACT. *Education Week, 38*, 7.

Grossman, P., Schoenfeld, A., & Lee, C. (2005). Preparing teachers for a changing world: What teachers should learn and be able to do. *Choice Reviews Online, 43*, 201-231.

Han, S., Rosli, R., Capraro, M., & Capraro, R. (2016). The effect of science, technology, engineering and mathematics (STEM) project based learning (PBL) on students' achievement in four mathematics topics. *Journal of Turkish Education, 13*, 3-29.

Harrington, T. (2016). U.S. math scores decline on international test of 15-year-olds. Retrieved from http://www.edsource.org

Holmes, V. & Hwang, Y. (2016). Exploring the effects of project-based learning in secondary mathematics education. *Journal of Educational Research, 109*, 449-463.

Larmer, J., Mergendoller, J. R., & Boss, S. (2015). *Setting the standard for project based learning: A proven approach to rigorous classroom instruction*. Alexandria, VA: ASCD.

National Research Council (NRC). (2000). *How people learn: Brain, mind, experience, and school*. Washington DC: The National Academies Press.

Parker, C. (2015). Research shows the best ways to learn math. Retrieved from http://www.ed.stanford.edu

Pieratt, J. (2010). Advancing the ideas of John Dewey: A look at the high tech schools. *Education & Culture, 26*, 52-64.

Shin, M. (2018). Effects of project-based learning on students' motivation and self-efficacy. *English Teaching, 73*, 95-114.

Siswono, T., Hartono, S., & Kochar, A. (2018). Effectiveness of project based learning in statistics for lower secondary schools. *Eurasian Journal of Educational Research, 75*, 197-212.

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Equity in Problem-Based Learning
A Guide for Teachers of Mathematics

Emily Mylek

Abstract: Achieving equitable outcomes in mathematics instruction is a lofty but elusive goal, as evidenced by standardized test results and representation in high-level courses. The role of teacher bias in choice of instructional materials and implementation requires strategic examination and corrective action in order for an individual teacher to begin pursuing equity in the classroom. Problem-based curriculum is a step towards using high-quality instruction to ensure that all students have access to challenging mathematics and the support they need to succeed. A closer look at a teacher's implementation of such curriculum illuminates the teacher practices needed to promote equity within the framework of a problem-based instructional model.

Introduction

Equity in mathematics instruction is dependent upon teacher beliefs and biases, which influence curriculum choices, instructional models, and expectations about who can learn mathematics. Problem-based learning is a reform model of teaching mathematics; in this kind of classroom, students "do math and talk about it," a shift from the traditional model of mathematics instruction demarcated by students doing more of the talking than their teacher. As equity-minded teachers implement this model, attention must be paid to which students are doing most of the talking, and whether the curriculum is engaging all students, particularly those students belonging to groups that typically lag in achievement. Mathematics classrooms characterized by problem-based learning and discussion can powerfully promote equity through carefully considered teacher practices.

Understanding Bias

Teachers, like all members of the human race, have unconscious biases, which can be thought of as unproductive beliefs based on faulty assumptions or stereotypes. Teachers are also, generally, well-intentioned individuals who are dedicated to ensuring that all students entrusted to them learn and grow. These good intentions can make teachers reluctant to admit to unproductive beliefs about some students, but it must be understood that bias is a universal condition that, left unexamined, will ultimately undermine teachers' ability to be effective. Instead of investing effort in defensiveness about intentions, teachers focused on equally educating all students must be willing to counter their unproductive beliefs.

Equal education for all students has long been a struggle for American public schools across all subjects, including mathematics. The National Assessment of Educational Progress (NAEP) test, administered from 1969 onward, has made it impossible to ignore the persistent gaps in achievement between groups of American students. A great deal of effort has been made to "close the gap," and while the

performance of all students trends upward, the gaps persist, as shown in Figure 1. Achievement gaps in math exist between students who are White and those who are Black or Hispanic; between English speakers and English-language learners (ELLs); and between high- and low-income students, as indicated by qualifying for the National School Lunch Program. Many students belong to an intersection of these groups; it is this kind of student who is most in need of high expectations from teachers who believe deeply in the ability of all students to succeed. Notably, the gap for each group has consistently widened from 4th to 8th grade, indicating that the middle grades of math instruction are vital for cultivating equitable practices (NRC, 2017).

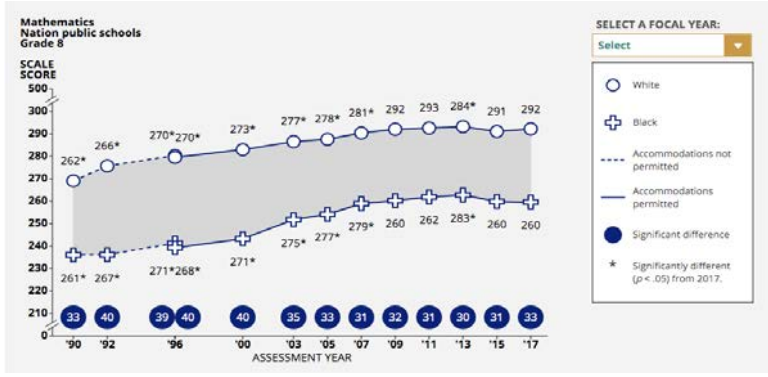

Figure 1. Mathematics scores for white and black students in grade 8 (compiled from NRC, 2017).

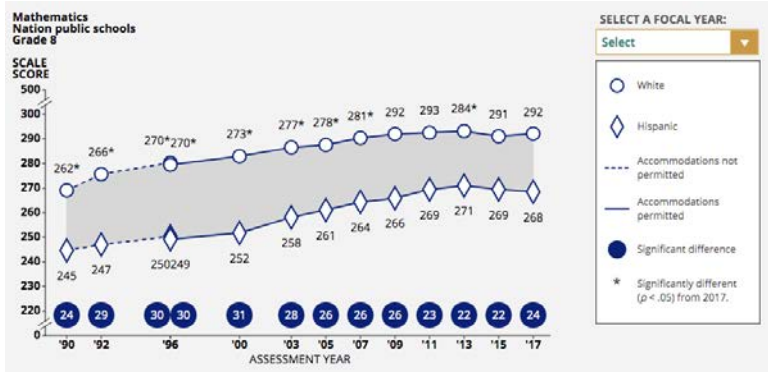

Figure 2. Mathematics scores for white and hispanic students in grade 8 (compiled from NRC, 2017).

Awareness of the ongoing gap in achievement between groups of students may contribute negatively to teacher expectations of certain groups. In fact, the belief that the achievement gap can be primarily attributed to factors that schools cannot control, such as student characteristics or home environment, has been found to be prevalent among teachers (Bol and Berry, 2005). Research has found that teachers tend to have significantly lower expectations of certain sub-groups, including Black, Hispanic, and low-income students (Ferguson, 1998; Boaler, 2002). Although teachers are often unaware of the bias behind these beliefs, Jackson and Delaney (2017) argue that "we use our beliefs, productive and unproductive, to make assumptions

and instructional decisions," which may explain the prevalence of basic-skills mathematics instructions in low-income, high-minority schools. In turn, this low-level style of instruction contributes to lower overall achievement for these students, creating a self-perpetuating cycle. This ultimately contributes to the under-representation of certain students in higher-level math courses and related career fields (Viadero, 2000). It is unjust to think of these students as under-achieving within a system that has failed to educate them for decades; instead, students belonging to these lower-achievement groups ought to be referred to as under-represented.

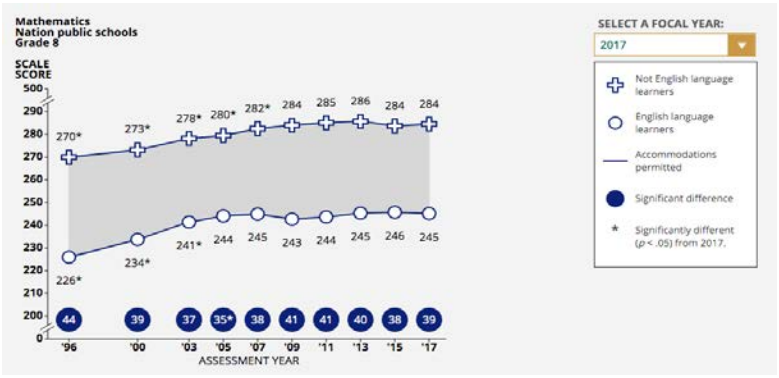

Figure 3. Mathematics scores for non-ELL and ELL students in grade 8 (compiled from NRC, 2017).

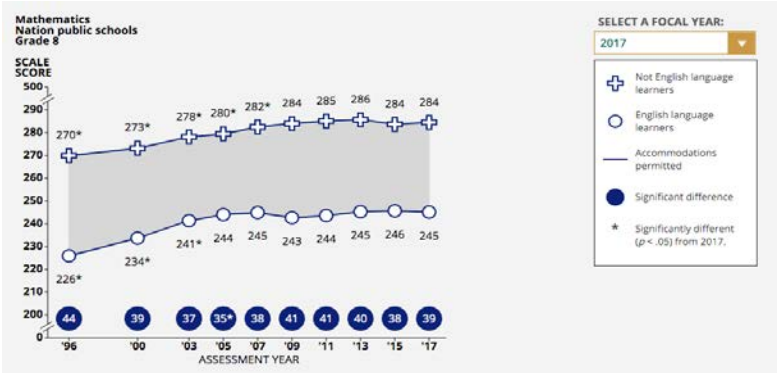

Figure 4. Mathematics scores for NSLP non-eligible and eligible students in grade 8 (compiled from NRC, 2017).

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To interrupt this cycle, a number of strategies can be employed to discover and combat biases and low expectations. These strategies are made more effective when a group of teachers and administrators from the same school engage in them together (Jackson & Delaney, 2017). Harvard's self-administered, online implicit bias test can reveal unconscious biases against certain groups (Fiarman, 2016). Biases identified by this evidence-based assessment can be confronted via exercises that build empathy for other cultural groups, such as reading journal entries written by students of color about their experiences as learners of mathematics (Fiarman, 2016). Teachers must also strive to understand the cultural background and individuality of each of their students, rather than relying on stereotypes as the basis of their interactions (Jackson & Delaney, 2017). Students internalize the stereotypes they experience from broader societal influences to shape their identities as math learners; it is the job of teachers to help students identify themselves as resilient learners of mathematics (Aguirre, Mayfield-Ingram, & Martin, 2013). Finally, it is vital for teachers to recognize their under-represented students' unique strengths in order to challenge "the common notion that students need to learn math in spite of who they are…students need to learn mathematics in light of who they are and the diverse gifts that they bring" to the classroom (Aguirre et al., 2013, p.10). As teachers begin to escape previously hidden unproductive beliefs about their students, they will become equipped to help their students escape them as well.

Equity in Problem-Based Learning

The idea of an equal education for all is a simplified version of the principle of equity. The National Council of Teachers of Mathematics defines equity as a key principle for effective math instruction, as described in the NCTM position statement on equity and access.

> Creating, supporting, and sustaining a culture of access and equity require being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and assessing its effectiveness. Acknowledging and addressing factors that contribute to differential outcomes among groups of students are critical to ensuring that all students routinely have opportunities to experience high-quality mathematics instruction, learn challenging mathematics content, and receive the support necessary to be successful. Addressing equity and access includes both ensuring that all students attain mathematics proficiency and increasing the numbers of students from all racial, ethnic, linguistic, gender, and socioeconomic groups who attain the higheest levels of mathematics achievement. (NCTM, 2014a)

It is important to note the distinction between equal and equitable education. Equality, as math teachers know, means two objects are identical; students receiving an equal education are receiving a set of instructional practices that are identical and indistinguishable. Equity requires more nuance. When teachers "[acknowledge and address] factors that contribute to differential outcomes," they must be focused on meeting the unique needs of each student, situated within all of their identities, within a system that chronically under-serves those belonging to groups described in the final sentence of the position statement (NCTM, 2014a). The work of addressing unconscious biases through awareness, empathy, and cultural understanding is an essential prerequisite to equitable instruction.

The three ingredients of equity that impact classroom instruction are high-quality instruction, challenging mathematics content, and support necessary for success (NCTM, 2014b). While the term "achievement gap" is useful for naming a statistical reality, it by implication blames students for their failure to achieve. Equity demands thinking of it as an instruction gap, which places the responsibility at the feet of the educators charged with teaching high-quality mathematics to all students. A teacher's choice of procedural, basic-skills instructional practices does not originate from malicious intent, but from the sincere, albeit misguided, belief that students from certain backgrounds are unable to "handle" a high level of mathematical thinking (Bol & Berry, 2005). On the contrary, faithful implementation of high-quality curriculum results in higher achievement for all students, but notably, has the important effect of decreasing racial and socioeconomic performance gaps (Schoenfeld, 2002). The proliferation of available high-quality curricula, such as the problem-based model authored by Illustrative Mathematics (n.d.; see https://curriculum.illustrativemathematics.org/MS/teachers/what_is_pbc.html), makes this kind of instruction viable for in-service teachers.

Presenting challenging mathematics content to students requires teachers to revise existing beliefs about what constitutes success in mathematics. Part of the allure of routine instruction is students' ability to emulate processes with admirable precision in spite of a lack of understanding of the underlying concepts. Causing struggle is difficult for teachers who are accustomed to this shallow kind of success, and the skill to balance the challenge so that students engage in productive struggle without giving up approaches an art form (Smith & Stein, 2011). Many teachers also resist the notion that students can learn the procedural fluency they need from engaging only with problem-based mathematics. This fear has proven to be unfounded, since students receiving this kind of instruction showed gains in both problem-solving and in basic skills, even when the latter was not emphasized outside of problem contexts (Schoenfeld, 2002).

Determining the support necessary for student success is a key component of creating equitable math classrooms. Ongoing debate about the most effective format of curriculum often neglects to consider how the curriculum is implemented; the key factor is the skill of the teacher in connecting the mathematics learning intended to the actual learning outcomes achieved by their students, regardless of curriculum (Boaler, 2002). Smith and Stein (2011) describe five practices that can make the difference between a mathematics classroom in which discussion is disconnected talking and one that connects intended to actual learning; the teacher must anticipate student responses, monitor student work in class, select student work to

focus the discussion, sequence the mathematical ideas that will be discussed, and connect the discussion to the mathematical learning that was its objective. Teachers making these kinds of instructional moves are already exhibiting a great deal of skill, but must take additional steps to ensure that the result is truly equitable, as we will see in the following vignette.

Teacher Practices for Equity

Ms. Clark is a fifth-year teacher who has intentionally sought to understand her students' cultural backgrounds and confront her own biases as she teaches in an urban school in a mid-size midwestern city. This is the first year she has implemented a problem-based curriculum in her grade 8 math class. Twenty-two students are seated in groups of four or five, which are randomly assigned several times within an instructional unit. The learning objective is printed clearly on the board: "Write the equations of lines in y=mx+b form, and explain where to find slope and vertical intercept in both an equation and a graph."

After a brief warm-up activity that helps students recall the definition of geometric translation, Ms. Clark introduces the first activity of the day by asking for a show of hands to answer, "How many of you have earned money from another family paying you to do something?" About half of the hands in the room go up, and a small burst of chatter occurs at one table. Ms. Clark only catches the last part of the exchange.

Jaden: I get bread, don't worry about it.

Ms. Clark: Raising hands does not mean opening your mouth, Jaden. Ok, let's try an actual silent response this time. How many of those jobs were babysitting? (A few hands go back up). So that's the job Diego has in this situation. He earns $10 per hour of babysitting and is keeping track of his earnings. Question about that, Malena?

Malena: Does he always babysit the same number of kids? If I babysit my cousin's three kids I charge more.

Ms. Clark: That's a good example of how real life can be more complicated than a math problem. Let's think of the $10 per hour as being a general model for how much Diego earns. Do you remember what a model is?

Malena: It's like, well, we make things easier so that we can understand them better, when we do the math for it.

Ms. Clark: Right, when we model, we keep things simple to focus on the math. So maybe Diego earns more or less for different families but it evens out to $10 per hour. Any other questions about how that works? Ok, for this problem, you will spend a few minutes working on your own to answer questions 1 through 3 before sharing with your group. Then answer question 4 together.

The students silently read the following question prompt (Adapted from Illustrative Mathematics, Grade 8, Unit 3, Lesson 8).

1. Diego earns $10 per hour babysitting. Assume that he has no money saved

before he starts babysitting and plans to save all of his earnings. Graph how much money, y, he has after x hours of babysitting.

2. Now imagine that Diego started with $30 saved before he starts babysitting. On the same set of axes, graph how much money, y, he would have after x hours of babysitting.

3. Compare the second line with the first line. How much more money does Diego have after 1 hour of babysitting? 2 hours? 5 hours? X hours? Explain.

4. Write an equation for each line.

Ms. Clark sets a visible timer to indicate when silent work time ends and begins to circulate the classroom, carrying a clipboard with her.

Connecting mathematics to students' cultural backgrounds and experiences requires knowledge of students. The task used is an appropriate context for the grade level, and Ms. Clark solicits student responses knowing that working for others is a common experience for her students. Malena's response was rooted in her experiences and was not mathematically relevant, but Ms. Clark connected it to the practice of using mathematics to model. Jaden's off-task comment also derived from his culture in a way that Ms. Clark may have been unprepared for, creating an opportunity for her to understand her students better by finding out the reasons for his defensiveness, including what was said to him to prompt his comment. Not every mathematical activity can relate directly to students' culture, since many abstract topics have no analog in the daily life of a teenager. Instead, teachers should focus on students' mathematical strengths as the main point of connection (Jilk & Erickson, 2017). Ms. Clark provided a definition of modelling since Malena's definition was vague, but the learning community in the classroom would have benefitted from hearing the definition clarified by a student who has an affinity for putting mathematical ideas into their own words.

Ms. Clark's clipboard is significant in her implementation of Smith and Stein's (2011) five practices, outlined previously. The focus of the lesson is printed at the top of the page, along with anticipated correct and incorrect student responses. In order for the discussion to be productive, the teacher cannot be an idle observer nor a taskmaster, but must instead prepare to connect student work to mathematical ideas by intentionally monitoring student work and making decisions about which mathematical ideas should be selected for discussion and in what order. These monitoring sheets, completed for each class of students, can be a useful resource for equity, since they serve as a record of which students have been full participants in the construction of mathematical learning (Jackson & Delaney, 2017). Dynamics within groups can also be recorded for the purpose of teaching students to work well with all of their diverse peers. Randomly selected groups is an example of a classroom system that combats bias by removing the human element from seat assignment (Fiarman, 2016). In the next part of the vignette, Ms. Clark checks in with one of her randomly selected groups.

The timer rings, indicating the end of individual work time. Ms. Clark has made notes

and intervened with a few students' minor misconceptions, and now releases the students to work as groups to write equations for Diego's babysitting situation. She notices one group, composed of Alice, Jordan, Tyler, and Jaden, is not talking and investigates. A quick survey of their papers shows that the students have not compared the graphs they each created, and only Jordan has an explanation for question 3.

Ms. Clark: How is this group doing? Jaden?

Jaden: We're done.

Ms. Clark: Ok, can you tell me about the equations you wrote?

Jordan: Well the first one is y=10x and the second one is y=30x.

Ms. Clark: How do those equations relate to the graph, Tyler?

Tyler: I don't know but it's what Jordan said and he is probably right.

Alice: I'm not sure, because if it was 30x, wouldn't the second point be at $60? I think it is at $40.

Ms. Clark: Tyler, what do you think about what Alice said? (pauses; Tyler is frowning at his graph now). All of you, move your papers to the middle so you can all see each other's graphs. Jordan, please think aloud with your group about what your equations mean so they can decide if they agree with your ideas, not just your answer.

Ms. Clark notes that the group responded to her reminder of class norms before moving on to check the work of other groups, looking for students who used tables, points, or verbal descriptions to create their graphs and equations. As groups approach the goal of this activity, Ms. Clark jots quickly at the bottom of the page: "Jaden disengaged."

In this interaction, Jordan engaged in what Lampert (1990) described as keeping thinking implicit, common for students who are accustomed to having their quick, usually correct responses accepted immediately and unquestioningly by their peers and teachers. The discipline of defending answers using mathematical reasoning deepens understanding for both the individual explaining their work and their peers. Jordan's peers deferred to him as the "expert" in their group, a role that is quickly sussed out by students like Tyler who are habitually passive in math, content to wait for someone else to tell them how to do it or what the answer is (Lampert, 1990). This power dynamic also leads to the silence of out-numbered voices like Alice's. The norms of everyone being able to see each other's papers and understand each other's work gives all students access to deeper understanding of the concept being presented (Jilk and Erickson, 2017). Teachers must also understand that student perceptions of peers as experts are certainly influenced by the same biases that shape their own identities as math learners (Aguirre et al., 2011). Ms. Clark's intervention disrupted the power dynamics of the group, because she understands that "teachers have an essential role in equalizing the power when the societal norms have oppressed certain students" (Jackson & Delaney, 2017, p. 149). Regardless of

their students' demographic groups, teachers cannot abandon their role in promoting equity.

A disengaged student requires further attention. Recalling her brief, justified correction of Jaden's off-task comment, Ms. Clark may attribute his reticence in engaging in group work to that negative public interaction. However, she may not be aware of her patterns of correction or the ways that Jaden experiences them. Perhaps he is chronically singled out when a peer was engaging in the same behavior, or perhaps the public nature of the correction transgresses a cultural identity. Minor discipline corrections and other moment-by-moment decisions are the most difficult to self-monitor and thus the most vulnerable to unconscious bias (Fiarman, 2016). A trusted outside observer or video-recording can facilitate self-reflection about these kinds of decisions. Jackson and Delaney (2017) describe a training process that focused on how the teacher engaged students on the concept, explained the concept to groups, responded to misconceptions, and addressed off-task behavior, and whether there was variation in the teacher's interaction in these domains with various sub-groups of students. Observing their peers within this framework allowed teachers to notice their own inconsistencies in interaction with under-represented students, in ways that they commonly found surprising (Jackson and Delaney, 2017). This reflects the reality that biases are hidden from their owners but influence instructional choices in subtle ways, distinguishable only to those it harms.

Conclusion

For teachers who aspire to meet the principle of equity in their practice, the lack of success can sometimes be confounding. However, best intentions cannot overcome our unconscious biases, which require dedicated effort to recognize and address. This work must carry over into classroom practice through intentional actions such as those described in relation to Ms. Clark's vignette. Although equity is a challenging principle, the better outcomes for all students make its pursuit worthwhile.

References

Aguirre, J., Mayfield-Ingram, K., & Martin, D. B. (2013). The impact of identity in K-8 mathematics learning and teaching: Rethinking equity-based practices. Reston, VA: The National Council of Teachers of Mathematics.

Boaler, J. (2002) Learning from teaching: Exploring the relationship between reform curriculum and equity. *Journal for Research in Mathematics Education, 33*(4): 239-258.

Bol, L., & Berry, R. (2005). Secondary mathematics teachers' perceptions of the achievement gap. *The High School Journal, 88*(4), 32-45.

Fiarman, S. E. (2016, November). Unconscious bias: When good intentions aren't enough. *Educational Leadership,* 10-15.

Illustrative Mathematics. (n.d.) What is a problem-based curriculum? Retrieved from https://curriculum.illustrativemathematics.org/MS/teachers/what_is_pbc.html

Jackson, C., & Delaney, A. (2017). Mindsets and practices: Shifting to an equity-centered paradigm. In *Access and equity: Promoting high-quality mathematics in grades 6-8*.(pp. 143-155). Reston, VA: National Council of Teachers of Mathematics.

Jilk, L. M., & Erickson, S. (2017). Shifting students' beliefs about competence by integrating mathematics strengths into tasks and participation norms. In *Access and equity: Promoting high-quality mathematics for Grades 6-8*.(pp. 11-26). Reston, VA: National Council of Teachers of Mathematics.

Lampert, M. (1990). When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal, 27*(1), 29-64.

Nation's Report Card (NRC). (2017). Achievement gaps dashboards. Retrieved from https://www.nationsreportcard.gov/dashboards/achievement_gaps.aspx

National Council of Teachers of Mathematics (NCTM). (2014a). Access and equity in mathematics education. Retrieved from: https://www.nctm.org/Standards-and-Positions/Position-Statements/Access-and-Equity-in-Mathematics-Education/

National Council of Teachers of Mathematics (NCTM). (2014b). *Principle to action: Ensuring mathematical success for all.* Reston, VA: Author.

Schoenfeld, A. (2002). Making mathematics work for all children: Issues of standards, testing, and equity. *Educational Researcher, 31* (1), 13-25.

Smith, M. S., & Stein, M. (2011). *Five practices for orchestrating productive mathematics discussions.* Reston, VA: National Council of Teachers of Mathematics.

Viadero, D. (2019, February 23). Lags in minority achievement defy traditional explanations. Retrieved from https://www.edweek.org/ew/articles/2000/03/22/28causes.h19.html

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Using Mathematics Conferences in the Classroom

Amy Switlick

Abstract: There has been abundant research demonstrating the benefits of using reading conferences in the English Language Arts classroom and it describes how to make such reading conferences as effective as possible. However, little research has been conducted exploring how teachers can transfer or adapt such practices for the mathematics classroom. This paper examines specific, research-based strategies for conducting effective reading conferences in English language arts and proposes ways to transfer those techniques to support successful mathematics conferences. It presents an argument for using mathematics conferences to address current difficulties in mathematics instruction and offers specific advice on incorporating mathematics conferences into the classroom.

Using Mathematics Conferences in the Classroom

Picture an English language arts classroom where the teacher is using a Reader's Workshop approach (Hudson & Williams, 2015). The teacher sits with one student for the conference and listens as they discuss their understanding of a text. The rest of the class is using the time to engage in a range of activities: reading books of their own choosing, responding to those texts in their journals, or having small-group discussions of texts they have read. While the teacher is conferring with their student, the teacher is also making assessments that drive instruction, demonstrating strategies when needed, and providing successful reading experiences (Gill, 2000). In these ways, the teacher applies research-supported strategies to maximize the benefits from these conferences.

Now visualize this same teacher using teacher-student conferences in the mathematics classroom. The teacher is again conferring with their student; however, the rest of the class is using the time to collaborate together, to solve teacher-given problems using a flipped classroom approach, or to work with mathematics software (Zengin, 2017). Using the same research-supported strategies from the ELA conferences, while working with individual students the teacher can assess learning, provide instruction, demonstrate mathematical strategies, and provide successful mathematics experiences. Mathematics teachers may also find that the evidence suggests that using these types of conferences in the mathematics classroom can help resolve issues in mathematics instruction.

The Need for Mathematics Conferences in the Classroom

According to Polikoff (2012), there is redundancy in mathematics instruction in the U.S. The mathematics curriculum for each grade level is broad and shallow. Teachers are required to cover many topics at each grade level, but they only cover these topics at superficial levels of detail, which results in students receiving instruction on the same topics again and again without ever developing a deeper understanding

of those topics. For example, in Ohio, the same state standard repeats in first and second grade: to represent and interpret data under the Measurement and Data category (Ohio Department of Education, 2017). In third grade, the same standard reappears; students are asked to "represent and interpret data," although the standard has now moved to the Geometry category. This is just one sample standard among many other similarly repeated standards. Because of this repetition and because of how many standards there are at every level, teachers deliver instruction on a wide range of topics but quickly move from one to the next in order to hit all of the standards each year. As a result, according to Schmidt (as cited in Polikoff, 2012), American students have limited conceptual understandings of mathematics which represents a major deficit in mathematics instruction.

Mathematics conferences can help solve the difficulties that we are seeing in the current mathematics instruction in the United States. First, by using mathematics conferences in the classroom, teachers can guide students to a deeper level of understanding by assessing on an individual basis. Once a teacher sees the degree of understanding a student has of a certain topic or concept, they can pose higher-level questions that will challenge the student to think further and arrive at a deeper conceptual understanding. Without mathematics conferences, in which teachers really get to see their students' understanding on an individual basis, this can be difficult to achieve.

Second, once this deeper level of understanding on a specific topic or concept is achieved, teachers can extend and expand student learning, rather than repeating topics. They can build on their students' current knowledge and scaffold within the students' zones of proximal development (the difference between what a student can achieve alone and what a student can achieve with assistance) (Polikoff, 2012). For example, through conferencing, a teacher might observe that a student is able to sort a group of objects and count how many objects are in each category. Since the student is already able to meet this kindergarten standard, the teacher takes the opportunity to show the student how to compare the total of each category to determine which has more or less, which is the first-grade standard. Once the student can meet this standard with help, the teacher can support this student as they work to meet this standard independently by helping them less and less every time until the student learns to do the task independently. Now the student has a deeper level of understanding of this concept, so the student's first-grade teacher the following year will not have to revisit this same topic again. In place of that topic being taught again, the teacher can spend time on a new topic or concept.

Teacher-student conferences can also give teachers the opportunity to support discourse in mathematics education and make formative assessments. The research that supports the implementation of conferences in Reader's Workshop also supports the application of conferences in mathematics to ensure that these conferences address the challenges facing mathematics education.

Effective Reading Conferences

For any approach to be effective in the classroom, such as individual teacher-student conferences, teachers must understand how to successfully implement it in the

classroom. The studies cited below on how to make reading conferences effective offer useful guidelines for implementing effective mathematics conferences.

Talk Less, Listen More

Porath (2014) analyzed two teacher-student reading conferences that were part of a nine-month case study. During these reading conferences, Porath helped the teacher, June, realize that she was dominating the conference by doing most of the talking. Instead of posing thought-provoking questions and listening to what her students were saying to her, she was making assumptions and giving her personal opinions. When June's student chose a book about poetry, June assumed that her student loved poetry, so Jane spent the conference talking to her student about how much she loved poetry as a child. If June had asked her student why she had chosen the poetry book and listened to her student's response, she would have discovered that her student liked the poetry book because it included poems about animals and her student liked animals. After receiving support from Porvath and instruction in listening strategies, June began her next conference with the same student, with a question about why the student chose the book. It opened up the opportunity for Jane's student to explain her own reasons and motivation for choosing and liking a particular book. When June chose to spend the conference listening to the student, she discovered that her student could support her ideas with examples from the text and she was able to see her student's ability to infer.

This approach of talking less and listening more can also be applied in the mathematics conference, as shown in Table 1. For example, when conferring with an individual student in a conference, the teacher could ask the student to clarify their thinking, or to explain the specific strategy used to solve a problem, why they choose this strategy, and how they arrived at a particular answer. The teacher would then be able to use the student's answer to help assess current learning of the individual student.

Conference Focal Points

Pletcher and Christensen (2017) found that during their reading conferences ELA teachers focused heavily on accuracy instead of other aspects of the reading process such as comprehension, expansion of vocabulary, or fluency. Pletcher and Christensen saw this as problematic since the meaning of text is the most important part of reading, rather than simply reading accurately. They suggested that teachers keep careful records regarding what focal points (the teaching point that the teacher decided to focus on) were used during the conference. For instance, with accurate records of the teacher's past focal points, a teacher may notice that he/she is never spending time on expanding a student's vocabulary. Instead, he/she is focusing on the accuracy of the student's reading every time they confer. Accurate records will ensure that each student is getting instruction related to all areas of the reading process.

Additionally, they argue that teachers should narrow their focus to one or two focal points per conference that stem from each student's text or from the teacher's observation of the student's reading skills. This approach will help them focus on

the student's need at the time, so they can identify the student's zone of proximal development and provide the appropriate scaffolding (Pletcher & Christensen, 2017). This also helps teachers use their time effectively, so they will have time to reach more students.

In mathematics, it can be easy for teachers to narrow their focus to number sense or computation without even realizing that they are missing other areas of mathematics (see Table 1). Keeping careful records of conversation focal points can help mathematics teachers ensure that they are reaching all areas of mathematics even while only focusing on one or two points per conference.

Types of Questioning

Once teachers determine their focal points for the student conference, the types of questions they ask can determine how much information the teacher collects about the student's learning. Nystrand (as cited in McElhone, 2013) says that even though talk has been suggested as an important learning tool, most talk occurring in classrooms limits opportunities for learning and closes dialogue down because students do not have opportunities to engage in elaborated talk. Instead, teachers frequently use the initiate-respond-evaluate (IRE) pattern in teacher-student talk (Cazden, as cited in McElhone, 2013). Teachers ask a question that has a correct answer they expect to receive from a student. Once the student responds to the question, the teacher evaluates whether the student has answered correctly or not. McElhone considered how instead of evaluating feedback in the "E" section of the IRE, teachers can use non-evaluative feedback that can lead to more elaborated talk. She describes two categories of such non-evaluative feedback: high press and reducing press talk moves. Examples of high press talk moves would be (a) "Say more about that; (b) "What evidence supports that?" or (c) "How did you figure that out?" Examples of reducing press talk moves would be giving the students multiple-choice answers or asking yes/no questions.

Using high press talk moves can lead to conferences that are more effective because pressing individual students to think in depth about their own ideas pushes them to refine their reasoning and sets up for future challenges. This can increase student learning and enable in-depth teacher assessment. Supporting this, McElhone (2013) found that when teachers used more high press talk moves in their classroom, reading achievement and teacher-student engagement increased.

This study (McElhone, 2013) may be even more relevant when applied to mathematics (see Table 1). In mathematics, teachers tend to look for correct computation instead of asking these types of high press questions that can open pathways into assessing students' learning and challenging their students' thinking. In mathematics instruction, there is conceptual and procedural knowledge. Procedural knowledge means recognizing the symbols and procedures/rules used to solve mathematical tasks. Conceptual knowledge means understanding the underlying mathematical concepts, which allows students to link all the pieces of information together. The use of high press talk moves during mathematics conferences can help students link information together to form deeper conceptual understanding.

Table 1
Purpose of strategies in reading and mathematics conferences.

Strategy	Reading Conferences	Mathematics Conferences
Teachers talk less and listening more to students	Allows teachers to determine which comprehension skills students are proficient in, what genres students prefer, and text comprehension levels.	Allows teachers to see what strategies their students are using to solve a problem and prompts students to clarify their thinking.
Focal points prepared ahead of time; a variety of focal points used	Helps teachers avoid focusing on decoding and engages comprehension, accuracy, and vocabulary expansion, among other skills.	Helps teachers avoid focusing on computation and engages their ability to measure, to work with data, and to support their problem solving.
Teachers use targeted, high-press questions during the conference (versus reduced- press questions)	Offers teachers a better understanding of student knowledge that can be used to deepen current understandings and to construct new ones.	Offers teachers a better understanding of student knowledge that can be used to deepen current understandings and to construct new ones.

The common theme in all of these strategies is that the communication that happens within teacher-student conferences opens the doorway to additional opportunities for increased student learning and teacher assessment. Communication is important in all subject areas including mathematics.

Communication

If communication is pertinent in the mathematics classroom, mathematics conferences are pertinent in the mathematics classroom. Jung and Reifel (2011) investigated the importance of communication in mathematics education, based on Vygotsky's idea of socio-constructivism (as cited in O'Connor, 1998), which argues that children build their understanding of any topic through talk, social interaction, and the construction of shared meaning. Jung and Reifel (2011) observed a teacher who gave her students many opportunities to communicate their learning in mathematics. They found that allowing her students to communicate about their mathematical thinking moved the instruction from the procedural level to the conceptual level of mathematics. If she had only checked to see if her students had the correct or incorrect answer, she would not have given them the opportunity to move to that higher level of mathematical understanding.

Such communication also meets the recommendations of the National Council of Teachers of Mathematics (as cited in Jung and Reifel, 2011), which argues that students must be challenged.

> To organize and consolidate their mathematical thinking through communication, to communicate their mathematical thinking coherently and clearly to peers, teachers, and others, to analyze and evaluate the mathematical thinking and strategies of others, and to use the language of mathematics to express mathematical ideas precisely. (p. 60)

Conferences offer one approach to allow such communication to happen. Students sitting at their desks performing computations to get the correct answers in

their workbooks are not communicating with each other or the teacher and are not expressing their mathematical thinking; by engaging students in mathematical conferences, teachers can ensure they are giving their students the opportunity to meet these goals.

How to Incorporate Mathematics Conferences in the Classroom

When introduced to the idea of mathematical conferences, a teacher's first question might be, "What will all the other children be doing while I am conferring with one student?" It is important to note that teachers do not need to meet with each student daily: once every week or two may be enough. That said, in the Readers Workshop approach, students spend their time reading texts of their own choosing while the teacher holds individual reading conferences (Hudson & Williams, 2015). This same idea can be applied in the mathematics classroom. While teachers are conferring with individual students, the other students in the classroom can be strengthening their mathematics skills. That said, there are several options that teachers can chose from to incorporate during conferences. One option would be to take a flipped classroom approach. In this approach, instead of students learning the concepts from their teacher in the classroom and doing their homework at home, students learn the lesson at home by watching a video that has been carefully made by their teacher and then uses class time for active learning in collaboration with their classmates. This approach also supports communication amongst students in the mathematics classroom. Zengin (2017) explored this idea specifically in the mathematics classroom using videos from Khan Academy for the lessons learned at home and using other software programs as well. Mathematics conferences would fit into this type of approach rather easily. While the students are using class time to collaborate with classmates, to solve problems that were given by the teacher, or to work with other supportive software programs, the teacher can be conferring with students individually.

Another option, especially in the primary classrooms, is to have students work on small group activities. The teacher in Jung and Reifel's (2010) study set up challenging tasks that created discussions amongst the students to help foster the communication that is so important in the learning process. These activities focused on the children's learning processes rather than on finding the correct answer. The students would have the opportunity to discuss with their classmates their reasoning and thought processes. At the same time that the students are engaged in these small group activities, the teacher can conduct individual mathematics conferences, thus using class time in an effective manner.

Conclusion

Research suggests that the current mathematics curriculum and instruction is not reaching its potential (Polikoff, 2012). Implementing mathematics conferences may provide many of the same benefits that using reading conferences offers in ELA classrooms. First, mathematics conferences give teachers a chance to challenge students individually with high press talk moves. Second, they open the door to communication about the students' mathematical thinking. Third, they give teachers the

opportunity to assess their students' quality of mathematical thinking, which can help them plan future instruction accordingly.

Research focused on English language arts conferences has many applications for mathematics conferences and can help ensure effective conferences that increase learning. Such mathematics conferences can be organized in a variety of ways depending on the age level of the students. They might require a little extra work on the teachers' part to get the conferences started, but the research suggests that they will have a wide range of long-term benefits.

References

Gill, S. R. (2000). Reading with Amy: Teaching and learning through reading conferences. *Reading Teacher, 53*(6), 500-509.

Jung, H.Y., & Reifel, S. (2011). Promoting children's communication: A kindergarten teacher's conception and practice of effective mathematics instruction. *Journal of Research in Childhood Education, 25*(2), 194-210.

Hudson, A. K., & Williams, J. A. (2015). Reading every single day. *Reading Teacher, 68*(7), 530-538.

McElhone, D. (2013). Pressing for elaboration in student talk about texts. *Journal Of Classroom Interaction, 48*(1), 4-15.

Ohio Department of Education. (2017). Ohio's learning standards for mathematics. Retrieved from http://education.ohio.gov/Topics/Learning-in-Ohio/Mathematics/Ohio-s-Learning-Standards-in-Mathematics

Pletcher, B. B., & Christensen, R. R. (2017). Conferring in the CAFÉ: one-to-one reading conferences in two first grade classrooms. *Reading Horizons, 56*(3), 1-15.

Polikoff, M.S. (2012). The redundancy of mathematics instruction in U.S. elementary and middle schools. *Elementary School Journal, 113*(2), 230-251.

Porath, S. l. (2014). Talk less, listen more. *Reading Teacher, 67*(8), 627-635.

Zengin, Y. (2017). Investigating the use of the Khan Academy and mathematics software with a flipped classroom approach in mathematics teaching. *Journal of Educational Technology & Society, 20*(2), 89-100.

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Science

Using the Project-based Approach to Teach Scientific Reasoning

Allison Ahrns

Abstract: It is important to teach subject matter reasoning in the science classroom. Science is a process of making sense of the natural world. Unfortunately, science is often taught as a list of discoveries to be memorized. Inquiry is essential to teach scientific reasoning. Inquiry is core component of the National Science Education Standards, and is required by many state science standards. Project-based learning is an approach to teaching inquiry. Students are taught subject matter reasoning through using skills necessary to be successful in a project-based learning (PBL) classroom. PBL takes a great deal of planning and investment on the teachers' part, but the benefits to the students' knowledge and reasoning skills are more than worth the time and effort.

Introduction

Imagine a classroom with 24 students sitting at desks in rows where the teacher is standing in front of the room. The teacher has been lecturing for 20 minutes about ecology and ecosystems. While looking around the room, most students are doodling, looking out the window or are sneaking to use their cellphones. Obviously, these students are disengaged from what the teacher is lecturing about. The students are being taught to memorize and regurgitate information rather than participate in the active process of science.

Now imagine a classroom with the same 24 students and teacher. The students are all over the classroom working in small groups while the teacher circulates among them. The students are talking with one another. Some students are using computers, while others are drawing on poster boards and looking through the textbook. All the students are engaged and working on something. The students are actively using the skills they have been taught to produce a product that models their understanding. What you are seeing is a project-based learning environment, which enables students to use subject matter reasoning.

Building a classroom environment that is able to support this approach to teaching science take time and effort on the part of the teacher. Students must be willing to learn a new way to learn. Despite the effort needed to accomplish this approach to teaching, all the effort is well worth it. Students who learn science using this approach have a deeper knowledge of the process of science. Students can reason with problems presented to them both in the classroom and in the real world. The students well rounded understanding of scientific concepts and reasoning are shown by increased standardized test scores.

Subject Matter Reasoning

Subject matter reasoning is the ability to reason and make sense within the context of one's subject matter (Next Generation Science Standards, 2013). Reasoning

is used cross all content areas, to argue and evaluate claims in a subject using supporting arguments and evidence. The Next Generation Science standards state that students should be able to do the following to be able to reason in science:

- ask questions,
- develop and use models,
- plan and carry out investigations,
- analyze and interpret data,
- use mathematics and computational thinking,
- construct explanations (for science) and design solutions (for engineering),
- engage in argument for evidence, and
- obtain, evaluate, and communicate information. (NGSS, 2013).

Many students struggle with science in an academic setting. These are students who completely understand the concepts in science if they are explained using common language. This same set of students struggle to answer questions if they are worded differently than the practice problems performed in class. They have trouble making connections in science class and applying their knowledge to new situations. By teaching subject matter reasoning, students will learn how to find patterns and apply what they are learning to new circumstances.

Whitehead (1929) stated "In training a child to activity of thought, above all things we must beware of 'inert ideas'---that is to say, ideas that are merely received into the mind without being utilized, or tested, or thrown into fresh combinations". With a large emphasis on data driven content strategies and government oversight looking for a way to hold teachers accountable, many educators are searching for ways to push their students to have higher ordered thinking skills. Subject matter reasoning is one-way educators can teach their students to think critically and make connections between content areas.

Inquiry Education

Today research leans heavily on the constructivist view of education. There is a big push in education to teach using student centered techniques and inquiry. National Science Education Standards states "inquiry into authentic questions generated from student experiences is the central strategy for teaching science (National Research Council, 1996)." Inquiry involves designing a learning environment that allow students to explore and make sense of natural phenomena. Hawkins (1974) states "messing about evolves with the child, it becomes a way of working that is no longer childish, the kind of self-disciplined probing and exploring that is the essence of creativity."

Inquiry is a way of teaching that support students in using subject matter reasoning. In inquiry learning, students need to be able to communicate with one another as well as the teacher. The National Academy of Science states that students

need to be proficient in four areas to be considered proficient in science. Through inquiry students should be able to:

- generate and evaluate scientific evidence and explanation,
- know, use and interpret scientific explanations of the natural world,
- understand the nature and development of scientific knowledge, and
- participate productively in scientific practices and discourse. (NRC, 2000)

Project Based Learning

Project-based learning is a student-centered method of inquiry instruction in which students gain deeper knowledge by actively exploring and investigating an authentic, engaging, and complex question, problem or challenge (Buck Institute for Education, 2017). Project based learning or PBL encompasses all areas of subject matter reasoning. In PBL students must communicate, collaborate, ask questions, argue their point as well as use technology and make connections. Hugerat (2016) states that PBL must be central to the curriculum, not peripheral to the curriculum. PBL must also focus on projects or problems that are realistic and allow students to encounter central concepts and principles of their discipline. Projects should involve student's investigation and be student driven to a significant degree. Above all projects should be real world and not school like, student should be answering a real work question.

In a three-year study conducted by Han, Capraro, & Capraro (2015) researchers found that struggling students have increased achievement scores on state tests when taught STEM skills using PBL. Students were taught core concepts in STEM using PBL every six weeks for three years. This longitudinal study showed that low performing students of all demographic backgrounds scored significantly higher on achievement tests in mathematics. The results show that implementing PBL in the stem classroom has a positive influence on student test scores and helps in closing the achievement gap.

In a study out of Turkey, researchers found that teaching physics though games under a PBL model was effective in long-term retention of concepts. For example, some physics topics can be taught though everyday games such as billiards and darts. Through PBL students were engage in asking questions and developing explanations with real-world situations. Presenting physics through games illustrates to students that physics is not limited to the laboratories and theory but is present in everyday life (Baraan, Maskan, & Yasar, 2018).

PBL pitfalls to avoid

While studying student achievement scores Kizkapan & Bektas (2016) found that teaching using PBL shows no significant difference over students taught using traditional methods. However, the researchers found their methods were lacking. The students in the study failed to take the projects seriously, they believed the projects

were just another grade like homework that they did not have to complete 100% of the time.

The researchers found that they did not allow enough time for the students to complete the projects and the students needed more guidance regarding time. There were three large factors that played into the study finding no significant difference: students lacked social skills needed to work in a group and deal with conflict, the students were unfamiliar with a student-centered approach to learning, making the jump from being lectured to, to having to perform and produce a product difficult for the students in the study and fear of failure and disinterest (Kizkapan & Bektas, 2016). The researchers found that the students did not want to look stupid in front of their peers.

The students also had trouble getting excited about the topic. Since the topic did not interest the students, they failed to put in the effort necessary to complete the project. Kizkapan & Bektas (2016) suggests that educators introducing the concept of PBL with their students should slowly introduce the ideas with small activities throughout the semester. The teachers should also setup a time schedule to ensure that students are working efficiently and are on track with their learning. The study by Kizkapan & Bektas (2016) shows that implementing PBL in the classroom can be difficult for educators, but it is not impossible.

Although there are struggles with PBL, this approach has proven to be effective in teaching students subject matter reasoning. Students who are unfamiliar with PBL need immense amounts of guidance. PBL is a learned teaching strategy for both the educator and the students. It takes time and lots of energy to design and use PBL in the classroom. An article by Quigley, Marshall, Deaton, Cook, & Padilla (2019) includes many questions posed by educators about PBL and ways to meet the challenges of teaching PBL (2019). McBride, Bhatti, Hannan, & Feinberg, (2004) also address challenges to PBL and inquiry-based science teaching methods. They identified a lack of training and time as factors for why science teachers chose not to teach using inquiry and recommend that be specifically designed to help train science teachers how to teach using inquiry.

Communication is key

To be able to inquire about their learning, students must be able to communicate with each other and their teachers. "Social independence theory suggests that social skills play an important role in enhancing collaboration and solving conflicts" (Lee, Huh, & Reigeluth, 2015). Collaboration is a process in which group members exchange ideas, opinions as well as emotions. Whenever people are working together there is room for conflict to enter. Being able to deal with conflict and communicate effectively to complete an assignment is crucial to students learning though inquiry (Lee, Huh, & Reigeluth, 2015). No one learns in a bubble; the students around them as well as the classroom environment impact students. By building a classroom environment of respect and openness, educators allow students to explore their learning freely.

Yun & Kim (2015) observed 44 8th grade Korean students and taught them argumentation techniques through small group hands on activities. After teaching the students how to support their ides with evidence and allowing students to ex-

plore freely, Yun and Kim found that students were better able to listen to each other's ideas and more freely share their own thoughts. The key to this study was the teacher reminding students that there is no correct answer and asking the students metacognitive questions. By asking questions and valuing participation, the teachers enabled the students to take responsibility for their own learning. "To create a permissive atmosphere for participation, schools should enable students to learn how to argue and build scientific argumentation norms" (Yun & Kim, 2015).

How to implement PBL in secondary science

Quigley, et al, 2011 discuss four challenges to teaching using inquiry. The four challenges are:

> Challenge 1: How can we measure the quality of inquiry as implemented in the classroom?
>
> Challenge 2: How can teachers use discourse and discussion to encourage more effective inquiry-based learning?
>
> Challenge 3: How can we get teachers to think of content and inquiry as not mutually exclusive, but rather aspects of the same goal?
>
> Challenge 4: How can we help teachers learn to manage an effective inquiry classroom?

To address challenge one, the authors suggest using a program called EQUIP to measure the quality of teachers' lessons and their ability to teach using inquiry skills. EQUIP stands for Electronic Quality of Inquiry Protocol. One indicator used by this program to assess teacher inquiry quality is order of instruction. Teachers who allow students to explore a concept in some way before giving an explanation of the concept receive a higher inquiry quality score. Once teachers are able to rearrange the order of their lessons, they are on the path to include higher quality inquiry tasks within their teaching (Quigley, et al, 2011).

Another indicator used by the EQUIP program is complexity of questions. Teachers who ask their students to explain their reasoning and justify their claims score higher in inquiry quality than teachers how ask base level questions with one correct answer. By asking more why questions, teachers are challenging their students to think deeper and make connections between content presented.

The second challenge for educators teaching inquiry is discourse. Many students struggle with discourse and speaking kindly with one another. This was touched on the communication section earlier. One way to increase student discourse is to provide feedback to students about how well they are communicating with one another and how they can improve. Teachers can facilitate discourse within their classrooms by keeping discussions going and encouraging students to answer one another's questions, not just the questions from the teacher (Quigley, et al, 2011).

The second way is to provide follow up information to students while they are working on their projects. Many educators find it difficult to let go of the reigns and allow students to be in charge of their own learning in inquiry settings such as project-based learning. By allowing students to question one another, educators

open many different lines of communication. When students do ask the teacher a question, the teachers should provide further knowledge of the concept or challenge students to justify their answers. Educators should ask follow up questions to provide information in the classroom, not just ask questions to evaluate student knowledge. By opening lines of communication and being supportive, science educators transform the atmosphere of their classroom into one of community learning and exploration.

Challenge 3 is all about changing the teacher's mindset on inquiry. Inquiry and questioning should not be a lesson on the scientific method at the beginning of the year and content the rest of the year. Teachers should switch their teaching to allow students to explore concepts and then have the concept explained. One way to do this is a three-step approach. First allow students to observe a scientific phenomenon, then students should make a claim explaining the phenomena. Second the students should question, analyze and research the phenomena to back up their claim. Thirdly the students should present their findings and make connections between the evidence they have collected (Quigley, et al, 2011).

Challenge 4 is the biggest challenge of all for educators. Almost all science educators have heard of inquiry and its importance in the science classroom, but how do you actually do inquiry? The first step is building a solid presence in your classroom as the teacher. The students need to know you are in charge and will keep all students learning. Along with this presence is building an atmosphere of learning and respect. This atmosphere is built by building relationships with each student and encouraging students to get to know one another. By setting an example of being able to make mistakes and learn from them, students see that it is okay to make mistakes in your room. Set forth general expectations of how students should communicate with one another and the teacher. There should be an expectation that students listen to one another, hear each other out and have appropriate ways to agree and disagree with one another (Quigley, et al, 2011).

The biggest component in a project-based learning classroom is having high expectations for your students and holding them accountable for learning. Expectations such as classroom rules and how discussions should unfold can be determined with the students. Students need to know that you as an educator are there to guide them and help them learn, but ultimately learning is up to each individual student.

Conclusion

Students need different skills today than they needed 20 years ago. The skills needed today include, creativity and initiative, the ability to communicate and collaborate with others, as well as the ability to problem solve and use technology. This group of skills are known as 21st century skills that all students will need in both in and out of school (Edmunds, Arshavsky, Glennie, Charles, & Rice, 2017).

There are many ways to teach science and science subject-based reasoning in the classroom. Much of the research points to inquiry science as being one of the best ways to teach subject matter reasoning. In the realm of inquiry, the most studied approach to inquiry learning, is project-based learning. PBL is a tall order for educators. Teaching using the PBL approach requires large amounts of time, plan-

ning and guidance of students. The more students participate in PBL, the easier it becomes for students to complete projects effectively.

Subject matter reasoning is needed in all subject areas. Teaching students how to reason in the science classroom will hopefully prompt students to use their reasoning skills in their other classes as well as in real life situations. Subject matter reasoning is needed to gain 21st century skills. By using the Project-based learning approach to teaching, we as educators are setting our students up for success in a changing world.

References

Baraan, M., Maskan, A., & Yasar, S. (2018). Learning physics through project-based learning game techniques. *International Journal of Instruction,11*(2), 221-234. doi: 10.12973/iji.2018.11215a.

Buck Institute for Education. (2017). What is project-based learning (PBL)? Retrieved from http://www.bie.org

Edmunds, J., Arshavsky, N., Glennie, E., Charles, K., & Rice, O. (2017). The relationship between project-based learning and rigor in STEM-focused high schools. *Interdisciplinary Journal of Problem-Based Learning, 11*(1), doi: 10.7771/1541-5015.1618

Han, S., Capraro, R., & Capraro, M. 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 and Mathematics Education, 13*, 1089-1113.

Hawkins, D. (1974). Messing about in science. In D. Hawkins (Ed.). T*he informed vision essays on learning and human nature* (pp.65-76). New York: Agathon Press.

Hugerat, M. (2016). How teaching science using project-based learning strategies affects the classroom learning environment. *Learning Environments Research, 19*(3), 383-395. doi:10.1007/s10984-016-9212-y

Kizkapan, O., & Bektas, O. (2016). The effect of project-based learning on seventh grade students' academic achievement. *International Journal of Instruction, 10*(1), 37-54.

Lee, D., Huh, Y., & Reigeluth, C. M. (2015). Collaboration, intragroup conflict, and social skills in project-based learning. *Instructional Science, 43*(5), 561-590. doi:10.1007/s11251-015-9348-7

McBride, J. W., Bhatti, M. I., Hannan, M. A., & Feinberg, M. (2004). Using an inquiry approach to teach science to secondary school science teachers. *Physics Educator,* 434-439.

National Research Council. (2000). *How people learn: Brain, mind, experience, and school*. Washington DC: The National Academies Press.

National Research Council. (1996). *National science education standards*. Washington, DC: National Academy Press.

NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academies Press.

Quigley, C., Marshall, J. C., Deaton, C. C., Cook, M. P., & Padilla M. (2011). Challenges to inquiry teaching and suggestions for how to meet them. *Science Educator, 20*(1), 55-61.

Whitehead, A. N. (1929). *The aims of education and other essays*. New York: The Free Press.

Yun, S. M., & Kim, H. (2015). Changes in students' participation and small group norms in scientific argumentation. *Research in Science Education, 45*(3), 465-484. doi:10.1007/s11165-014-9432-z

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Using Project-Based Learning to Enhance STEM Education in Elementary Science Classrooms

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Abstract: As the demand for highly qualified workers continues to rise in STEM career fields, US schools are responding by placing a greater emphasis on STEM education with the goal of improving both student achievement and interest in these areas. Despite the trend toward increased STEM initiatives in schools, there has been limited research into best teaching practices for STEM education, and many teachers express discomfort with both STEM content and pedagogy. One approach to STEM education that research has shown to be highly effective is Project-Based Learning (PBL). This article explores the impact of PBL and outlines a pedagogical framework for implementing PBL in the science classroom to support student achievement and improve student and teacher attitudes toward STEM fields.

Introduction

Over recent years, the demand for workers in the fields of science, technology, engineering, and mathematics (STEM) in the United States has risen drastically. According to the Bureau of Labor Statistics, the number of STEM careers is expected to grow by 13% between 2012 and 2022, in comparison to an 11% growth rate for non-STEM careers (Vilorio, 2014). As of 2016, the ratio of the number of available STEM jobs to unemployed STEM workers was 13:1—leaving approximately three million jobs unfulfilled (New American Economy, 2017).

The projected increase in STEM jobs coupled with the current deficit in highly qualified STEM workers has led to an emphasis on STEM education in US schools, with the goal of improving both student achievement and interest in STEM fields. Yet despite the trend toward increased STEM initiatives, there has been limited research into best teaching practices for STEM education, and many teachers express discomfort with both STEM content and pedagogy. One approach to STEM education that is both supported by research and also becoming increasingly popular is Project-Based Learning (PBL). Research has shown project-based STEM learning is an effective pedagogy approach to STEM education. When incorporated effectively in the classroom, it has a positive effect on student achievement and motivation.

Historically, STEM has referred to any of the four STEM disciplines as an isolated unit, most typically science (English, 2017; Han, Capraro, & Capraro, 2014). More recently, the term has also been applied to describe the teaching of two or more of the content areas simultaneously. In either case, contemporary science teachers are regularly charged with incorporating STEM into their curriculum. For this reason, while PBL can be applied in many different classroom contexts, this paper will examine the ways in which this approach can be implemented specifically in the science classroom.

Why a project-based approach to STEM education?

Though research into the impact of PBL on STEM education is limited, the research to date has shown that PBL can be used to improve student achievement in STEM content areas as well as student attitudes toward STEM. When students engage in open-ended projects, they demonstrate deeper growth in their understanding and appreciation of the content (English, 2017). This is particularly important if the goal of increasing the number of students pursuing STEM careers is to be met. When students appreciate the topic and are successful in the classroom, they may be more likely to pursue additional education or a career in the field.

Many studies have found that students' mastery of content knowledge increases when they are engaged in PBL. Cwikla, Milroy, Reider, and Skelton (2014) found that after completing a collaborative research project titled Pioneering Mars, 100% of high school students showed an increase in content knowledge immediately following the project and 70% demonstrated an increase in subject knowledge during a follow-up assessment several months later. Additionally, PBL has been shown to be an effective tool for closing the achievement gap. Though STEM-centered PBL has a positive effect on student achievement for students at all learning levels, low-achieving students often benefit more than their higher-achieving peers, as evidenced by the largest growth in content knowledge gained (Han et al., 2014).

In addition to increasing student achievement, PBL has also been correlated to improved attitudes toward content. Following the Pioneering Mars project, Cwikla and colleagues (2014) found that 64% of students felt the project provided them greater insight into STEM fields, and 85% of students indicated they were interested in pursuing STEM careers. Students in this study also expressed positive feelings about the real-world implications for the project, because they believed that it was meaningful, and could contribute to later scientific breakthroughs. Likewise, middle school students who participated in the project-based See Blue STEM camp indicated a 3.1% increase in interest in STEM careers, resulting in approximately 80% of participants being interested in pursuing STEM careers (Mohr-Schroeder et al., 2014).

A Pedagogical Framework

Despite the popularity and effectiveness of the project-based approach to STEM education, there remains a lack of consensus about what constitutes effective STEM educational practices, or effective PBL STEM practices. This has led to a shortage of highly qualified STEM teachers (Schmidt & Fulton, 2015). Even in instances where STEM is taught, several key principles of project-based STEM education are regularly not addressed, indicating students may not be experiencing all the benefits of this approach (Hall & Miro, 2016). In response to this problem, many research studies have attempted to more clearly define PBL by identifying key components and guiding principles. Though the language and minor details of the current research varies, there are several overarching themes in the components of effective PBL for STEM education. Key components of effective project-based STEM learning include authentic problem-solving, experiential learning tasks, engagement

in higher-order thinking skills, cross-curricular integration, and collaboration and reflection.

Authentic Problem-Solving

The first step in designing a project for STEM instruction is to pose a question or problem to students. This can be done in one of two ways. The first is by beginning with an activity that requires minimal content and providing opportunities for students to generate questions and ideas (English, 2017). For example, when introducing a project about weather, the teacher may ask students to make observations about the weather over the course of several days in a journal along with any questions or ideas they have. This allows students to raise questions such as "Why is it always cloudy before it rains?" or make hypotheses like "The sun is hot because it is sunny on warm days." Students can then use these questions and ideas to design a project to help them answer or confirm them. The second strategy is for the teacher to pose a question or problem to students and encouraging them to think about ways to answer or solve the problem (Wan Husin et al., 2016). This promotes critical thinking strategies and engages students' creativity

When developing a question or problem, teachers should use authentic, real-world experiences. Cwikla and colleagues (2014) revealed the importance of using real-world experiences through their research on the use of PBL with high school students. As a result of the authenticity of the project, students showed increased gains in knowledge and skill acquisition; they commented on how the meaningful and hands-on nature of the project helped them remember the content more effectively (Cwikla et al., 2014). However, such "real-world" experiences may not always be feasible due to a lack of resources or funding, and there may also be an increased possibility of failure associated with the risks of real-world projects. In this case, "real-world" is better described as "realistic" (Warin, Talbi, Kolski, & Hoogstoel, 2016).

Experiential Learning Tasks

Learning tasks should engage students in meaningful, hands-on opportunities to answer questions posed by the teacher. This idea is rooted in the belief that students construct meaning through interactions with their environment (Liu, Lou, Shih, Meng, & Lee, 2010). Rather than the teacher transmitting knowledge to students, students create knowledge for themselves as they design and implement an investigation, and they practice using real skills and tools to solve problems (Hall & Miro, 2016; Schmidt & Fulton, 2015). This facilitates not only students' understanding of the content, but also their appreciation of that content (English, 2017). When students are actively involved and have a voice in designing learning experiences, they make connections between the content and their background knowledge, often using experimentation and questioning to fill gaps in their understanding (Karchmer-Klein & Layton, 2006). This moves students from being receptive learners to active learners.

Higher-Order Thinking Skills

When students become active learners, they develop habits of mind associated with 21st century skills such as lifelong learning, civic responsibility, and personal or career success (Liu et al., 2010; Warin et al., 2016). In order to encourage the development of these skills, PBL must intentionally address all six levels of Bloom's Taxonomy. Engaging students in higher-order thinking skills, extends their thinking beyond simple knowledge and strategy application and shifts the focus of learning from rote memorization to the long-term development of cognitive skills (English, 2017; Schmidt & Fulton, 2015). In order to accomplish this, PBL should be focused on the process rather than the outcome (Schmidt & Fulton, 2015). Teachers should encourage students to think about the steps they are taking, why they are taking those steps, and should be considering their own understanding of the content throughout the process.

Cross-Curricular Integration

Building off the idea that projects should be authentic, integration of two or more subjects is vital to the success of PBL. In the real word, disciplines are not separated as they are in schools. Consider the development of a new pharmaceutical. When developing the drug, pharmaceutical scientists will use knowledge and skills in science to develop and test the drug, in mathematics to calculate chemical ingredients and analyze data, and in technology to synthesize the drug and collect data. The disciplines are not approached in isolation but rather woven together to contribute to the overall success of the development of the pharmaceutical. The objective of integrative STEM education is to prepare students for real-world problem solving and work in which cross-disciplinary approaches are being utilized (English, 2017).

STEM integration extends far beyond simply teaching two content areas simultaneously. The most common form of STEM integration is the utilization of one content area to support the learning objectives of another (English, 2017). For example, technology is often used to support learning objectives in science. It is important to note that incorporating one discipline simply for the sake of incorporation is not an integrated experience. Rather, true integration occurs when one discipline is a conduit for learning and students are acquiring knowledge about both disciplines. For example, by utilizing technological tools to complete an investigation, students acquire new technological literacies while simultaneously learning science content (Schmidt & Fulton, 2015).

Collaboration and Reflection

Additionally, the effective implementation of PBL creates positive communication and collaborative relationships among diverse groups of students and STEM professionals (Liu et al., 2010; Mohr-Schroeder et al., 2014). When students collaborate with STEM professionals who are experts in their fields, they gain insights into subjects that allow them to better construct ideas and increase their knowledge and skills. Collaboration with peers allows students to share their ideas and reflect upon their own understandings. When students share their learning with one another, they extend their learning within and beyond the classroom (English, 2017). And

when students reflect upon and evaluate their results, they are able to find ways to improve their work (Kitagawa, Pombo, & Davis, 2018; Macalalag, Johnson, & Johnson, 2018; Schmidt & Fulton, 2015). By sharing with their peers, students are able to identify their own misunderstandings and areas for improvement.

PBL within the Science Classroom

Imagine a fourth-grade classroom in which the teacher implements PBL to facilitate learning about the interrelationships among and between biotic and abiotic factors in ecosystems. To begin the project, the class visits a local Metropark where they learn about the endangered Karner Blue Butterfly. Park rangers guide students on a hike and students use a field guide to help identify the species in egg, larvae, cocoon, and adult stages within the park. Once students identify the species, they use a journal to record observations of the various biotic and abiotic factors within the butterfly's habitat. Knowing that some biotic factors may not be immediately visible, the students use field guides and consult the park rangers to interpret evidence of other species (such as animal tracks) within the area.

Following their visit, students meet in small groups and discuss their findings. Several groups noticed that Karner Blue larvae are only observed on blue lupine plants and hypothesize that it must be food for the caterpillars. Once all groups have had a chance to share their findings, the teacher poses the question, "How can we use this information to help the Karner Blue Butterfly?" After careful consideration, students hypothesize that if they were to plant more blue lupine plants, the larvae would have enough food to grow.

Over the next several days, the students begin to plan experiments to determine ideal growing conditions for the lupine plants. As part of their planning, students conduct research online about recommended growing conditions for the plant and even video conference with a horticulturist from their local zoo to help answer questions about sun exposure, temperature requirements, soil type, pH, nitrogen and rainfall requirements. After several days, students believe they have identified ideal growing conditions and have formulated an experiment to confirm their hypothesis. Their teacher provides students with the necessary materials for conducting their experiments and the students carry out the experiments over the next two weeks.

Once tests are complete, the students use a map of the Metropark, their prior knowledge, and the findings of their experiments to identify six potential locations the plant could grow. The teacher arranges for the students to visit the park again and asks the park rangers to set out rain gauges in areas students plan to test. Two weeks later, students return to the Metropark and collect soil samples. Students record information about sun exposure, temperature, rainfall, and soil type upon collection to label the samples. Students also use pH gauges and nitrogen strips to test the pH and nitrogen of soil respectively.

The following day at school, the teacher shows students how to compile and analyze data in a cluster graph. Small groups work together to generate and analyze graphs, with each group focusing on one soil factor. Once complete, the groups share their findings and the class decides that the best area in which to plant the seeds is in a part of the park covered by pine forest.

A few weeks later, the class visits the Metropark once more to spread blue lupine seed in the area. After completing the project, students write a short essay about the experience and what they expect to happen. One student writes, "It was so cool to think all the tests we ran could actually help save the butterflies! I felt like a real scientist!"

In this project, we see how all the components of effective PBL come together. Students had worked together to answer a question about how relationships within an ecosystem can impact an individual species. In this case, the students had decided that increasing the food supply of the butterflies would help increase the number of individual butterflies. Since the students were working with the Metropark, the project is authentic. Throughout the entire project, students were engaged in hands-on experiences and high-order thinking skills as they formulated hypotheses, ran tests, and drew conclusions based on evidence. Collaboration occurred in small peer groups, whole class discussion, and with experts within the field. Though the primary focus discipline of the project was science, students also learned technological skills through their use of technology to conduct their tests. Mathematics was also integrated through the creation and interpretation of graphs to justify where the plants should be planted. Finally, students reflected on the experience and their understanding during the writing of their essays at the end.

Conclusion

In today's educational climate, despite extensive research into the benefits of project-based STEM education on student attitudes and achievement, little evidence exits that these strategies are being effectively implemented. The ambiguity surrounding what constitutes effective STEM and PBL practices, as well as a lack of teacher preparation has led to feelings of discomfort among teachers and left them hesitant or unable to provide such instruction. As the emphasis on STEM education continues to grow, educators will need to identify best practices for STEM education to help teachers feel more confident in providing instruction in STEM education. The objective of this manuscript was to clarify the components of effective PBL and discuss how they could be applied within elementary science classrooms to support STEM. Improving teacher understanding of how apply PBL effectively can help science educators effectively implement STEM education, and help them transform their students from receptive to active learners.

References

Cwikla, J., Milroy, S., Reider, D., & Skelton, T. (2014). Pioneering mars: Turning the red planet green with earth's smallest settlers. *The American Biology Teacher*, *76*(5), 300-305.

English, L. D. (2017). Advancing elementary and middle school STEM education. *International Journal of Science and Mathematics Education, 15*(S1), 5-24.

English, L. D., & King, D. T. (2015). STEM learning through engineering design: Fourth-grade students' investigations in aerospace. *International Journal of STEM Education, 2*(1), 1-18.

Hall, A., & Miro, D. (2016). A study of student engagement in project-based learning across multiple approaches to STEM education programs. *School Science and Mathematics, 116*(6), 310-319.

Han, S., Capraro, R., & Capraro, M. M. (2014). 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 and Mathematics Education, 13*(5), 1089-1113.

Karchmer-Klein, R., & Layton, V. (2006). Literature-based collaborative internet projects in elementary classrooms. *Reading Research and Instruction, 45*(4), 261-294.

Kitagawa, L., Pombo, E., & Davis, T. (2018). Plastic pollution to solution. *Science and Children, 55*(07), 38-45.

Liu, Y., Lou, S., Shih, R., Meng, H., & Lee, C. (2010). A case study of online project-based learning: The beer king project. *International Journal of Technology in Teaching and Learning, 6*(1), 43-57.

Macalalag, J. A., Johnson, B., & Johnson, J. (2018). Engineering encounters: STEM-ify me: It's elementary! Designing butterfly wings. *Science and Children, 55*(09), 76-82.

Mohr-Schroeder, M. J., Jackson, C., Miller, M., Walcott, B., Little, D. L., Speler, L., Schooler, W, & Schroeder, D. C. (2014). Developing middle school students' interests in STEM via summer learning experiences: See Blue STEM camp. *School Science and Mathematics, 114*(6), 291-301.

New American Economy. (2017, March). Sizing up the gap in our supply of STEM workers. Retrieved from https://research.newamericaneconomy.org/report/sizing-up-the-gap-in-our-supply-of-stem-workers/

Schmidt, M., & Fulton, L. (2015). Transforming a traditional inquiry-based science unit into a STEM unit for elementary pre-service teachers: A view from the trenches. *Journal of Science Education and Technology, 25*(2), 302-315.

Vilorio, D. (2014, Spring). STEM 101: Intro to tomorrow's jobs. *Occupational Outlook Quarterly*, 2-12. Retrieved from https://www.bls.gov/careeroutlook/2014/spring/art01.pdf

Wan Husin, W., Mohamad Arsad, N., Othman, O., Halim, L., Rasul, M. S., Osman, K., & Iksan, Z. (2016). Fostering students' 21st century skills through project oriented problem based learning (POPBL) in integrated STEM education program. Asia-Pacific Forum on Science Learning and Teaching, 17(1). Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=118111100&site=eds-live

Warin, B., Talbi, O., Kolski, C., & Hoogstoel, F. (2016). Multi-role project (MRP): A new Project-Based Learning method for STEM. *IEEE Transactions on Education, 59*(2), 137-146.

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Preparing Gifted Students for College Success within the High School Science Classroom

Julia R. Boehler

Abstract: Succeeding in college is a crucial step for many students in order to reach their desired career. Yet, research has shown that gifted students often have poorer college adjustment than their non-gifted peers. Gifted students have unique needs in high school classrooms, and when these needs are not met, they may not develop important skills they need for college success. It is important for all high school teachers to not only help their students achieve in a high school setting, but also to prepare them for success following graduation. This article discusses the areas gifted students often lack skills in as well as instructional strategies that high school science teachers can use to help their gifted students develop these skills. By using a combination of strategies like homogenous grouping, higher-order cognitive tasks, differentiation and project-based learning, high school science teachers will better prepare their gifted students for success in college.

Introduction

Imagine you are a gifted science student, just beginning your college career. You think you are ready. High school science was easy. You paid attention in class, turned in your work (mostly) on time and got A's on all the tests without needing to really study. You never had to go ask the teacher questions to understand how to figure out an assignment, you could do it on your own. You never felt challenged, but that was fine, you had a high GPA and got a good scholarship to college, so you are all set. You are the one who easily gets all As, who is just naturally good at school. Why would college be any different?

Except college is different. There are not as many grades in the classes, so exams have higher stakes, and are more comprehensive and difficult. You find that you are not doing well on them without studying, but you have never needed to study before and are not sure exactly how to study. The papers and laboratory assignments are much harder, and you cannot seem to figure them out on your own. Maybe you should ask a peer or a professor? But you have never needed to ask for help before, so you hesitate now. Why can't you figure it out on your own? And all these assignments, exams, lab times, office hours and study times are a lot to keep track of. You never had to plan so much time around school work before; you usually finished assignments much more quickly than your peers in high school, so you never had to figure out how to manage your time wisely. You were the one with all As, but now you are barely passing your classes. High school was easy, but college is much harder than you anticipated. You are stressed and anxious, and you do not like school anymore. You start to feel like maybe college is not the place for you.

Most people assume gifted students, especially those with high GPAs in high school, will flourish in college, but this is often not the case. "53% of high performing [gifted] high school students achieved relatively less well in college" (Peterson, 2000, p. 38). Think about the thought experiment above, and you can begin to see why this might be the case. Gifted students often do not develop the same skills

needed for success in college that their high-achieving non-gifted peers do. Gifted students have unique needs in the high school science classroom and face unique needs in the transition from high school to college. Unlike students with disabilities who are guaranteed Individualized Education Plans during their high school education, there is no federal law requiring differentiation and assistance for gifted students. In addition, definitions of what constitutes a gifted student vary from state to state and each school decides its own plan to meet the needs of gifted students. As a result, these students are at risk for not receiving the support they need to be successful.

Given their strengths, gifted students have great potential as leaders in their fields, but in many fields, college success is an important step on the path to reach that potential. If gifted students fail in college due to not developing the skills they needed while in high school, this can negatively impact their future as well as causing a loss of potential innovation in society. It is the responsibility of teachers to prepare all students, including gifted students, for success after graduation, which includes preparing them to succeed in college. Ideally, no gifted student should experience the struggles outlined in this introduction. The purpose of this article is to provide high school science teachers with instructional strategies that target the areas in which their gifted students need additional support in order to be ready for the increased academic rigor and personal responsibility of college.

Where Gifted Students Struggle in College

The scenario I offered of a gifted student starting college is based both on research of college transitions, as well as on my own experience as a gifted student struggling to make this transition. For example, a study by Gómez-Arizaga and Conejeros-Solar (2013) found that gifted students often feel unprepared for academics at the college level because they did not take notes during lessons in high school. Additionally, the gifted students in college reported that high school tests were easy so they could study quickly the night before and do well. However, in college, these students found that minimal studying was not sufficient if they wished to do well. These researchers subsequently conducted a study comparing the adjustment of gifted and non-gifted students and found that the main differences between them were in academic development and in relationship building with faculty members. The gifted students reported struggling more with time management and having weaker overall study habits then non-gifted students (Conejeros-Solar & Gómez, 2015). Another study found that when students were asked how they perceived their high academic ability as affecting their college adjustment, about 20% identified their high ability as a liability negatively impacting their college success. These students identified their giftedness as a hindrance due to it leading them to develop poor learning skills because they were not challenged in ways that required them to study in high school. Students who identified high ability as a detriment in college also identified perfectionism, tendencies to overburden themselves, and social deficiencies as struggles they experienced in college that they attributed to their giftedness (Peterson, 2000). Clearly, having effective study habits and time management skills are important for college success and these are areas in which gifted students often fall behind their non-gifted peers.

What High School Science Teachers Can Do

Although there is little research that directly links specific instructional strategies in science to better adjustment of gifted students in college, there are instructional strategies that have been linked to the development of skills important for success in college. In addition, certain instructional practices have been linked to higher achievement and engagement for gifted students in high school science. Students who are more engaged in science classrooms are more likely to develop skills essential for college success.

The Ideal Classroom Environment

There are certain aspects of high school classrooms that have been linked to gifted student engagement and achievement in science. A2013 study by Gómez-Arizaga and Conejeros-Solar found that students who participated in an enrichment program designed for gifted students felt that the program's accepting environment and opportunities to interact with gifted peers helped them develop important social skills and overcome personal challenges during college. Another study that asked gifted college students to reflect on their high school science experiences found that the qualities that the gifted students valued in their science teachers were high skill levels in the field of science, high expectations of the gifted students, and demonstrations of personal interest in the lives of students. Additionally, students were more likely to form positive peer relationships in homogenous over heterogeneous grouping (Muller et al., 2017). The importance of interactions with gifted peers and supportive teachers is further supported by research showing that gifted students reported enjoying specialized classes, such as Advanced Placement and International Baccalaureate, not only because of the more challenging curriculum but also because such classes offered them opportunities to work with like-minded peers. Gifted students also emphasized the importance of teachers who made them feel valued, supported them, and held them to high standards (Coleman et al., 2015). Overall, these results suggest that the best high school science classrooms for gifted students should include opportunities for homogenous grouping, hold students to high expectations and value the key individualities of each student.

Differentiation

An important aspect of ensuring the needs of gifted students are being met is including differentiation for the gifted students. Differentiation is the process of gauging student ability and assigning different tasks to these students based on that ability. Differentiation can occur at the level of content, process, or product, and can help ensure gifted students are being challenged appropriately. Differentiation also can help teachers avoid having their classes be so easy for gifted students that they do not need to develop effective study and time management skills. For example, in one study, three chemistry teachers differentiated the tasks for their classes during a thematic unit by allowing students to work at their own pace and assigning different students different tasks based on their abilities. All three teachers that used differentiation showed high levels of engagement and positive feedback from both the gifted and non-gifted students in their classes. This study also found that asking

gifted students to generate unique products and giving options that allowed for visual, oral, performance, and written assessments increased engagement and achievement in chemistry (Park and Oliver, 2009). Differentiation is one way that science teachers can increase engagement and achievement of gifted students.

Higher-Order Cognitive Tasks

In general, any task that engages gifted students in higher-order thinking is beneficial for achievement and engagement in science as well as preparing them for college. High school science teachers preparing gifted students for college may wonder whether to prioritize covering broad swathes of content knowledge or to instead focus on in-depth critical thinking experiences. The research suggests that higher-quality thinking is more valuable than greater content coverage. For example, a study of an enrichment program that had gifted high school students engage in college level science experiences found no advantage for those students who had more chemistry knowledge entering the program. Instead, results showed students who had little prior chemistry knowledge scored higher on the posttest (Worrell, 1987). This implies that prior knowledge is not necessarily an advantage in a rigorous academic environment. An additional 2004 study conducted by Ngoi and Vondracek on a gifted student enrichment program asked students to think critically about advanced topics within science and to problem solve within science. The authors found that the rigor of this program and its commitment to critical thinking and problem solving in science greatly benefited gifted students: "Approximately 95% of all graduates who have taken the Chemistry / Physics Program have reported in surveys that they definitely feel better prepared for college and careers not only because they had college-level material in high school, but also because of the study skills and time-management skills they developed" (Ngoi & Vondracek, 2004, p. 146). This study found a connection between critical thinking in science and the development of study and time-management skills and college success. Another study similarly found when gifted students reflected on high school experiences in science and math, they placed a high value on critical thinking and devalued classes that focused on memorizing large portions of information rather than on complex critical thinking tasks. Students valued the classes in which they had the freedom to critically think and to figure out concepts on their own through inquiry (Muller et al., 2017). Overall, science teachers who focus on providing opportunities for critical thinking in science rather than covering as much content as possible will have more engaged gifted students who are better prepared for college.

Project-Based Learning (PBL)

PBL is an instructional strategy that has been linked to increased engagement and achievement of gifted students in science, as well as one that engages student in higher-order cognitive tasks and provides a framework that can be easily differentiated. The PBL approach in any content involves having problems for students to approach that require the student to have an understanding of relevant information. This relevant information is the content and the PBL approach has the students actively engage in exploring and using this content. This creates a learning environ-

ment that is more student-centered than teacher-centered. Coleman recommends PBL for gifted students because it meets many important goals for gifted students, including helping students develop higher-order thinking skills and self-discipline, as well as providing opportunities for them to engage with advanced content (Coleman, 1995). Other researchers have also found that gifted students had significant increases in creativity, self-regulation, frequency of content discussion, and interest in science following PBL experiences in science (Jo & Ku, 2011). The use of PBL and differentiation together for gifted students have also been associated with the development of skills associated with creativity, developing creativity provides "the skills and habits of mind that support innovation" (Vantassel-Baska, 2012, p. 2). Undoubtedly, using PBL with differentiation can help gifted students not only develop skills important for college success but also for being innovators and leaders in their fields.

Conclusion

To prepare gifted students for success in college, high school science teachers should use instructional strategies that develop gifted students' critical-thinking, time-management, and study skills. Research has shown that using PBL and differentiation can help increase engagement of gifted students in high school science while also helping these students develop critical thinking and time management skills. Additionally, studies have identified the importance of using homogenous grouping and having high expectations of gifted students in order to foster both the engagement and achievement of gifted students in science classrooms. High school science teachers who are designing instructional plans to help their gifted students prepare for college will not find one simple answer on what is best. However, by using a combination of suggested strategies such as PBL, higher-order cognitive tasks, differentiation and homogenous grouping, educators can nurture the development of study, time-management, and critical-thinking. High grades can be a false indicator of gifted students' preparedness for college, so it is important to collect additional data and speak with gifted students to ensure they are being appropriately challenged and that they are developing these important skills. In addition, science teachers should be aware that gifted students have unique needs and should regularly communicate with gifted students and families to ensure their needs are being met.

References

Coleman, L. J., Micko, K. J., & Cross, T. L. (2015). Twenty-five years of research on the lived experience of being gifted in school. *Journal for the Education of the Gifted, 38*(4), 358-376. doi:10.1177/0162353215607322

Coleman, M. R. (1995). Exploring options: Problem-based learning. *Gifted Child Today, 18*(3), 18-19. doi:10.1177/107621759501800309

Conejeros-Solar, M. L., & Gómez-Arízaga, M. P. (2015). Gifted students' characteristics, persistence, and difficulties in college. *Roeper Review; 37*(4), 241-251. doi: 10.1080/02783193.2015.1077909

Gómez-Arízaga, M. P., & Conejeros-Solar, M. L. (2013). Am I that talented? The experiences of gifted individuals from diverse educational backgrounds at the postsecondary level. *High Ability Studies, 24*(2), 135-151. doi:10.1080/13598139.2013.838898

Jo, S., & Ku, J. (2011). Problem based learning using real-time data in science education for the gifted. *Gifted Education International, 27*(3), 263-273. doi:10.1177/026142941102700304

Ngoi, M., & Vondracek, M. (2004). Working with gifted science students in a public high school environment: One school's approach. *Journal of Secondary Gifted Education, 15*(4), 141-147. doi:10.4219/jsge-2004-459

Park, S., & Oliver, J. S. (2009). The translation of teachers' understanding of gifted students into instructional strategies for teaching science. *Journal of Science Teacher Education, 20*(4), 333-351. doi:10.1007/s10972-009-9138-7

Peterson, J. S. (2000). Preparing for college—beyond the getting-in part. *Gifted Child Today, 23*(2), 36-41. doi:10.4219/gct-2000-727

Vantassel-Baska, J. (2012). Curriculum issues. *Gifted Child Today, 36*(1), 71-75. doi:10.1177/1076217512465289

Worrell, J. H. (1987). A mathematics and science program for gifted high school students. *Journal of Chemical Education, 64*(7), 12-13.

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Using an Interdisciplinary Approach with Problem-Based Learning for Gifted Learners

Nathan Cotton

Abstract: Gifted learners and their needs are often inadvertently overlooked. Planning for the needs of all students requires deliberate thought including specific goals. Additionally, tested and reliable instructional methods and techniques should be sought out and implemented within our classrooms to meet the needs of students and problem-based learning, PBL, is one such method. PBL is based on ill-structured, open-ended problems; problems that do not have a correct answer. Gifted learners need the type of learning environment that PBL can create in order to utilize their creativeness, improve their critical thinking, and problem-solving abilities. This manuscript includes an overview of how an interdisciplinary approach with PBL can provide a path to increase opportunities for gifted learners to maximize their potential.

Introduction

I had a unique, year-long experience with a class in the recent past. Two of the most gifted students that I have known during my 23-year teaching career were in the same high school Honors Chemistry class. This class offered both challenges and moments of success concerning the class dynamics but also left me with questions about differentiating for gifted learners. The two students fit the textbook definitions of two types of gifted learners; Dylan (a pseudonym) was autonomous learner and Sidney (a pseudonym) was a successful learner. Dylan was not driven by grades but by the challenge of learning itself, whereas Sidney would typically only do what was required to earn an A.

During one class period we were studying the classifications of chemical reactions and as an example of combustion reactions we used common hydrocarbons that students come in contact with daily as reactants, such as natural gas (used in heating homes) and octane (found in gasoline). By this time of the year, I was familiar with my student's behavior and mannerisms enough to know that Dylan and Sidney already knew the answers while most of the students in the class were still predicting the products. Sidney very rarely contributed to extending conversations on science subject matter but Dylan consistently wanted to extend topics and this occasion was no different; Dylan connected the production of carbon dioxide in these very common reactions to the concept of global warming and climate change before I had the chance to bring it up.

Dylan asked, "So what are we doing about this?"

I responded to him and the class, "What can we do? Don't we want to maintain our modern conveniences?"

While Dylan's and some of his classmates' responses were centered on popular science and technology-based solutions, Sidney finally spoke up and said, "It's simple, tax the people who produce or use the most carbon dioxide and credit those that don't." At that moment, our discussion turned from one of just science-

centered solutions to a holistic, interdisciplinary discussion. Gifted learners thrive in the type of educational environment that provides them with open-ended questions and freedom of choice. I propose that an interdisciplinary approach with problem-based learning can provide the required parameters to promote growth for gifted learners.

Gifted Learners

According to the Ohio Revised Code (Ohio Department of Education [ODE], 2019), a gifted learner is a student who "performs or shows potential for performing at remarkably high levels of accomplishment when compared to others of their age, experience, or environment." ODE requires public school districts in Ohio to identify gifted students in categories that include superior cognitive ability, specific academic abilities, creative thinking and ability, and visual and performing arts ability. Students can be identified as gifted in one or more disciplines. Approved, uniform testing measures are used for identification; however, once students are identified by their district, the district is not required to provide any additional services, although the choice not to provide services or to provide only limited services negatively affects the district's report card. The ODE recently updated the requirements for school districts to earn credit on their district report card for providing gifted education. This scenario leads to a non-uniform application of gifted education practices across the state and magnifies the challenges facing individual teachers trying to maximize learners' opportunities.

Gifted learners have different needs in regards to their education than either regular or special needs learners. They generally have a greater capacity for learning and creativity than either of those other groups. At the same time, it is important to note that not all gifted learners have the same ability levels or strengths. In my experience teaching in southeastern Ohio, there are roughly an equal number of students identified as gifted learners as learners with special needs. Each of the school districts that I have taught seemed to have held the belief that gifted learners will be successful without intervention; therefore, resources were not generally allocated for the benefit of those students.

It is a challenge when planning curriculum for gifted learners, deciding on course offerings, and determining the distribution of staff and other resources. These challenges do not appear to have easy solutions. Yet differentiation for these students is necessary, and how we go about designing and implementing plans to do so can determine how successful we are.

Differentiation

All students, regardless of their ability, have the right to instruction that is appropriate for their needs (McGrail, 1998) and differentiation is one method to meet diverse student needs. Each individual student has their own strengths and weaknesses in regards to their learning process and differentiating curriculum can benefit all students. The students found on either end of the ability spectrum have the greatest need for differentiation, and can benefit the most from it. That said, differentiation to serve the needs of special needs learners has been common practice in

education for many years, but only recently have the needs of gifted learners started getting some attention.

Differentiation or curricula modification can be accomplished through assignment modification, lesson modification, and scheduling modification (McGrail, 1998). Most high school science classes are heterogeneous groupings of mixed-ability-level students. At the same time, due to scheduling modification linked to tracking, gifted learners are often found in higher-level courses with other motivated and above average learners which may also include students that have missed being identified (Fiero, 2012). This presents opportunities to use techniques such as problem-based learning (PBL) to differentiate through lesson modification. PBL can offer each student in the class an equal opportunity to challenge themselves while also providing the necessary environment for gifted learners to thrive.

Problem-Based Learning

Problem-based learning is a technique used for differentiation that has been adapted in a range of educational settings, from colleges to medical schools to K-12 schools, as a way to support students' development of problem-solving skills. PBL is designed around ill-structured problems, the kind of questions that most adults face in real life (Gallagher, Rosenthal & Stepien, 1992). Most problems that students face in school are well-structured problems; questions and problems that have correct answers. An ill-structured problem has no correct answer, allowing for multiple possible solutions. Consequently, students must develop a knowledge base of relevant information in order to reach a solution (Coleman, 1995). Steps taught in PBL include fact-finding, problem finding, brainstorming, solution finding, implementation, and evaluation. Entire courses can be based on PBL but most often, the problem-based approach is used to present a focus topic within a traditional course (Gallagher, Rosenthal & Stepien, 1992). Since high school science education curriculum is content heavy, I do not believe that it would be feasible to teach entire courses using PBL. Nevertheless, science classes do offer unique opportunities to apply the content to common environmental issues facing society today in a student-centered, problem-based format.

Gifted students and PBL

While all students in a mixed ability level class could benefit from PBL, Gallagher, Rosenthal and Stepien (1992) have argued it can offer more benefits for gifted learners by increasing opportunities for them to use active learning strategies, to engage in higher order thinking and self-directed learning, and to work with advanced content. Learning how to engage in PBL can improve a student's ability to research, manage data, and present and share information, which are all important goals for gifted education (Renzulli, 1994).

Many science teachers may already be familiar with PBL, but I argue that an interdisciplinary approach using PBL can allow gifted high school learners opportunities to merge their discipline-specific knowledge base, their own interests, and their creativity, all while allowing them to work toward possible solutions for the complicated environmental issues that today's society faces. These socio-scientific

issues do not presently have solutions and thus we should not expect our students to solve the actual problems, but rather that attempting to do so would create opportunities for them to work and to learn productively alongside their peers.

Interdisciplinary approach with PBL

According to Margot and Kettler (2019), student-centered instructional strategies used in STEM (science, technology, engineering and mathematics) courses such as PjBL (project-based learning) and PBL have been gaining popularity, shifting away from the traditional lecture based, and teacher-centered strategies. These newer strategies have been found to promote improved critical thinking, students' attitudes toward science, and learning enhanced science content knowledge (Burris & Garton, 2007). Tamim and Grant (as cited in Keiler, 2018) state that PjBL is a product driven strategy that can be intimidating to teachers. However, PBL may be less intimidating for teachers and students, because while students involved in PBL explore real-world problems in groups, a finished product is not the goal (Coleman, 1995). This difference between PjBL and PBL can make PBL more appealing and less intimidating for classroom teachers looking to transition to a student-centered approach (an approach also favored by gifted learners; McGrail, 1998). Designing units or activities to include disciplines such as the social sciences and/or English Language Arts (ELA) may further provide a route to increase the students' interest in education and better prepare our gifted learners for their future.

Issues that are interdisciplinary by nature, such as global warming and climate change cross multiple science disciplines and have complex explanations that are well supported by scientific experimentation and data that identifies the causes and the included effects on the environment. Even though scientists have presented their findings and gone as far as proposing possible solutions and necessary timelines, a solution to the issues goes beyond science requiring students to engage with content from mathematics, social studies, and ELA.

Science

In order to set the stage for students when developing a PBL activity for and environmental science course, the students need to first be able to rely on content from past science courses in order to work through understanding the underlying science behind issues in question, such as with acid rain. During chemistry courses students learn how acid rain is formed and how the increase in acidity effects the water and soil pH, and the solubility of metals found in rock. Life sciences are needed to explain how plant and animal life are affected by the lower pH and the increased concentration of metals in the water. Students would attack the issue by first researching what has been discovered, already changed, and the associated data. Science courses would be responsible for the portion of the issue that explains the mechanisms and possible solutions. Even though Dylan was ready to hear what science is doing to solve the issues, he and his classmates would soon learn that decisions and policies cannot be enacted based on science alone; we must also consider how other factors such as the political, social, and financial aspects are involved in decision making.

Social Studies

In Ohio schools, social studies departments offer both U.S. government and economics. As taught in our school, U.S. government introduces students to the process involved in making policy and laws, and how organizations such as the EPA operate within the government. Students also learn what information is required by the politicians when making decisions and the effect that lobbyists and special interest groups have on the decision-making process. Economics courses address how policy changes can affect the decisions made by other levels of government, individuals' personal finances and spending, and companies, and how these changes impact the nation's economy as a whole. This is all pertinent to understand and respond to Sidney's comment related to taxation.

When Sidney suggested that we tax those that use the most, how would an individual or company respond and what would the effects be on the nation's economy? Would individuals cut back on personal usage, would they be able to absorb the increased cost of purchased goods because industry would pass their expenses on to the consumers? Would the increased taxation push smaller industry out of business and decrease the workforce? Science and technology have possible solutions and using an interdisciplinary approach, learners would research and evaluate how possible solutions and decisions drive and influence the process of policymaking.

English Language Arts

Presentation and public speaking, skills generally associated with ELA, are necessary for learners to share and communicate their ideas and findings with their peers effectively. Open, effective dialogue is essential in the decision-making process; it extends opportunities to promote cooperation, collaboration, argumentation, and learning from others.

Students often do not connect the importance of communication with the learning process and the overall functioning of society. Many gifted learners fall into this category where their strengths are increased cognitive abilities; they may still lack an ability to communicate effectively. Presenting and sharing information is one of the goals of gifted education (Renzulli, 1994) and incorporating the components into an interdisciplinary PBL activity can help meet that goal.

Conclusion

Students are often uninterested in the topics embedded within our standards, often asking the question, "When am I ever going to use this?" The application of PBL using interdisciplinary methods could provide an excellent example of when they will use the topics and also an opportunity to actually put their knowledge into practice. Learning is much more effective when the students take the concepts they have been introduced to and put them into practice.

Science and social studies courses are the primary areas of focus for researching, gathering and interpreting data and language arts courses play a vital role by providing the instruction and direction for presenting and sharing the information. We are charged as teachers to maximize our learners' opportunities and we can do

so while improving their ability to research, manage data, present and share information. PBL provides an appropriate avenue to reach these goals.

Each of our students have their own strengths, weaknesses and personal interests, which often determines their motivation to learn. While our students probably cannot become experts in every field, they can at least contribute to the process and understanding the problem-solving process, leading them to be readier to take on the responsibility of solving important societal problems as adults.

References

Burris, S. & Garton, B.L. (2007). Effect of instructional strategy on critical thinking and content knowledge using problem-based learning in the secondary classroom. *Journal of Agricultural Education, 46*(1), 106-116.

Coleman, M.R. (1995). Problem-Based Learning: A new approach for teaching gifted students. *Gifted Child Today, 18*(3), 18-19.

Fiero, A. (2012). Heterogeneous classes: Why inclusion and mixed grouping create a better science classroom. *Science Scope, 35*(9), 36-40.

Gallagher, S., Rosenthal, H. & Stepien, W. (1992). The effects of Problem-Based Learning on problem solving. *Gifted Child Quarterly, 36*(4), 195-200. doi:10.1177/001698629203600405

Keiler, L. S. (2018). Teachers' roles and identities in student-centered classrooms. *International Journal of STEM Education, 5*(34). doi.10.1186/s40594-018-0131-6

Margot, K. C. & Kettler, T. (2019). Teachers' perception of STEM integration and education: A systematic literature review. *International Journal of STEM Education, 6*(2). http://dx.doi.org/10.1186/s40594-018-0151-2

McGrail, L. (1998). Modifying regular classroom curricula for high ability students. *Gifted Child Today Magazine, 21*(2), 36-39.

Ohio Department of Education. (2019). Gifted education. Retrieved 2/4/2019 from https://education.ohio.gov/Topics/Other-Resources/Gifted-Education

Renzulli, J. (2012). Reexamining the role of gifted education and talent development for the 21st century: A four-part theoretical approach. *Gifted Child Quarterly, 56*(3), 150-159.

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The Use of Dialogue to Build Scientific Literacy in the Laboratory Setting

Richard Jacox

Abstract: Students who are scientifically literate demonstrate the ability to use verbal descriptions, pictorial representations, the language of mathematics, and technological applications to build conceptual models of natural phenomena that are useful for describing observations and making predictions based on observations. The laboratory setting is ideal for the use of classroom dialogue that emphasizes invitational questioning to identify student preconceptions, gently expose misconceptions, and help students extend their understanding in ways that enable them to reconceptualize their prior knowledge. A framework for designing laboratory experiences to emphasize invitational questioning and conversational interaction to integrate as many of the four domains of scientific literacy as possible, is proposed in this manuscript.

Introduction

A primary challenge I have faced in my 28 years of classroom experience has been initiating and maintaining of effective classroom dialogue. Prior to entering teaching, I had been a cardiopulmonary technologist, working for several years in a teaching hospital. As part of my professional responsibilities in critical care, I accompanied medical residents, interns, and students, as they made bedside rounds with the chief physician of critical care services. The day-to-day training relied on Socratic Dialogue, ideally a methodology in which questions are asked to ascertain current knowledge with follow up questions directed toward the expansion of knowledge (Stoddard & O'Dell, 2016). Frequently, with the chief of service doing the questioning, the sessions were uncomfortable to witness, with the tone of questioning highly confrontational and a failure to provide adequate answers eliciting sarcastic and humiliating retorts from the questioner.

In recent years, the medical education community has begun to look with disfavor on this highly confrontational questioning style. The goal of Socratic questioning should be to identify prior knowledge and awaken connections with new knowledge, an invitational paradigm, rather than emphasizing hierarchal judgment and confrontation (Oh & Reamy, 2014). A medical resident's literacy would be supported by verbal descriptions integrating quantitative data, pictorial representations and the use of technological applications in assessing the status of the patient in question. The persistence of the use of Socratic Method in the training of medical residents lies in its utility for stimulating critical thinking while exposing prior learning and misconceptions (Huang, 2005). Yet the Socratic method need not be confrontational; at its best effective Socratic dialogue is instead invitational, inviting conversation rather than confronting the subject of questioning.

A Framework for Scientific Literacy

The medical literacy sought through the use of Socratic dialogue is analogous to the scientific literacy we seek in the classroom. An operational definition of scientific literacy incorporates four domains: natural language (verbal descriptions), mathematical descriptions (equation based), pictorial representations such as particle or motion diagrams, and technological applications using spreadsheet-based graphical representations and data collection software and hardware (Lemke, 2004). Another way to describe these four domains is, (1) practical knowledge from observations, (2) qualitative physical models utilizing diagrams, (3) concrete mathematical models incorporating measurements and graphing, and (4) written symbol manipulations integrating equations and calculations (Clement, 1978). The framework of common laboratory experiences can provide a template for building scientific literacy integrating all four of these literacy domains, as described by Lemke (2004) and Clement (1978).

Traditional laboratory activities often follow a 'cookbook format,' offering explicit instructions that students are expected to follow verbatim; this structure can inhibit opportunities to stimulate thinking in students due to the passivity of students working within this model (Germann, Halkins, & Auls, 1996). By applying a template developed from the literacy domains described by Lemke (2004) and Clement (1978) teachers of all experience levels can design laboratory experiences that integrate invitational dialogue to help build student's scientific literacy. It is understood, especially at lower grade levels, many laboratory activities are qualitative in nature rather than quantitative, so not all laboratory activities will incorporate all four domains. The goal should be to incorporate as many domains as possible, with invitational questioning and dialogue as the bridge integrating them, to achieve the goal of students actively "doing" science.

Domain 1: Natural Language Verbal Descriptions

The natural language domain is over-arching; assessing student literacy in the other three domains will always incorporate their observations, analysis and predictions as expressed in their natural language. Written assessments are generally dominant in the classroom setting, and are often a necessity because of the demand that students document their progress, but they are limited in their usefulness because of lack of opportunities for clarification and correction in real time. The intentional use of invitational dialogue allows for diagnosis of current knowledge levels, conceptual understanding, and possible misconceptions because of the dynamic nature of dialogue.

Typically, laboratory handouts in pre-laboratory sections introduce students to scientific vocabulary that describes the experimental variables, safety procedures, and calculations that the student must use to evaluate laboratory data. While informative, these types of handouts lack the capacity to confront student misconceptions based on prior knowledge and experience, misconceptions that frequently hinder student acquisition of conceptual understanding necessary to construct correct scientific models of natural phenomena (National Research Council, 1997).

For example, a common misconception that students bring into the classroom is that heat and temperature are synonymous. Careful questioning can quickly assess whether this is an issue. Yet simply asking a student to define temperature and heat, or to state the difference between them, is confrontational and limiting; the student will usually respond with a formal definition using scientific language, understanding that their answer is subject to the teacher's evaluation and judgment. An invitational way of asking this question is to make it open-ended by asking something like "what do we know about temperature and heat?" Though this may seem like a very subtle difference, asking it in this way deescalates the sense of judgment that questioning often stimulates. The goal is to provide a structure in which students are at liberty to use their natural language rather than relying on more formal scientific language. If the answers that students give reflect the misconception that temperature and heat are the same, a simple set of questions can guide students to differentiate between them. For example, you can ask students what a thimble full of boiling water and a bucket full of boiling water have in common. They will answer that both are 100oC water, the temperature is the same. Agreeing with them that the temperature is the same, then you can ask if the thimble and bucket contain the same amount of heat. In my experience, there is usually a pause before students answer because this question directly confronts the misconception. If there is a pause, I ask them which would do more damage if the contents were spilled on their arm; at this point all students will grasp that heat content is dependent on the amount of the substance, not just its temperature, since a bucket full of boiling water would do much more damage than a thimble full of boiling water. Dialogue such as this is non-judgmental and safe for students, and it provides an opportunity to extend student understanding in an atmosphere that builds trust. It is critical in the questioning process that the teacher does not devalue or denigrate students' initial responses, because this can cause students to become fearful and unwilling to engage. Invitational questioning facilitates a reconceptualization process, a clarification, and perhaps replacement of prior knowledge and conceptual understanding (Posner, Strike, Hewson, & Gertzog, 1982).

Domain 2: Pictorial Representations and Diagrams

The use of whiteboards in the laboratory setting for the pictorial representation of student conceptual understanding is both practical and generally a positive experience for students. Pictorial representations externally manifest internal understanding (Johnson-Laird, 1980). It is critical to the process that the instructor engages students with questions from both domains 1 and 2 while the whiteboard preparation takes place. If there is something very obviously wrong with their predictions or diagrams that could lead to embarrassment during the pre or post-laboratory presentations, assistance can be offered to the students in a more private setting. Effective dialogue is based in trust. Generally, I have found it most effective if all of the whiteboards are displayed simultaneously with the instructor choosing two or more of the whiteboards for discussion. The first task for students is to look at all of the whiteboards, note similarities and differences, and discuss these within their groups.

Invitational dialogue emphasizes open-ended questions, such as a simple "tell us about your diagram or picture." Again, the goal is to facilitate student expression

in their initial response, which enables the teacher to extend student understanding through follow-up questions. A key here is the use of natural language; if students respond in what I call science vernacular, I ask them to explain again in words that a non-scientist would understand. This is important because often our students have internalized theoretical definitions using proper scientific terminology but lack the conceptual understanding to express an operational definition, a definition that is based on our observational senses and that demonstrates understanding that extends beyond the immediate situation.

Pictorial diagrams are useful not only in helping students learn science, but also in helping them produce knowledge (Evagorou, Erduran, & Mantyla, 2015). An example of pictorial representation done on a whiteboard from a lab that addresses the effect of changing temperature on the pressure of a gas is shown in Figure 1:

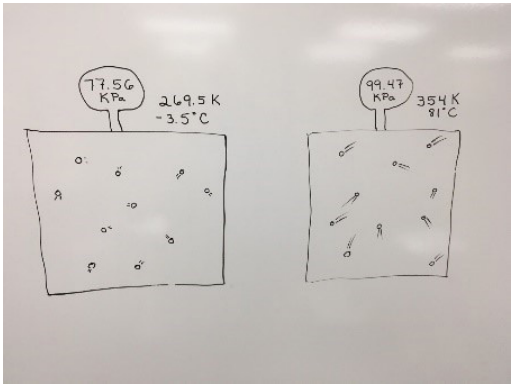

Figure 1. Pictorial representation of pressure (kPa) of gases at different temperatures (K).

One of the strengths of dialogue centering on pictorial representations and diagrams is that such discussions are not limited to labs that are quantitative in nature, but are also useful in qualitative or descriptive labs as well.

Domain 3: Technology Applications

Effective use of technological applications enables students to engage in knowledge construction and to develop sophisticated problem solving skills (Trowbridge, Bybee & Powell, 2008). For example, spreadsheet programs allow students to quickly generate graphical representations of their data as well as to construct mathematically fitted curves and equations of best-fit lines. In Figure 2, Microsoft Excel was used to generate a graph for the lab described earlier which explored the relationship between pressure and changing temperature.

Student-generated graphs can be displayed using an overhead projector and discussions should begin with invitational, open-ended questions such as "explain what your graph represents." The depth of the answer to this question will dictate the direction of the instructor's questioning, with the goal of extending and clarifying knowledge. A close examination of the example graph shows the equation of the best-fit line present, a representation that combines the graphical and mathematical domains. In this way the four domains crucial to scientific literacy often cross over and are rarely exclusive of the others, especially when quantitative data

is represented. The instructor can also open up questions to other students, which can help reveal the depth of conceptual understanding of the students asking questions. Again, care has to be taken here that the atmosphere of safety and trust is not compromised, and that students do not feel judged or criticized.

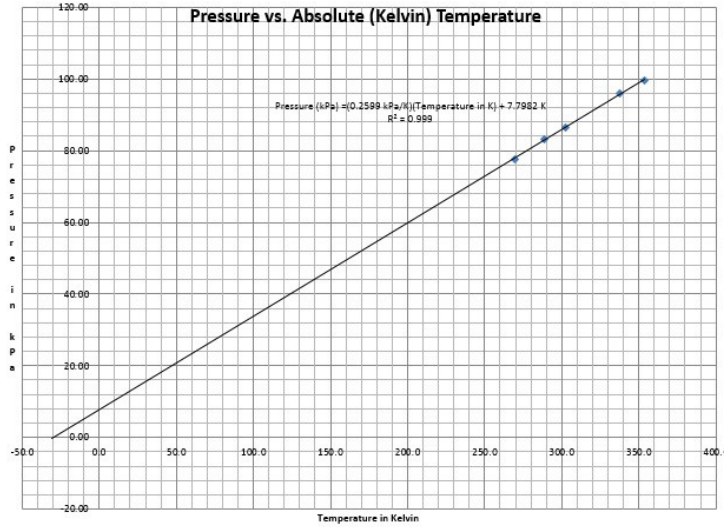

Figure 2: Graph of pressure and absolute temperature relationship from Gay-Lussac's law laboratory activity.

Domain 4: Mathematical Descriptions (Equations)

Students in advanced science classes such as physics are often adept at using equations to solve problems. For instance, given the quantities of mass and acceleration, students can use the equation Force = mass X acceleration (F = ma) to calculate the amount of force that must be applied to an object to cause acceleration. However, it is much more challenging for students if you ask them to express what F = ma means in words. Students at this level are often more comfortable with manipulating numbers by rearranging equations than expressing their conceptual understanding in words. An astute student will recognize in the equation that acceleration is directly proportional to the force applied if the mass is kept constant and inversely proportional to the mass of the object if the force is kept constant. Invitational dialogue can help students develop their natural language in expressing mathematical relationships, and can help them develop such understandings.

Students typically recognize the equation of a straight line applied to a straight line curve on a graph quickly (as seen in Figure 1). Often, students will default to describing it by offering the equation y = mx + b. Invitational questioning can help students extend and clarify their knowledge by simply asking them to use their natural language to replace the symbols in the equation. In the equation on the graph in Figure 1, y represents the pressure in kPa, m represents the slope of the line in kPa per Kelvin, x represents the temperature in Kelvin and b represents the pressure when the temperature is 0 Kelvin. This language skill can be reinforced by asking students to make predictions about relationships and to describe the behavior with-

out numbers, given the equation or a picture of the graphical curve. For instance, if the curve of the graph is not linear, asking students to explain how they could linearize the graph will give great insight into student's mathematical literacy. A graphical curve representing an inverse relationship such as pressure vs. volume of a gas at constant temperature, can be linearized by graphing the pressure vs. the inverse of the volume ($P \propto 1/V$). The slope of this curve represents a product equal to a constant, ($PV = k$), rather than a ratio equal to a constant such as the relationship of pressure and temperature, ($P/T = k$). The relationship of distance traveled vs. time while the object increases in velocity shows a graphical curve that is a top-opening parabola, rather than a straight line. The graph can be linearized by graphing the distance vs. the square of the time ($d \propto t2$). The ratio represented by the equation that represents this relationship, $d/t2 = k$, the constant k represents the acceleration of the system. Asking students to relate the equations that describe the system to the slope revealed in a linear or linearized graphical representation requires the integration of the two most difficult domains of scientific literacy while expressing this understanding in a third domain, that of natural language. Requiring the use of motion or particle diagrams in their explanations links all four domains. Students find this challenging at first, similar to learning a foreign language, but their ability to make coherent predictions demonstrates understanding from a performance perspective (Perkins, 1993). Patient, invitational dialogue is the key to building the linguistic skills necessary to express correct conceptual understanding, as well as helping students further and correct their conceptual understandings.

Conclusion

Linking types of representations of scientific data can result in improved learning of science content (Basu, Biswas, & Kinnebrew, 2016). Invitational, rather than confrontational, questioning techniques that address the four domains of knowledge as addressed by Lemke (2004) and Clement (1978) can provide a concrete pedagogical foundation for increasing scientific literacy in the classroom that is both observable and measurable, and can help students engage in this linking. Through such questioning teachers can easily assess student understanding, by providing students with data from one or two of the domains described and asking them what the appropriate remaining domains would look like. Teachers planning laboratory or recitation activities can refer to the four domains as a way to self-assess their activity's ability to build scientific literacy. If it is impractical for all four domains to be addressed in a single lesson, teachers can still work to maximize the number of domains incorporated in the activity, and can consider the kinds of questions will serve as bridges between the domains. Beyond the ability to link domains through such questioning, invitational questioning and the conversations that ensue also affirm the value of the humanity of our students. This is of inestimable worth.

References

Basu, S., Biswas, G., & Kinnebrew, J. (2016). Using multiple representations to simultaneously learn computational thinking and middle school science. P*roceedings of the Thirtieth AAAI Conference on Artificial Intelligence (AAAI-16)*, (pp. 3705-3711). Phoenix, AZ, Association for the Advancement of Artificial Intelligence.

Clement, J. J. (1978). Some types of knowledge used in understanding physics. Retrieved from https://files.eric.ed.gov/fulltext/ED291568.pdf

Evagorou, M., Erduran, S., & Mantyla, T. (2015). The role of visual representations in scientific practices: From conceptual understanding and knowledge generation to 'seeing' how science works. *International Journal of STEM Education 2* (11). DOI 10.1186/s40594-015-0024-x

Germann, P., Haskins, S., & Auls, S. (1996). Analysis of nine high school biology laboratory manuals: Promoting scientific inquiry. *Journal of Research in Science Teaching, 33*(5), 475-499.

Huang, W. (2005). The Socratic method in medicine—the labor of delivering medical truths. *Family Medicine, 37*(8), 537-539.

Johnson-Laird, P. (1980). Mental models in cognitive science. *Cognitive Science, 4*, 71-115.

Lemke, J. (2004). The literacies of science. In E. W. Saul, (Ed.), *Crossing borders in literacy and science instruction*. Arlington, VA: NSTA Press.

National Research Council. (1997). Misconceptions as barriers to understanding science. In *Science teaching reconsidered: A handbook*. Washington D.C.: The National Academies Press.

Oh, R., & Reamy, B. (2014). The Socratic method and pimping: optimizing the use of stress and fear in instruction. *American Medical Association Journal of Ethics, 16*(3), 182-186.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66*(2), 211–227. doi:10.1002/sce.3730660207

Stoddard, H, & O'Dell, D. (2016). Would Socrates have actually used the "Socratic method" for clinical teaching? *Journal of General Internal Medicine, 31*(9), 1092-1096.

Trowbridge, L., Bybee, R., & Powell, J. (2008). *Teaching secondary school science: Strategies for developing scientific literacy* (9th ed). Upper Saddle, NJ: Prentice Hall.

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Redesigning Dissection Lessons
Considerations for a Meaningful 21st Century Learning Experience

Amanda Mager

Abstract: Dissection has become less common in the life science classroom as science educators have questioned what these experiences teach. Constructivist theorists of education have long suggested redefining the purpose of dissections to better fit the needs of student learning in the 21st century. Using the Next-Generation Science Standards framework, educators can create more meaningful dissections by incorporating opportunities for students to engage in true scientific inquiry. For dissection experiences to be worthwhile and meaningful for students, the activities must be carefully planned and worked into units where students can use such experiences to help answer central unit questions. Innovative 21st century dissection activities that allow students to engage in true scientific inquiry are addressed.

Introduction

For many years, dissections have been performed across a variety of grade levels in life science classes. Yet as the content standards in high school biology courses have increased, teachers have had less time to engage students in laboratory experiences such as dissections.

In addition, the value of dissection activities in the high school curriculum has been debated because of their potential to cause students anxiety and discomfort (Shine, 2014). This trend began in 1987, when a 15-year-old California student refused to participate in the dissection of a frog because she felt it was unethical. Because she did not participate, she failed the assignment. She then sued her school district because they did not provide her with a reasonable alternative assignment. As a result, California passed a law giving students the ability to opt out of dissection activities for moral reasons. Following this, schools across the country began implementing similar "opt out" policies. Some districts have chosen to remove dissections activities altogether (Shine, 2014). While some experts have suggested virtual lab experiences are beneficial for student learning (Shine, 2014), others suggest that the way dissections are taught rarely benefit student learning (Hug, 2005). Researchers agree that in order for dissections to continue to be taught, the goals and activity itself must adapt to the demands of a meaningful 21st century learning experience (Hug, 2005).

Laboratory Experiences
Not All Created Equal

The Next-Generation Science Standards (NGSS) focus on the application and integration of the best practices of engaging in science using 21st century skills and technology. Using the NGSS, students engage in science in a fashion similar to that

of working scientists, promoting retention of concepts learned in class and a deeper understanding of science. Unfortunately, because Ohio's state biology science standards require teachers to cover an overwhelming amount of content in a year, teachers have had to reduce their quality of lessons, moving classroom work away from the NGSS goals. Note-taking and lecturing do not offer students opportunities to engage in true scientific inquiry. Educational researchers agree that active learning opportunities such as laboratory experience are most worthwhile for student learning (Hug, 2005; Solot & Arluke,1997).

Active learning strategies can be defined as "instructional activities involving students in doing things and thinking about what they are doing" (Bonwell & Eison, 1991, p. 18). Active learning is rooted in the social cognitive theory and constructivist framework of education, and places less emphasis is placed on the transmission of knowledge and more emphasis on the development of scientific processing skills (Wilke, 2003).

Active learning opportunities such as laboratory experiences offer students the opportunity to create hypotheses, develop experiments, make inferences, and draw conclusions. For example, Wallace (2003) designed a quasi-experiment where students took a questionnaire regarding the nature of science at the end of a semester. The results suggested that students had more significant gains to their knowledge base for designing an experiment after engaging in science labs that were inquiry-based. Because students were given an opportunity to engage in inquiry like a true scientist, they felt more connected to their learning. Passive learning practices such as note-taking and authoritative lab instructions do not give students the opportunity to put knowledge into practice, nor to synthesize ideas together creating a solution to a problem.

However, not all laboratory experiences have the same educational value. While Wallace (2003), argues that there is an educational benefit for students engaging in scientific inquiry during lab activities, there remains debate as to which kind of inquiry project is most beneficial. Sadeh (2011) has defined three types of inquiry: structured inquiry, guided inquiry, and open inquiry. In structured inquiry, students investigate teacher-formulated questions through prescribed procedures. During guided inquiry, students investigate teacher formulated questions and procedures and later determine the processes and conclusions. In open inquiry, the teacher defines the knowledge framework, but the students formulate a wide variety of inquiry questions to investigate. Incorporating inquiry experiences into the life science classroom can help students engage in more scientific discourse and help students better understand the nature of science as intended by the NGSS.

Using a Constructivist Framework to Reshape Student Thinking

One goal of dissection labs is to help students better understand the structural organization of various animal specimens. Unfortunately, most teachers do not give students time to address their concerns or allow them time to understand the purpose for performing a dissection. According to Solot and Arluke (1997), teachers must be aware that a majority of students will feel anxious when being presented with the task of completing their first dissection because up until that point, students have been taught to respect living organisms and not to disturb them. The anxiety and is-

sues students have with dissections begins with the idea of using instruments to cut open a once-living animal, because it seems contradictory to students' prior lessons on interacting with nature. Prior to performing a dissection, cutting open an animal to expose their internal structures would have been an inappropriate way to interact with the organism. According to Solot and Arluke, teachers must first spend time working with students to teach students that the dissection activity is meaningful and appropriate. Teachers need to give students time to understand the purpose of the lab and to grapple with their uncomfortable feelings rather than diving straight into a dissection lab. By spending time addressing student concerns, teachers can ensure that their students interact with them positively, and that they feel encouraged and excited about completing their work rather than feeling anxious or indifferent. Using Solot and Arluke's constructivist framework can teachers help prepare students mentally for the task of dissecting their first specimen.

Need for Alternative Assignments

Because so many students nowadays feel apprehensive about performing dissections, alternative assignments should be offered in place of a traditional dissection for those who choose not to take part in the dissection. Barr and Herzog (2000), investigated how students in a biology class felt after performing a fetal pig dissection and how their opinions changed overtime. They found that a majority of the students enjoyed the activity and believed the experience to be worthwhile, but every student also suggested that there should be an alternative option available to students.

Virtual dissections, allowing students to use computer programs to virtually dissect a variety of organisms, have gained popularity as a suggested alternative activity in place of dissection. Virtual dissections give students a reasonable opportunity to achieve the same learning goals as their peers performing a traditional dissection. There are many virtual dissection software tools available. Publishing companies such as McGraw Hill have virtual dissections that are available online for free. For example, the website URL http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html offers a virtual frog dissection. There are also supplemental handouts for teachers available for free download.

Researchers have examined whether or not virtual experiences are as educationally valuable as traditional dissections. For example, Predavec (2001) compared a traditional dissection to a virtual dissection of a rat. The students in this experiment were separated into a traditional dissection group and a virtual dissection group, each of which were asked to complete a multiple-choice quiz consisting of text-based questions, pictures and structures of dissection, and real dissected structures. The results suggested that students who were assigned to the virtual experience performed better on the multiple-choice quiz than those students who completed the traditional laboratory experience.

While it may seem strange that students in the virtual dissection performed better on their quiz than students who performed the traditional dissection, it's important to remember that this study took place in the early 2000s when such technology was just beginning to become popular. It's possible that students were fascinated by the computer programs and were more focused because they had the opportunity

to use technology they normally would not use. The results of Predavec's (2001) research is promising for teachers who may need alternative options for students who wish to opt out. If a student cannot participate in a traditional dissection, it's good news that the virtual dissections are able to help students achieve the same goals as their traditional dissection peers.

Improving Dissections to Meet 21st Century Learning Goals

Dissections have been performed for many years, but the activity itself has generally not been adapted to fit the needs of students as the goals in science education have shifted. Dissection activities as they exist now do not typically help students to develop skills in practicing or engaging in scientific inquiry. In order to meet the needs of learning in the 21st century, laboratory activities should be a space where students test scientific ideas and create hypotheses that can be adapted over time.

Hug (2005) has argued that one valid criticism regarding dissections is that they are typically procedural experiences rooted in tradition. Students are often given a procedure to follow in which students identify structures of a specimen. In traditional dissections, the students are not testing any scientific ideas; they already know the outcome and can anticipate the results. This type of passive dissection does little to help students develop a deeper understanding of animal anatomy. Often when a dissection lesson is planned, it is incorporated during a convenient time for teachers such as right before a break or when there is free time. This signals that the dissection is an extraneous activity rather than one central to the scientific work of the class.

Hug (2005) has suggested ways of recreating dissection activities to make the experiences more meaningful for students. These including creating dissection activities that are carefully planned to fit into a larger units and that help students answer a central question. She embedded the dissection activity within the ecology unit of a high school biology class. The central question for the unit was "How do sea lamprey affect populations of yellow perch in the Great Lakes?" Throughout the unit, students learned about population dynamics and threats to certain ecosystems. Two dissection labs were incorporated into the unit, in which students compared the anatomical features of the sea lamprey and yellow perch. The lab helped students recognize why and how yellow perch were threatened by sea lamprey. Students felt more connected to the dissection activity because the activity helped them explore their unit's central question.

Recently, I created my own dissection activity that could be included in a high school biology class. This laboratory experience that could be embedded within the evolution unit of a high school biology course.

A teacher could begin a unit on evolution by introducing students to two very similar fish: the Atlantic Salmon and the Rainbow Trout. The unit would begin by introducing students to learn about each fish's environment and to describe the daily habits of each fish. Students would then spend a day comparing the exterior anatomy of each fish while the teacher asks guiding questions to help students make connections between evolutionary success and morphological adaptations (see https://atlanticsalmontrust.org/salmon-and-sea-trout-facts/). During the next two lessons, students would dissect each fish and compare their anatomical features.

Students might be able to see slight differences in muscle structure of each fish and to develop hypotheses linking the success of each fish in their environment to adaptations in their anatomy.

Dissection activities need not only involve animal specimens. Teachers should get creative with dissection activities and find ways to incorporate fungi or plant dissections as well. For example, when teaching units on plants, most teachers use an oversimplified model of flowering plant anatomy, which causes students to develop misconceptions (McIntosh & Richter, 2007). Teachers can help address such misconceptions by having students complete a flower dissection activity and comparing monocot and dicot flowers. Students could begin by first dissecting and comparing monocot and dicot seeds and identifying a monocot's single cotyledon and a dicot's two cotyledons. Students would then be able to identify monocots and dicots in nature.

Conclusion

The demands of the 21st century have inspired teachers to reconsider the way dissections are taught in their classes. Hug (2005) suggests dissections have the potential to address student misconceptions and serve as powerful opportunities for students to think in creative ways. However, dissections are often poorly delivered in the classroom and therefore provide little benefit to student learning. In order to use dissections more effectively, teachers need to address the purpose of performing a dissection, to plan when to incorporate the activity into a larger unit, and to ensure that the activity will help students address questions from the larger unit they are learning. Incorporating dissection activities into a larger unit of learning can help students recognize the purpose of those dissections and see how these activities will help them better understand content from the larger unit. By reframing how they lead dissections, educators can help students engage in scientific inquiry in ways that improve on the methods of the past.

References

Atlantic Salmon Trust. (n.d.) Salmon and sea trout facts. Retrieved from www.atlanticsalmontrust.org/salmon-and-sea-trout-facts/.

Barr, G., & Herzog, H. (2000). Fetal pig: The high school dissection experience. *Society and Animals, 8*(1), 53-69. doi:10.1163/156853000510989

Bonwell, C. C., & Eison, J. A. (1991). Active learning: Creating excitement in the classroom. Washington, DC: George Washington University, ERIC Clearinghouse on Higher Education.

Hug, B. (2005). Dissection reconsidered: A reaction to de Villiers and Monk's 'The first cut is the deepest'. *Journal of Curriculum Studies, 37*(5), 601-606. doi:10.1080/00220270500061182

Mcintosh, A. V., & Richter, S. C. (2007). Digital daisy: An inquiry-based approach to investigating floral morphology and dissection. Science Activities: Classroom Projects and Curriculum Ideas, 43(4), 15-21. doi:10.3200/sats.43.4.15-21

Predavec, M. (2001). Evaluation of e-rat, a computer-based rat dissection, in terms of student learning outcomes. *Journal of Biological Education, 35*(2), 75-80. doi:10.1080/00219266.2000.9655746

Sadeh, I., & Zion, M. (2011). Which type of inquiry project do high school biology students prefer: Open or guided? *Research in Science Education, 42*(5), 831-848. doi:10.1007/s11165-011-9222-9

Shine, N. (2014, October 15). The battle over high school animal dissection. Retrieved from https://psmag.com/environment/battle-high-school-animal-dissection-92391

Solot, D., & Arluke, A. (1997). Learning the scientist's role. *Journal of Contemporary Ethnography, 26*(1), 28-54. doi:10.1177/089124197026001002

Virtual frog dissection. Retrieved April 14, 2019, from http://www.mhhe.com/biosci/genbio/virtual_labs/BL_16/BL_16.html

Wallace, C. S., Tsoi, M. Y., Calkin, J., & Darley, M. (2003). Learning from inquiry-based laboratories in nonmajor biology: An interpretive study of the relationships among inquiry experience, epistemologies, and conceptual growth. *Journal of Research in Science Teaching, 40*(10), 986-1024. doi:10.1002/tea.10127

Wilke, R. R. (2003). The effect of active learning on student characteristics in a human physiology course for nonmajors. *Advances in Physiology Education, 27*(4), 207-223. doi:10.1152/advan.00003.2002

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Active Learning and its Impact on Higher-Order Thinking Skills in Preschool Science Education

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Abstract: Active-learning strategies encourage preschool children to use higher order thinking skills such as critical thinking and problem solving. However, teaching methods that encourage active learning are underused in favor of traditional methods. This article will offer a background to establish the effectiveness of using active learning strategies with early learners in science instruction. It will then present common reasons teachers do not implement active-learning strategies and address how to implement active learning effectively. The most important point is that a teacher does not need to have mastered this strategy in order to implement it. Suggestions and examples will be given to show how to transform a standard preschool lesson into one that engages higher-order thinking skills using active-learning strategies.

Introduction

The education of preschoolers, children ages 3-5 years old, has been long overlooked by the education community at large and has been considered a low priority in favor of K-12 issues. Some parents and even people within the education field view preschool as alternate form of daycare. For example, Neal McCluskey, the director of the Cato Institute's Center for Educational Freedom has even stated that preschool is oversold (Wong, 2014). Yet in recent years the education community has started recognizing the importance of preschool as the foundation for future learning. Research has concluded that the development of non-cognitive skills in early childhood such as persistence and curiosity, are some of the strongest indicators of adult success in acquiring new knowledge (Warash & Workman, 2016).

Since the importance of a preschool education has only recently become a serious consideration, standards for instruction at this level are relatively new. In 1999 only 10 states had formal expectations for what young children should know before entering kindergarten. By 2002, 27 states had standards and 12 states were in the process of developing standards. However, when early learning standards have initially been adopted, most states have only posted guidelines without any indication of how early childhood teachers could practically implement them in the classroom (Scott-Little, Lesko, Martella, & Milburn, 2007). As a result, early-childhood instruction and implementation of these standards remains varied.

In order to provide a template for what early childhood education should look like, the National Association for the Education of Young Children (NAEYC) has established a position statement for developmentally-appropriate practices in the education of young children. According to the NAEYC, the greatest impact on children's development and learning derives from moment-to-moment interactions and the teacher's responsiveness to each child. The position statement goes on to state that because of this a curriculum cannot be fully planned ahead of time without deviation (NAEYC, 2009). At the same time, NAEYC acknowledges that while the study of child-centered active learning based on constructivist approaches to

education is relatively new, it has been shown to be an effective way to teach children higher-order thinking skills. However, despite the call for child-centered active learning, many teachers in early childhood education are still relying on teacher-directed methods in their classrooms. This article examines and addresses the reasons for this discrepancy.

Active Learning

Active learning is defined as an approach that utilizes activities and experiences to allow children to think critically, to generate in-depth ideas, and to implement these ideas (Pekdogan & Kanak, 2016). The ability to think critically in education was a prominent concern of John Dewey, who felt that critical thinking was something that all citizens needed to participate in on a daily basis (Abrami et al., 2015). Dewey's philosophy on education was that it should be informal and experiential and occur within a social context with guidance (Lake, Winterbottom, Ethridge, & Kelly, 2015). Another philosopher who stressed the importance of experiential education was Lev Vygotsky, who noted that preschool learning experiences in structured environments make important contributions to children's cognitive development (Pekdogan & Kanak, 2016). Jean Piaget is yet another theorist who described children as scientists who try to explore the world (Sapsaglam & Bozdogan, 2017).

The beliefs of these theorists contributed heavily to constructivism, a learning theory that places emphasis on the active role of learning, where the learner drives the process, guided carefully by an instructor. The basis of constructivism is that the work must be intrinsically motivating to the student, self-directed, and guided by the teacher through scaffolding, context, relevance, and feedback (Cattaneo, 2017). A related educational theory, cognitivism, which arose around the 1950s, views the learner as an information processor that processes information based upon past knowledge and experience. The learner receives information from the environment, processes the information, stores information in the memory, and retrieves the information later.

Active learning is thought to be based upon these two theories, which combines the self-directedness of constructivism and the environmental influence of cognitivism (Pekdogan & Kanak, 2016). While active learning centers around the activity of the child, the teacher's role in active learning is not simply that of an observer, as some believe. Rather, the teacher is rather a guide who observes, then carefully designs the environment using materials and projects that will push student learning to the next level. As students interact with materials, teachers should encourage them to make observations and to ask pointed questions that will push them to think critically. In such a role, instruction can often lead to places that were not originally planned. This improvisational quality requires the teacher to possess a working knowledge of early childhood development.

There are different types of active learning methods, including problem-based learning, discovery-based learning, inquiry-based learning, project-based learning, and case-based learning. Cattaneo (2017) discovered that though there are theoretical differences in each of these methods, in practice they have become intertwined. However, the confusion between them can act as a barrier for teaching implement-

ing active learning strategies in the classroom; this will be discussed in more depth later.

Literature Review

The research on active learning is somewhat limited, however, research to date has shown that teachers utilizing the active learning approach are more successful (Pekdogan & Kanak, 2016). A study by Andiema (2016) found that there was a positive correlation between the use of child-centered or active-learning approaches and the acquisition of science skills in early childhood schools in Kenya. This makes sense because active learning encourages higher-order creative thinking as well as social and cognitive learning. Children who learn in this type of environment have better problem-solving skills and learning capacity (Pekdogan & Kanak, 2016). In addition to supporting the cognitive elements of science education, active learning also helps promote language proficiency in relation to science education. Ohio science standards state that children ages 3-5 years old should be able to make careful observations, pose questions, and describe the subject of study. These standards require a proficiency in language and the ability to communicate effectively. A study by Jawaid (2014) found that using active learning in a preschool in Malaysia motivated children learning English to speak and read with confidence. This study concurs with a study by Dresden and Lee (2007) that showed that the number of words used by first graders in responding to an open-ended question about the subject matter increased from a mean of 7.93 words after completing a teacher-directed activity to a mean of 22.00 words after completing an active-learning activity. This study also found that student responses were more general in nature after the teacher-directed study and more specific after the active-learning study.

Not only has active learning been proven to be effective in teaching young learners, it also can be used to meet all early childhood standards and domains. Active learning meets the increasing demands of state and district requirements. Encouraging children to learn through active learning should be viewed as a supplement to an existing curriculum and not as a replacement (Dresden & Lee, 2007). Teaching students through this method not only can cover all academic standards, but because it encourages active and meaningful learning experiences, is also consistent with the best practices listed by the NAEYC (Lake et al., 2015).

Barriers

A study by Ntumi (2016) found that some barriers that early childhood teachers face regarding implementation include not understanding the curriculum deeply, not having appropriate learning materials, and not having proper in-service training. The same study found that teachers also view their role in implementing instruction as an autonomous one. The implementation of active-learning methods does not generally follow a script or come with a teacher's manual, which can make a teacher feel uncertain or unsure (Vartuli, Bolz, & Wilson, 2014). As stated previously in this paper, there also exists some confusion between the different active learning strategies, further adding to the uncertainty a teacher might feel when attempting to implement active learning strategies in the classroom.

Practical Steps

The first step in active learning is to identify a topic that the students will be interested in. This can be done by starting the year polling the children about what topics they would like to learn more about. Write down every answer, no matter how silly. When the kids know their answers are heard and valued, they will not be afraid to speak up. Learning topics can also come from things in the environment in which the children show a natural interest.

Design the environment to encourage active learning. Sometimes simplicity is the key to fostering these skills. Always have paper and writing utensils available for children to use for writing about or drawing their findings. Have materials out that encourage higher-order thinking such as scales and rulers. If a toy breaks in the room, figure out together how it was put together instead of just throwing it away.

Model how to ask and answer questions. Always have children explain their thinking. The use of questioning is crucial to pushing higher-order thinking skills. In the beginning you will have to model your thought process and reasoning skills. As you repeatedly model your thinking processes the children will begin to naturally copy the ways that you explain yourself. They will also copy your questioning. Students will begin asking "why" and "how" questions and answering with "I know because…" with more frequency because you modeled how to do so for them. Learning becomes more self-directed when active learning strategies are used.

A Study on Acorns

Let's consider a typical preschool study on acorns. A teacher will typically plan for a 1-2 week focus on the topic. Activities might include painting with acorns, singing songs about acorns, and reading books about acorns. Teachers might discuss facts such as that acorns are brown, that the word "acorn" starts with letter A, and that squirrels like acorns.

None of these things are wrong, yet simply introducing facts means that students are not pushed to think critically. The students are passively receiving information from the teacher. Even if they are producing the answer to questions like "What color are acorns?" or "What letter does acorn start with?" they are not thinking critically. Knowing letters and colors is good knowledge to have, however it is straightforward information that does not require deep thought. These activities are appropriate but should be supplemented with higher order thinking.

Let's consider the acorn study from an active-learning perspective. The study should start with students noticing acorns in real life. The NAEYC states that learning is most likely to occur when it builds upon what a child already knows and has experienced (2009). If there are acorns on the playground and the students don't naturally comment on them, the teacher should show an interest in them and the students' interest will typically follow. The class can then collect acorns. Meanwhile, the teacher should be modeling questions that encourage higher order thinking. "What is the difference between these two acorns?" "How did the acorns get on the ground?" "They fell out of the tree? How?" "Why are some of these acorns green and some are brown?" "Look at this acorn. It is broken in two. What do you think this piece is? Should we look it up when we get in the classroom?"

In my classroom, my special-needs preschool students learned that our acorns came from an oak tree by comparing our collection to a chart I printed out that had pictures of different types of acorns. We discovered the chart together while researching acorns on our classroom iPad. The students weighed acorns to determine who had the heaviest one using balance scales that had been available in the science center. While researching on the classroom iPad we discovered the acorn float test, which determines if the acorn is good for growing. Before attempting the float test, we made predictions about which acorns would float. After the float test, we tried to find similarities between the acorns that had sunk in order to develop our own conclusions about what makes an acorn good or bad.

Through questioning and researching we also discovered that the little holes in our acorns were created by weevil larvae. We later found these larvae crawling in our sensory table, and we freed them in a special celebration. Note that you should expect the unexpected when trying active learning! The children then drew pictures of their acorns and the weevils after we found a "how to draw" video online. Creating these drawings gave them an opportunity to practice their fine motor skills and they were easy to label using the language from the Learning Without Tears handwriting curriculum utilized in our program.

The key to active learning is to constantly ask questions. The best questions for pushing critical thinking are "how?" and "why?" Another critical component is to constantly encourage the students to ask additional questions if they would like to find out more about topics that come up through natural conversation. Using this method not only taught the students but taught me a lot about acorns as well. Teaching this way requires thinking on your toes. And admitting that I didn't always know the answer modeled for my students that it is OK to not know something and to research it when you do not know the information.

Lake et al. (2015) found that preservice teachers who used an active-learning approach felt that teaching in this manner was the closest they had come to their vision of themselves as teachers. After attempting this method, I would agree with this statement. I used to do the standard theme units and letter of the week but since I've begun pursuing active learning I will never go back to more traditional methods. By modeling higher-level thinking questions and self-directed learning, the children are now questioning things on their own and asking to research questions they come up with. Six months after our initial study children are still bringing acorns to me with excitement and using descriptive language as they do so. Using active learning strategies to push critical thinking has created an excitement to constantly learn in my students, which is the most fulfilling feeling a teacher can have.

Conclusion

The use of active learning strategies in preschool science instruction helps students become co-owners of their learning and makes knowledge more meaningful and longer-lasting. Not only does this method help children learn information, it also helps them learn how to learn. The use of active learning strategies gives students tools that help them investigate queries on their own long after their time in your classroom is done. The use of active learning does not conflict with curriculum requirements of school districts and ensures that teachers are using best practice

according to the NAEYC. To implement this strategy, teachers need not be masters of how to do so but must only be willing to try something new.

References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research, 85*(2), 275-314.

Andiema, N. C. (2016). Effect of child centered methods on teaching and learning of science activities in pre-schools in Kenya. *Journal of Education and Practice, 7*(27), 1-9.

Cattaneo, K. H. (2017). Telling active learning pedagogies apart: from theory to practice. *Journal of New Approaches in Educational Research, 6*(2), 144-152.

Dresden, J., & Lee, K. (2007). The effects of project work in a first-grade classroom: a little goes a long way. *Early Childhood Research & Practice 9*(1). Retrieved from https://eric.ed.gov/?id=EJ1084751

Jawaid, A. (2014). Benchmarking in TESOL: A study of the Malaysia education blueprint 2013. *English Language Teaching, 7*(8), 23-38.

Lake, V. E., Winterbottom, C., Ethridge, E. A., & Kelly, L. (2015). Reconceptualizing teacher education programs: Applying Dewey's theories to service-learning with early childhood preservice teachers. *Journal of Higher Education Outreach and Engagement, 19*(2), 93-116.

National Association for the Education of Young Children. (2009). Position Statement: Developmentally appropriate practice in early childhood programs serving children from birth through age 8. Retrieved from https://www.naeyc.org/sites/default/files/globally-shared/downloads/PDFs/resources/position-statements/PSDAP.pdf

Ntumi, S. (2016). Challenges pre-school teachers face in the implementation of the early childhood curriculum in the cape coast metropolis. *Journal of Education and Practice, 7*(1), 54-62.

Pekdogan, S., & Kanak, M. (2016). A qualitative research on active learning practices in pre-school education. *Journal of Education and Training Studies, 4*(9), 232-239.

Sapsaglam, O., & Bozdogan, A. E. (2017). The effect of active-participant experiments upon the skills of nursery class students to recognize measuring instruments. *Journal of Education in Science, Environment and Health, 3*(1), 100-109.

Scott-Little, C., Lesko, J., Martella, J., & Milburn, P. (2007). Early learning standards: Results from a national survey to document trends in state-level policies and practices. *Early Childhood Research & Practice, 9*(1). Retrieved from https://eric.ed.gov/?id=EJ1084857

Vartuli, S., Bolz, C., & Wilson, C. (2014). A learning combination: Coaching with CLASS and the project approach. *Early Childhood Research & Practice, 16*(1-2). Retrieved from http://ecrp.uiuc.edu/v16n1/vartuli.html

Warash, B. G., & Workman, M. (2016). Teaching preschoolers to self-assess their choices in pre-k. *Journal of Educational Research and Practice, 6*(1), 97-104.

Wong, A. (2014, November). The case against universal preschool. TheAtlantic.com Retrieved from https://www.theatlantic.com/education/archive/2014/11/the-case-against-universal-preschool/382853.

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Social Studies

Why Teach Current Events?

Byron Swartz

Abstract: Current events should be taught in the social studies classroom. Moreover, there are more reasons why these events should be taught than why they should not. This article will discuss the reasons why current events should be taught, but will also have an honest discussion about why summative standardized testing may stand in the way of doing so. Through research regarding social media and it's place in the world today, this article will explore how these findings show the increasing amount of news media that students interact with, and how current events can help students stay informed, identify fake news, and help them become overall effective citizens. This is the mission of the National Council for the Social Studies (NCSS).

Introduction

Current events provide an interesting connection between the world outside of the classroom, and the world inside the classroom. By utilizing current events in a social studies classroom (or any classroom for that matter) social studies material can come to life. When material can become a living event, the students can see more connections to their day-to-day lives. The goal of this article is to articulate to the reader why current events should be taught, as well as a few reasons why one may consider not teaching them. The article, no doubt, is intended to provide teachers with reasons why they should begin to incorporate current events into their classroom; however, the goal is also to be fair, as not everything has only positives. Before we go any further, let us visit a hypothetical classroom, to see what it may look like when current events are not incorporated, versus a classroom where they are.

> *Imagine you are in a classroom. A lesson over the end of George Washington's presidency is taking place. The teacher in the classroom, has just covered President Washington's farewell address, where he warned future generations of the rise of political parties. Upon the completion of the reading of President Washington's address, Johnny raises his hand and asks, "didn't this all happen in the past?" The teacher pauses, attempting to figure out a way to approach the question without losing the students any interest they may already have in the subject. The teacher, unprepared with respect to how to provide a response, says to the student "yes and please be quiet while we learn material that is necessary for you to perform well on the standardized test." Johnny is left frustrated.*

Not only did the teacher in the classroom just neglect the student's concern, but also contributed to the potential belief that there is no purpose in the study of social sciences. But, what if the response by the teacher had been different?

> *This time, Johnny asks the same question from above; and the teacher, having the formal training in the presentation of current events previously mentioned, responds: "You are correct, Johnny! This did all happen in the past. However, what do we possibly know about politics in our country and throughout the world that would tell us whether or not we listened to President Washington's advice?"*

In a turn of events, the teacher has gone away from disregarding the student's question and has now moved on in a way that continues to engage the students in a classroom discussion, while also providing them with real world examples, similar to those being covered in the textbook or other materials. By incorporating current events, the students in the classroom can feel better connected to ideas. In this sense, the material is becoming alive and may be more engaging for the students, as opposed to a history lecture about names and dates. It was Dewey, who subscribed to a theory such as this, as he defined education as "that reconstruction or reorganization of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience" (Dewey 1966, p. 76). By providing students with a restructured or reorganized account of history with a current event, a teacher can thus better direct the learning of the student in an effective manner.

The example described above is one that we must keep in mind when deciding whether to utilize current events to teach. This is necessary to do, as we see that when the teacher uses current events or current concepts and applies them to their classroom, the discussion becomes more focused on developing effective citizens (more to come on this idea later). Teaching current events or teaching through current events is, in my opinion, the path to take in a classroom. In the example above, by utilizing current events as a means to enhance classroom curriculum, students are learning about how the outside world can connect to their history classroom, further making history come alive.

As a social studies teacher, I view the topic of current events as something which can benefit in my discipline. However, it's my hope that teachers from all disciplines can take away from this article, the importance and effectiveness of teaching current events. While there are many pros to teaching current events, there may be a con as well. It is my hope that the reader will see the importance of teaching current events, and be able to reason whether teaching them may suit their classroom and subject.

Social Media and Current Events

In today's world, students are surrounded by more media than ever before. In fact, according some people, some of this news encountered on a daily basis is "real news," while other news media may be considered "fake news." By providing content instruction of current events, students gain an insight to the world around them. This understanding of what is real and what is "fake" is especially important in a world where social media has never been more prevalent, especially among young people. A study conducted by Rideout and Robb (2018) researched just how much social media teenagers find themselves involved with. The survey, polled 1,141 kids, ranging in age from 13-17 looked into the social media habits of the students. In 2012, 34% of teenagers in a similar survey, stated they used social media once per day. Today, that number is 70%; and the findings showed that this 70% of students check their social media accounts more than once per day (Common Sense Media, 2018). Further, according to Head, Wihbey, Metaxas, MacMillan, and Cohen (2018), 89% of those sampled had suggested that within the previous week they had used Social Media as a method of inquiring about news.

Compare these statistics with that found in Project Literacy, which found in its survey, that 58% of respondents repost/share news media with their social media followers/friends. (Head et al., 2018). Connecting the dots of these two studies would suggest that, students' use of social media is an ever-rising number. Combine the percentage of teenagers who look at their social media more than once per day (70%) with the percentage of individuals who share news media at least once per week (58%) and one could infer that students are interacting with more forms of social and news media than ever before. Further, in the study conducted by Head and colleagues, the results showed: two-thirds (68%) said the sheer amount of news available to them was overwhelming, and half (51%) agreed it was difficult to identify the most important news stories on any given day.

It is my belief that as an educator, my job is to prepare students for the "real world" that they will enter after they graduate from high school. But it's not just a personal goal that pushes me towards this belief. So too is it the mission of the National Council for the Social Studies (NCSS) to develop citizens whom are engaged and effective (NCSS, n.d.). What makes an engaged and effective citizen though? NCSS has defined an effective citizen as one who has the knowledge, skills, and attitudes required to assume the office of citizen in our democratic republic. If we revisit the study from Head and colleagues (2018), it is noted that there is only one category in which students received news more than from social media, and that is word of mouth and discussion with peers (93% stated receiving news in this way). Keeping this information in mind, I would ask the reader, what better way is there to prepare students to be an effective and engaged citizen, and engage in discussions with accuracy and relevance, than by providing them with content pertaining to current events?

Standardized Summative Assessments and Current Events

While I am a strong advocate for utilizing current events in a classroom to teach, I do feel it is only right to express that there is another side to this argument of teaching current events, as standardized summative assessments may stand in the way of one's ability or decision to take current events. Journell (2010) studied six government teachers in the suburbs of Chicago. The results indicate that teachers find themselves wary of teaching current events, regardless of what else is happening in the world around them, due to a fear that the students in the given class may not pass or perform well on an end of year, standardized assessment (Journell, 2010)

Journell was conducting his research the United States was nearing the 2008 presidential election between then Senator Barack Obama, and then Senator John McCain. These teachers, whom he surveyed, were located in a suburb of Chicago. The teachers were asked how much of the election (a current event) they had covered in their government classes. These educators found themselves in an interesting predicament. On the one hand, their junior senator was running for the presidency. However, on the other hand, students in Illinois must pass a Constitution Standardized Test in order to be eligible to graduate. Within the survey, there were teachers who suggested that they were leery of teaching any aspect of the election. However, they were not wavering on the teaching of the election on the grounds of controversial. Rather, they were unsure what to do because of the standardized

testing. One teacher stated, "I don't want to teach to the test, but I want to give them exactly—I just want to nail in them the information they need to know" (p. 117). This teacher also stated : "I do want to incorporate current events because I do think it is very important that they know what is going on…" (p. 117). This last quote is telling. Here, we see a teacher who wants to incorporate current events, but is unsure if it is the right thing to do from the test score perspective.

Unprepared Educators?

Standardized testing may be one reason not to teach current events, but there is also another potential problem with teaching current events, and that is simply that teachers may not be adequately equipped to do so. In this case, the con of teaching the current event becomes simply that not all teachers are prepared to teach them. For example, in another study conducted by Journell (2013) he sampled preservice social studies teachers over the span of three years, seeking insight to these up-and-coming teachers' knowledge of politics and current events. The results varies slightly for secondary and middle grades social studies preservice teachers. On the surveys (compiled), both secondary and middle grades teachers did not score above a 79% on either of the first two surveys pertaining to party politics and government. In addition, focusing more on the current events survey, the scores for each secondary and middle grade teacher was also low. Specifically, neither groups of teachers got more than 50% of the questions correct.

The survey results described above leave me wondering about several things. First, in what ways could we prepare these preservice teachers to better handle current events and political happenings (keeping in mind, though that, these are really one in the same)? Further, are these preservice teachers' scores on the surveys a reflection on a lack of current events and civic awareness taught in the public schools? If the answer to this question is yes, then again we revisit the concept that teaching current events in school is the way to go, both to develop effective citizens, keep content relevant, and assist with the development of tomorrows teachers.

Conclusion

Current events surround students every day. Happenings of their city, state and national governments, as well as global events shape the world in which they live. Additionally, students have more access to news media than they have ever had before. Gone are the days of waiting for the newspaper to see what happened in the world on a particular day. Now, students can find this information easily, as they have internet and news applications right at their fingertips. Keeping in mind that students are surrounded by news media, it's important that students learn current events as a method to not only engage in civil activism if they are so inclined, but so too does it help them differentiate between real and "fake" news.

From a social studies aspect, and likely from all disciplines, the job of a teacher is to develop citizens who can be effective in the world in which they live. Students can use current events to do just this. Learning current events allows students to stay informed and learn to formulate an opinion that belongs to them as opposed to their parents. Further, students can embrace different opinions and can come to

respect those opinions that are different from their own. Current events serve not just as a teaching tool of classroom content, but as a teaching tool of life. Inevitably, there may be drawbacks to teaching current events, but there are always pros and cons to anything one looks at. It is my opinion, however, that current events in the case of the general education classroom setting, serve a positive purpose that far outweighs any drawbacks. We as teachers must unite in the idea that standardized testing is no substitute for preparing students for the real world that they will enter upon completion of school. Current events can be a regular part of classroom content, and based on research previously conducted, they should be incorporated into the general classroom setting.

References

Dewey, J. (1966). *Democracy and education*. New York: Collier Macmillan.

Head, A. J., Wihbey, J., Metaxas, P. T., MacMillan, M., & Cohen, D. (2018). How students engage with news: Five takeaways for educators, journalists, and librarians. Project Information Literacy Research Institute. (October 16, 2018), http://www.projectinfolit.org/uploads/2/7/5/4/27541717/newsreport.pdf.

Rideout, V., & Robb, M. B. (2018). *Social media, social life: Teens reveal their experiences*. San Francisco, CA: Common Sense Media.

Journell, W. (2010). The influence of high-stakes testing on high school teachers' willingness to incorporate current political events into the curriculum. *The High School Journal, 93*(3), 111-125.

Journell, W. (2013). What preservice social studies teachers (don't) know about politics and current events—and why it matters. *Theory and Research in Social Education, 41*(3), 316–351

National Council for the Social Studies. (n.d.). Creating effective citizens. Retrieved from http://www.socialstudies.org/sites/default/files/publications/se/6505/650511.html

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Promoting Growth of Historical Thinking Skills

Brian Trogus

Abstract: This manuscript addresses the need for developing historical thinking skills for students in social studies, specifically in the high school setting. The goal is for students to learn the material like historians would rather than through memorization. This article explores methods in which to foster critical thinking skills and, thus, support students in thinking like historians. Methods include group-based assignments, different approaches for teaching vocabulary, work with primary sources, and relating the content to students' everyday experiences. Overall, these methods are important for improving a student's capability of historical thinking.

Introduction

How can we, as social studies teachers, improve our students' analytical skills and overall higher learning? This is a question I have often pondered throughout my year of student teaching. Often, students in history are only taught to memorize names and dates. This cannot be our goals as teachers. History is fluid, meaning that it is continuous in the fact that the past shapes the present and the present shapes the future. To truly understand ourselves and our situations, we must look to the past. No, better yet, we must understand the past. Understanding the significance of the past allows us to better understand the present, and possibly find patterns to predict the future. In order to do this, we must look beyond basic knowledge and start considering the significance of events and people. Rather than asking questions such as "When did the Communists take over China?" We should be asking, "How does the communist revolution in China affect China's current status today?"

Teaching the significance of events and how students are to examine and evaluate ideas in history is challenging but necessary. If we cannot enable our students to do this, we cannot connect them to history, and if we cannot connect them to history, not only will there be no need for social studies teachers, but also students will not understand the significance of humanity. Classes like psychology and sociology not only enable students to understand more about themselves but about others from different backgrounds as well. Don't we as educators strive for diversity? For our students to be exposed to the world as it is so that they may change it to the world we want it to be. These courses also allow students to develop sympathy and empathy. With these courses, students may not agree with others' positions, but they will understand others more and be able to cope with the stress that life gives all of us.

Why else should we strive for historical thinking? I can answer this from my own experience. First as historians (amateurs or professionals), we know the importance and the priority of primary source documents. But often, primary source documents use language techniques that we are not familiar with. Not only that sources must be translated if it is written in a different language, but also even sources in a familiar language may use a different dialect or words that are not in regular use today. There are plenty of primary sources, such as the Declaration of

Independence or Lincoln's Gettysburg Address, that use words that students would be unfamiliar with or do not give context clues.

Another kind of primary source we as social studies teachers use often is political cartoons. Political cartoons give us a better perspective of what the public (or the cartoonist) thought of the current times. These are also important since newspaper companies still use political cartoons today. In my own experience however, many of my students struggle to understand them.

For example, a political cartoon that was created during the Great Depression depicts President Hoover as a mother as he is trying to deal with the many issues during the depression represented as babies (see https://www.nps.gov/features/shen/2019/hoover/lesson-2/map/rapidan-camp/prime-minister.html). That the artist was a supporter of Hoover is indicated by how he depicts the Democrats' reaction to the depression while not helping find any solutions. This was what I had hoped to see as an answer on an assessment when students were asked, what was the significance of the cartoon? The question was worth two points, one for what Hoover was doing and the other for what the DNC was doing in the image. Instead, the graph in figure 1 shows a summary of the class scores.

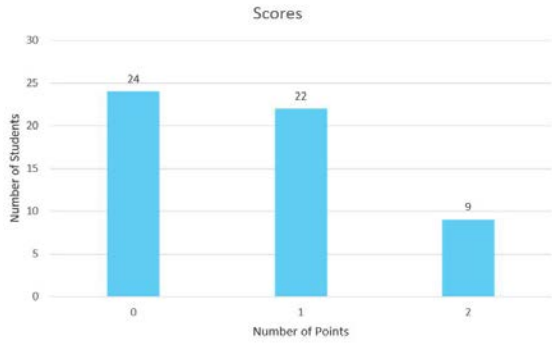

Figure 1. Class scores on a two-point question about a political cartoon.

As you can see, many did not reach the goal of understanding the political importance of the cartoon. I acknowledge that satire in either written form or visual aids is harder to detect compared to when it is spoken, but students still need to learn these as it enables them to pick on different forms of communication. Now that the need for historical thinking skills in social studies are in need, how do we as teachers employ our students to develop these skills?

There have been many topics that researchers have used to address this question. They can be categorized into two main sections. The first is about how group work can contribute not only to collaboration but can foster higher order thinking. The second part will consist of the importance of teaching vocabulary using content literacy methods. Finally, teachers must be ready to ask thought provoking questions to promote historical thinking.

Group Work

There are many approaches to group work that teachers can implement. Yusmanto, Soetjipto and Djatmika (2017) examined two different kinds of group activities

known as carousal feedback and round table. Carousal feedback is an approach that groups students together to answer a question posed by the teacher. This is followed by peer review as student's comment on each other's responses. Round table, on the other hand, is when students are paired together in heterogeneous groups and given a problem or question that has multiple answers. This approach is designed to be either restricted (only selected answers) or extended response (multiple answers or no wrong answers). Students record everyone's answers and decide on one answer, explanation, or solution as a group. The purpose of the study was to give an "opportunity for students to work in groups to discuss and understand issues, problems, and concepts to remember facts, beliefs, information, and/or agreements" (p. 40). The study was implemented in three cycles, each to repeat the experiment of both methods and to make any necessary changes in-between each cycle.

The results show that over many cycles, each method increased student scores and the students were able to answer questions that asked them to evaluate and analyze text or other forms of information. The research showed that at the end of the first cycle, only a third of the students reached the goal that the researchers were looking for. However, at the conclusion of the third cycle, over 86% of students reached the target level of higher order thinking skills (defined as analysis, evaluation, or creation on Bloom's taxonomy). The researchers concluded that as long as either carousal feedback or round table methods are accompanied by "giving time for students to think, provide scaffolding, observing students' activity, asking questions, asking questions, discussing in groups, analyzing the results, and providing feedback are the examples of activities that should be familiarized" (p. 39). The fact that the students were able to develop their thinking by using either methods illustrates the importance of students working together and sharing ideas and feedback.

Content Area Literacy

Group work can only do so much though. In order to have students able to respond to higher learning questions, we must first look at one of the major barriers: vocabulary. Vocabulary should not be a barrier and is essential in any field, especially social studies. Often, students are told to either look words up or write down their definitions. This can only do so much though, as they do not have any practice using these new words. Often students feel disconnected because they do not understand the vocabulary and will give up instantly. This should be no surprise as many use social media. Many articles, news clippings, and videos are short so students are used to scrolling through information fast and do not grasp a deep meaning of anything. This is why many YouTube videos are less than 15 minutes long as it keeps its viewer's attention since the attention spans are diminishing.

There are approaches, however, that combine group activity with a focus on vocabulary. One method is RAFT (role, audience, format, and topic). Put into practice a geography teacher can use this for their students to teach them the importance of geographic features. Students can make a brochure of a place for travelers as they take on the role of a travel guide. Incorporating the rules of raft, their role is to be a tour guide, their audience are tourists, they are visiting a country for the first time through a brochure (format), telling them the top ten sites they should visit and why they are important/significant (topic) (Alexander-Shea, 2011).

Primary Sources

Another thing that is important in history is the use of primary sources. Yet, this can also be another barrier for students in high school. Primary sources "may seem more difficult than textbook reading, because, unlike textbooks, the political speeches were intended not to create an understandable story for [modern day] students, but to speak directly to the people and issues of former times" (Newmann, 1990, p. 264).

Carpenter, Earhart and Achugar, (2014) conducted a study to investigate how to help teachers in a multilingual classroom with comprehension of primary documents. In this instance, the two documents examined were Section 13 of Virginia's Declaration of Rights and the second was the Second Amendment in the United States Constitution. To start the lesson, the teacher put images of both authors (George Mason and Thomas Jefferson) and projected them on the board. He asked them if anyone knew who they were. He then stated the objective of the lesson to his students. In this case, it was to find the origins of America's ideas in a political format and what kinds of language the founding fathers used. On his response sheet, the teacher asked what differences were between the two documents, specifically, what each document included that the other left out. To put in a portion of evaluation, he then asked them if Section 13 of Virginia's Declaration of Rights was the actual Second Amendment, how would that change America today? Many students' responses were on track as they examined that had this been the case gun laws and ownership would have been much stricter. They also examined that words such as peace can have different meanings in different contexts.

Detecting Bias

Historians also know that any kind of source will have bias at different degrees. Detecting bias is another important component in determining the validity of a source. So how can we as teachers show our students how to look out for it? Malik (2005) examined a lesson using primary sources on the Industrial Revolution in England. She started the lesson with a concept map with the entire class to try to define bias. In her study, she mentions that the students answered correctly that is someone's belief, opinion, or their preference. She then proceeded with the concept map pointing out how they can detect bias. The students pointed out through negative words, put-downs, or the distortion of truth that the author can use). The teacher then chooses an example of how to detect bias. She says her thoughts aloud as she examines the primary document. The example she used was from a member of British Parliament stating the horrible conditions of factory work, especially for child labor. She underlines the adjectives the author uses to describe the conditions. She points out to the students that these words help put imagery to make the reader know the experience of smell and what one would here in a factory. She then followed up with another piece in which the students would have their own practice independently. Students referred to their concept maps on what aspects they should see in primary documents. She used a think-pair-share method giving students had time to think about the passage using their concept map. The students were able to detect bias line by line in a source.

Asking Thought Provoking Questions

The final step we must do as educators of social studies is address questions with more questions that enable students to think historically. For example, in a lesson on the Battle of New Orleans, a teacher usedmany sources from songs, paintings, historical accounts, and a handful of primary sources (Nokes, 2010). One of his students looked at her teacher frustrated.

> "I don't know why we have to study the song. It doesn't tell us anything about the battle."
>
> "Does the fact that a best-selling song about the battle was written 150 years later tell us anything about it?"
>
> "I guess that it means that this battle is really famous?"
>
> "Yeah, I think that the Battle of New Orleans has become an important part of American pop culture. Is there anything else in the other documents that might support this idea?" (p. 63-64)

With this question, she is able to relate the song to a painting of Andrew Jackson and text stating he became a national hero. It is responses like these is what all social studies teachers must be prepared for.

Conclusion

So, what can teachers do if they want to have their students be able to think historically? Social Studies teachers must ask more thought-provoking questions that require discussion. They must also be ready to model how they decipher the significance of text and compare it to things that a student will understand. We must also use strategies such as RAFT or others to boost vocabulary that is crucial in the understanding of historical documents. Implementing these strategies such as RAFT in the form of a brochure, or perhaps creating a skit, will help students connected to the material. We are not trying for our students to memorize facts, but like historians, discover them, make connections, and come up with their own explanations that can be challenged.

References

Alexander-Shea, A. (2011). Redefining vocabulary: The new learning strategy for social studies. *The Social Studies 102*(3), 95-103. doi: 10.1080/00377996.2010.509371

Carpenter, B., Earhart, M., & Achugar, M. (2014). Working with documents to develop disciplinary literacy in the multilingual classroom. *History Teacher, 48*(1), 91-103.

Malik, K. D. (2005). Infusing critical thinking skills instruction into secondary social studies (Unpublished doctoral dissertation). University of Toledo, Toledo, OH.

National Park System. (n.d.). Retreat fit for a president: Lesson 2. Retrieved from https://www.nps.gov/features/shen/2019/hoover/lesson-2/map/rapidan-camp/prime-minister.html

Newmann, F. M. (1990) Qualities of thoughtful social studies classes: an empirical profile, *Journal of Curriculum Studies, 22*(3), 253-275. doi:10.1080/0022027900220304

Nokes, J. D. (2010). (Re)Imagining literacies for history classrooms. In R. J. Draper (Ed.), *(Re)Imagining content-area literacy instruction* (pp. 54-68). New York, NY: Teachers College.

Yusmanto, H., Soetjipto, B. E., & Djatmika, E. T. (2017). The application of carousel feedback and round table cooperative learning models to improve student's higher order thinking skills (HOTS) and social studies learning outcomes. *Canadian Center of Science and Education, 10*(10) 39-49. doi:10.5539/ies.v10n10p39

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Learning to Teach

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Through Research and Practice

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