Volume 7 | Issue 1 | August 2018

Learning to Teach

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

A publication of the Department of Curriculum and Instruction
Rebecca Schneider, Professor and Chair | University of Toledo

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Section on Language Arts

Section on Mathematics

Section on Science

Section on Social Studies

Language Arts

Integrating and Sustaining Creativity in the Language Arts Classroom

Morgan Batanian

Abstract: This essay examines the significance of integrating creativity in the English Language Arts (ELA) classroom by exploring the beneficial effects that nurturing creativity has on students. Based on theories and research on creativity and the learning experience, it proposes that students have an opportunity to enhance their personal and academic skills if teachers properly integrate creative activities into the classroom. Creative opportunities need to be encouraged and integrated regularly within the ELA classroom, as it is important to students' overall success in achieving higher-order levels of thinking. However, for students to both engage in creative activities and also believe in their creative abilities, their teachers must actively foster their belief in their own abilities and offer them opportunities to be creative.

Introduction

Creativity is the air that breathes life into any great classroom. It energizes students in such a way that the learning environment is enhanced through an excitement to engage with the material and their peers. However, many English Language Arts (ELA) classrooms don't regularly incorporate creative activities into their learning activities, thus limiting student growth and their development of higher-order thinking skills. As a result, students miss the unique opportunity to explore different viewpoints, explore unconventional styles of writing, and participate in multiple styles of learning. It is the obligation of teachers to strive for their students to not only know "the facts," but more importantly, for them to discover hidden meanings and truths in classrooms that promote exploration through creativity. By understanding what creativity is and why it is important in the classroom, as well as how teachers can integrate and sustain creative strategies within the classroom, teachers will be better equipped to foster a more successful learning environment, and even to better prepare their students to meet the standards of our increasingly outcome-focused educational system.

What is Creativity?

Across the educational world, there is no single, universal definition of creativity. This poses a problem for teachers, because how can they integrate and sustain creativity in their classrooms if they do not fully understand what creativity is? According to Lucas, Claxon and Spencer (2013), "If creativity is to be taken more seriously by educators and educational policy-makers then we need to be clearer about what it is" (p. 6). An increased understanding of creativity is the starting point to increase creativity consciousness, to demystify creativity, and to increase creative ideas and products (Davis, 1991).

A number of theorists have developed working definitions throughout the last 20 years to ensure clarity and credibility. For example, Richards (2013) defines creativity as, "having a number of different dimensions," including:

1) the ability to solve problems in original and valuable ways that are relevant to goals;

2) seeing new meanings and relationships in things and making connections;

3) having original and imaginative thoughts and ideas about something; and

4) using the imagination and past experience to create new learning possibilities. between letters and sounds" (p. 3)

Furthermore, other theorists and researchers have created working definitions of creativity that include the following elements. In these definitions, creativity is:

1) Complex and multi-faceted, occurring in all domains of life (Treffinger, Young, Selby, & Shepardson, 2002);

2) learnable (Csikszentmihalyi, 1996);

3) central to what it is to be successful today (Sternberg, 1996); and

4) strongly influenced by context and by social factors (Lave and Wenger, 1991).

While creativity is interpreted in multiple ways, and has several facets, all of the researchers cited above agree that creativity is profoundly influential and important. They argue that nurturing their creativity prepares students for many and varied possibilities in life. In particular, creative activities allow students to see and consider different perspectives that they might not have considered before. They offer students opportunities to analyze complex situations and choices either individually or collaboratively. And they give students opportunities to freely experience a journey of self-exploration which can help them shape their own identities. In fact, I see this final task as the central goal of fostering creativity in the classroom, which I define as challenging students to transcend traditional rules and patterns in pursuit of new, individually meaningful interpretation. If we wish to help our students make their way in a world that will offer them this challenge on a daily basis, it must be a priority for the educational system to help our students develop creative approaches which they can use to engage with that world.

Why is Creativity Important?

Creativity is important because it sparks the minds of students to find their purpose and passions in life. It evokes higher cognitive-thinking skills that elicits a broad spectrum of perspectives and develops a platform for more integrated learning. In fact, the most recent version of Bloom's Taxonomy states that producing new and original work, or "creating," is itself the highest cognitive process. As teachers, it is our job to incorporate all levels of critical thinking throughout our instruction so that students are able to develop higher-level thinking skills.

However, in order to challenge and advance the skills of students, teachers must move away from the lower-level thinking skills that much of the school day focuses on, and must focus more on the higher-levels of critical thinking, particularly as students make their way up the educational ladder. Due to the pressure of state-mandated testing and the focus on meeting the education system's standards, teachers too often rely on "textbook teaching." In other words, teachers often focus on simply teaching from textbooks and worksheets, no matter what age group or class they are working with, rather than deploying other instructional methods. Yet ironically, such "textbook teaching" does less to prepare our students both to meet standards and to function in the world. No two classes are the same, and it is the responsibility of teachers to mold their classrooms into learning environments that are suitable for the students in each class in order to achieve the standards. The standards remain the same, but the conditions and strategies to achieving those standards are malleable. Therefore, "creative" or "ambitious" teaching strategies are more likely going to result in the students meeting the necessary requirements to advance.

Creativity in the ELA classroom needs to be recognized as not a distraction, but a form of higher-level thinking. Once this insight is translated from the educational research into the real world, there is room to increase student success and student learning. Specifically in regards to an ELA classroom, where knowledge and ideas are not always "black and white," creative activities offer a sense of fluidity and flexibility that should be not only welcomed but also encouraged and considered essential. Creative, open-ended activities must be central to this content area because they allow for a range of different choices for students to make, encouraging divergent thinking and opening up a wider range of reading, writing, and speaking opportunities to our students (Avila, 2015).

How Can ELA Teachers Integrate and Sustain Creativity?

In order to successfully encourage and nurture student creativity, teachers must begin by demonstrating creative behaviors and offering their students the opportunity to be creative. If it is our goal to have students participate, engage, and excel in creativity in the classroom, doing so begins with the teachers' personal actions and demeanor toward the students. According to Fasko (2001), "When students understand that their teachers 'value' creativity, then this message has a positive effect on creativity" (p. 323). Ultimately, teachers who enable and encourage creative thinking and behavior in the classroom create positive perceptions among students and their abilities to be creative in the ELA classroom.

This can be challenging, particularly at first. For example, when I introduced creative activities into a classroom that had been solely focused on textbook learning, I was in sheer disbelief when one of my students asked me if they could simply complete a worksheet instead. The rest of the class responded to this request with cheering, chanting, and agreement—the unanimous opinion of the class was that they would prefer things remain as they had been. I felt myself second-guessing, questioning the assignment, wondering to myself if it might be too difficult for them. Then again, I knew I had to at least give it a try; nothing had ever been done like this in this classroom before – Since when are worksheets considered a great method for demonstrating knowledge in a ninth grade English classroom? Did my students just expect me to have them sit down in with a partner and let them answer insignificant questions that required little to no higher-order thinking? Of course they did; that's what they were used to prior to coming to high school. In response to my students, I answered them with a simple yet gentle "absolutely not."

Sure enough, that day was the first time that I saw my students smiling, laughing, and expressing excitement while completing an assignment. From that day on that I knew that I had to make a promise to not only these students, but also to myself as their teacher to ensure this kind of response every single day in English classroom. All I needed to do was integrate one simple ingredient into to the mixture: creativity.

One example of a way to integrate creativity into ELA classrooms is through creative writing. Creative writing provides opportunities for students to explore different kinds of writing, while still incorporating critical thinking skills. It also "promotes teamwork and peer editing," and "gives students liberty of expression, interest, and purpose in the course of work" (Avila, 2015, p. 98). Writing is a requirement at every grade level of students' academic journeys, and does not need to be limited to only essay writing, argumentative writing, and analysis. Rather, it can also be used to foster artistic expression, stimulate the imagination, clarify thinking, and explore the value of writing and its range of functions.

Research shows that ELA teachers recognize the value and importance of creative writing in their classrooms, as well as the importance of allowing students some freedom to be creative in discussion. For example, Adam (2015) surveyed a group of 50 ELA teachers, asking them to rank statements regarding their opinions on creative writing in the classroom. The questions were centered around if and how creative writing can be developed in the classroom for students through various activities and approaches. The following table displays the results from this empirical study, showing that a majority of the ELA teachers either strongly agreed or agreed on all five statements about how creative writing is an essential tool to use in the English classroom. This study confirmed that teachers understand how creative writing in the ELA classroom enhances students' skills as well as helping them develop their imagination, and higher-order thinking.

As Adam's (2015) study suggests, discussion offers another space for creativity in the ELA classroom. An example of a way to integrate creative thinking in ELA discussions is through the use of Socratic seminars. Named after the philosopher Socrates because of his belief in open-ended inquiry and the power of asking questions and voicing a variety of opinions through discussion, Socratic seminars focus not on arriving at correct answers but on letting conversations flow among and between students with little control exerted by the teacher. For this reason such seminars evoke creativity among students as the open-ended nature of the discussion allows them the freedom to express a range of ideas without being told they are "wrong," and consequently helps them to develop a sense of identity within the classroom.

Table 1
Teachers' beliefs about creativity.

Statementes	Percentaage				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Class discussion is a good method for deveopinig topics for creative writing	64	18	16	2	0
It is important to ask students to write short stories and poems	34	46	16	4	0
Creative writing assignments are essential for teaching literature	22	60	14	4	0
Creative writing workshops allow students to write freely	36	48	14	2	0
Asking students to write free-ly during literature courses improves creative writing	60	34	6	0	

Note: Adapted from Adams, 2015, p. 113

Research conducted by Copeland (2005) makes clear the benefits of Socratic circles and their connection with creative thought. According to Copeland, such seminars are effective at stimulating creative and higher-order thinking because they "help our students see that all thinking is flawed and incomplete, that all ideas can be furthered developed and better explained, and that questioning helps us explore these realities" (p. 8). For example, the scenario below shows how a teacher might introduce a Socratic seminar.

A teacher's introduction to a Socratic seminar.

Now that we have finished the novel, Animal Farm, you all will be facilitating and participating in a Socratic seminar today to discuss key concepts, issues, and themes that arose while reading. As always, the first half of class is dedicated to this group of students discussing in the inner circle, and in the second half of class the groups will switch. Remember that when you are in the inner circle, it is important to recognize that this is not a debate, but rather a discussion. You all at some point may disagree with one of your classmates, but it's important to keep this a civil conversation. As you know, when you are not in the inner circle you are in the outer circle. The outer circle students are responsible for commenting on the discussion that is taking place within the inner circle. But instead of commenting on paper, you are commenting virtually through the classroom website. Outer-circle comments will be projected onto the white board at the front; that way the entire class can see what the comments say, especially the inner circle, and can use them to carry the conversation forward. Also remember to include specific examples, including quotations

While these methods of integration may work in the short-term, creativity must become fully a part of a classroom culture that is sustained over time. Embracing and fostering divergent thinking – in reading, writing, speaking and listening – is a way of thinking that inspires students to incorporate it both inside and outside the classroom, which broadens their perspectives and increases their learning. In turn, students will then be emboldened to do the same, and to bring their outside experiences into the classroom, thus increasing creative participation that is relevant to them. When this occurs, students then feel a sense of responsibility and engagement to the classroom material because they were the ones who brought to the conversation. The teacher's job becomes facilitating the conversation in a way that integrates the course material and constantly assessing how the classroom responds to different methods of integration. By doing so, the teacher will have developed an environment where creativity is an integral part of the students' identities, and planted the roots of a lifelong learning skill.

Conclusion

Creative opportunities need to be encouraged and integrated regularly within ELA classrooms as they are important to students' overall success in mastering higher-order thinking. According to Avila (2015), "English teachers can use their creativity to make classes much more original, and go outside the formal bonds of teaching" (p. 95). It is our responsibility as teachers to foster this creativity by being the creative spark for our students, integrating creative writing and Socratic seminars, and molding an environment where students are challenged to engage in the highest forms of critical thinking. As a result, students will develop a lifelong learning skill that will transcend traditional rules and patterns and allow them to creating new, meaningful connections, interpretations, and even identities for themselves.

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About the Author

Morgan Batanian received a Masters of Education from University of Toledo and a Bachelor of Arts & Sciences in Journalism from University of Cincinnati. Her goal is to spark the minds of students to help them find their purpose in life. She teaches English at St. Ursula Academy in Toledo.

Incorporating LGBTQ Young Adult Literature into the AYA ELA Classroom as a Means to Bring Representation to Underrepresented Groups

Sam Hutchinson

Abstract: This article advocates for the incorporation of LGBTQ young adult literature into the AYA ELA classroom as a means to address the lack of representation of LGBTQ individuals in the curriculum. It begins by sharing statistics taken from a nation-wide survey pertaining to discrimination against LGBTQ students in classrooms around the USA. From there it argues for the importance of incorporating young adult literature in the classroom, and explores methods for incorporating LGBTQ young adult literature in the classroom. Finally, it discusses how to address the pressures that may be presented in response to the incorporation of these texts.

Introduction

"It is challenging to find representations of LGBTQ experiences in schools, libraries, local bookstores, or movie theaters" (Dodge & Crutcher, 2015, p. 97). In my own experience, Dodge and Crutcher's statement could not be more true; through all my years of schooling, not once do I recall encountering a text engaging the LGBTQ community, not even encountering a single LGBTQ character in a novel or short story. As a student teacher, I saw that this remained the case in the school in which I was placed, in that it did not contain any LGBTQ literature.

This lack of representation is somewhat startling, because as one survey conducted by the U.S. Centers for Disease Control and Prevention (CDC; 2018) in 2017 on high-school students in the United States found, 2.4% of students identified as gay or lesbian, and "8.0% identified as bisexual" (p. 8). That means approximately 10.4% of students are LGB and are not typically represented in the curriculum (this survey did not account for transgender or gender queer students).

Fortunately, there are movements underway to make schools more inclusive and representative of underrepresented groups. One movement is pushing for more representation of LGBTQ individuals in the curriculum (Dodge & Crutcher, 2015; Gallo, 2004; Boyd and Bereiter, 2017). One method of doing so is by incorporating LGBTQ literature in the Adolescent and Young Adult (AYA) English Language Arts (ELA) classroom. At present, however, LGBTQ characters are underrepresented in the various texts utilized in the AYA ELA classroom. Therefore, our curriculum must become more inclusive to represent those students that fall into this category.

Discrimination Against LGBTQ Students in Schools

Before focusing on how to better represent LGBTQ students in the curriculum, it is important to understand the problems that such students they deal with in school. Many LGBTQ students face discrimination in school, in the form of both verbal and physical harassment. For example, Table 1 shows the range of harassment and assault faced by such students, according to the 2015 National School Climate Survey conducted by the Gay, Lesbian & Straight Education Network (GLSEN; Kosciw, Greytak, Giga, Villenas, & Danischewski, 2016).

Clearly, this discrimination is not conducive to an effective learning environment. The effects of this discrimination can be observed in Table 2, which depicts the effects of discrimination by contrasting academic performance of LGBTQ students who faced discrimination with those who did not face discrimination. As the table demonstrates, LGBTQ students that are discriminated against suffered more psychologically and academically than those students that did not face discrimination in schools.

Table 1
Forms of harassment and assault against LGBTQ students in school settings.

Type of Assault	Based on Sexual Orientation	Based on Gener Expression
Physically harassed	27.0%	20.3%
Physically assaulted	13.0%	9.4%
Electronically harassed	48.6%*	48.6%*
Sexually harassed	59.6%*	59.6%*
Heard "gay" used ina negative way	98.1%*	98.1%*
Heard negative remarks about gender expression	95.7%*	95.7%*
Heard negative remarks pertaining to the LGBTQ community from teachers and other school staff	56.2%	63.5%

*Data groups students together based on sexual orientation and gender expression.
Note: Compiled from Kosciw et al., 2015, p. xvi-xvii.

Table 2
Effects of discrimination against LGBTQ students.

	Discriminated Against Based on Identifying as LGBTQ	Not Discriminated Against
Missed school in the past month	44.3%	12.3%
Average GPA	3.1	3.4
Disciplined in school	46.0%	27.9%
Self-esteem	Lower*	Higher*
Rates of depression	Higher*	Lower*

*Non-numerical comparisons were supplied in the source.
Note: Compiled from Kosciw et al., 2015, p. xviii.

The GLSEN survey also provided data pertaining to LGBTQ student achievement when an LGBTQ-inclusive curriculum was utilized in schools. As Table 3 demonstrates, students hear more negative remarks and feel less safe at school when LGBTQ representation is missing from the curriculum. Conversely, students feel safer and hear fewer homophobic and negative remarks about gender expression when LGBTQ representation is included in the curriculum.

As can be seen in Table 3, an LGBTQ-inclusive curriculum creates a more effective learning environment for students that fall into this group, as compared to a non-inclusive curriculum. When such a curriculum is present, LGBTQ students feel safer, earn higher grades, and are more likely to attend school on a regular basis. As teachers, it is our duty to create a safe, inclusive, and effective learning environment for our students. In the AYA ELA classroom, doing so can take the form of including LGBTQ young adult literature in the curriculum.

Table 3
Differences in LGBTQ experience with inclusive and non-inclusive curricula

	Non-inclusive Curriculum	Inclusive Curriculum
Heard "gay" used in a negative way	72.6%	49.7%
Heard homophobic remarks	64.1%	40.6%
Heard negative remarks about gender expression	66.6%	50.7%
Heard negative remarks about transgender people	44.5%	26.8%
Felt unsafe because of their sexual orientation	62.6%	40.4%
Missed school in the past month due to feeling unsafe	35.6%	18.6%

Note: Compiled from Kosciw et al., 2015, p. xx.

As can be seen in Table 3, an LGBTQ-inclusive curriculum creates a more effective learning environment for students that fall into this group, as compared to a non-inclusive curriculum. When such a curriculum is present, LGBTQ students feel safer, earn higher grades, and are more likely to attend school on a regular basis. As teachers, it is our duty to create a safe, inclusive, and effective learning environment for our students. In the AYA ELA classroom, doing so can take the form of including LGBTQ young adult literature in the curriculum.

Young Adult Literature: An Overview

Middle and high-school students generally relate well to young adult literature (YAL) because the characters portrayed in these texts share many similarities with our students. The main characters in young adult literature are typically close to the same age as our students and face many of the same challenges as our students because these texts bring up difficulties and realities faced by teenagers.

One traditional argument against teaching young adult literature is that YAL does not meet the standards set forth by the CCSS. However, this could not be further from reality, as a majority of it meets the standards quite well (Ostensen & Wadham, 2012). Ostensen and Wadham contend that YAL is:

> a strong fit with the Common Core expectations because it can meet the standards for quantitative and qualitative measures of complexity at the same time as it meets the needs of readers and the tasks in which they must engage (p.7).

Another concern about YAL is it does not fit into the canon of texts traditionally taught in schools. However, in many cases YAL can be used as a stepping stone for many of the canonical texts utilized in the ELA classrooms (Bright, 2011; Rybakova and Roccanti, 2016). Table 4 illustrates this with three examples taken from Rbakova's and Roccanti's article on pairing young adult literature with the canon.

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

Table 4
Examples of young adult literature (YAL) and canonical literature pairings

YAL Novel	Canonical Connections(s)	Connecting Element(s)
The Book Thief by Markus Zusak (Goodreads rating 4.35/5)	The Diary of a Young Girl by Anne Frank	Event: The Holocaust
	Night by Elie Wiesel	
Smile by Raina Telgemeier (Goodreads rating 4.12)	Little Women by Louisa May Alcott	Theme: Coming of age
	The Catcher in the Rye by J. D. Salinger	
	Roll of Thunder Hear My Cry by Mildred Taylor	
Mockingbird by Kathryn Erskine (Goodreads rating 4.16)	To Kill a Mockingbird by Harper Lee	Characters: Similar plot lines, characters, differing themes; references To Kill A Mockingbird several times

Note: Excerpted from Rbakova & Roccanti, 2016, p. 35.

As Table 4 shows, many canonical texts share thematic elements, character similarities, and other connections with YAL. Because of these similarities, and because young adult literature is generally easier for students to grasp and to relate to, YAL can serve as an excellent springboard when paired with canonical texts.

LGBTQ Young Adult Literature

Given the general effectiveness of using young adult literature in the curriculum, this same literature can also be used to effectively bring representation to underrepresented. In this case, young adult literature can be utilized to offer representation to LGBTQ students. As discussed earlier, LGBTQ literature offers teachers and schools one way to represent marginalized groups in our instruction. Incorporating LGBTQ young adult literature in our classrooms allows us to help all students relate to and empathize with the LGBTQ characters. This humanization consequently helps non-LGBTQ students relate to LGBTQ students. In effect, this can create a safer, more accepting environment for LGBTQ students. As Dodge and Crutcher (2015) explain, "[i]ntegrating LGBTQ YAL helps students question, discover, and discuss the multiple experiences of people in our society, creating a curriculum that promotes empathy and social justice" (p. 97).

One method of incorporating LGBTQ literature into the English language arts classroom is by tying works which contain LGBTQ characters "into themed units you already teach" (Gallo, 2004, p. 129). Gallo provides an excellent example of this incorporation:

I am currently working with a middle school on a bully unit. The generic term bullying covers all forms of harassment. Using literature circles, the students read six different books, all with bullying in them. The Misfits is one of those books.

Homosexuality is not the main theme in the book, or in the unit, but a character is harassed because of his effeminate ways, and that is discussed as part of the unit's main theme of bullying. (p. 129)

As can be observed in his example, Gallo ties in bullying experienced by a homosexual character in a novel into his unit on bullying. Not only does this humanize the homosexual character while fitting LGBTQ literature into an already established curriculum, but bringing in this novel also helps students see similarities between the variety of bullied characters whether they are LGBTQ or heteronormative characters within other texts read by the class. This helps students to sympathize with the homosexual character from the novel and has them consider the struggles faced by their LGBTQ peers.

In addition to fostering empathy and understanding for LGBTQ students, incorporating LGBTQ literature into the curriculum, can also help teachers engage students in the higher levels of thinking on the taxonomic scale. This is addressed quite readily by a series of four questions created by Boyd and Bereiter (2017) that can be asked when engaging their students with transgender literature. These questions were discussed in groups of students with each group engaging with a different text and were as follows:

1. How do power structures (social institutions) affect the transgender characters in your book? (e.g., hospitals, schools, religion, family)

2. How did point of view affect your book?

3. How is masculinity presented in this book? (i.e., How do certain characters perform masculinity?)

4. How would switching the gender in your book (if it were trans female instead of male in I Am J, for instance, or trans male instead of trans female in Almost Perfect, for instance) affect the character's interactions with other characters or institutions? (p. 16).

Not only do these questions engage students in higher levels of thinking, such as analysis and evaluation while engaging students in critical thinking practices, but such questioning addresses the literature portion of the Common Core State Standards set forth in the United States.

In addition, like other forms of young adult literature, LGBTQ young adult literature can be paired with the canonical texts utilized in the English language arts classroom as a form of scaffolding. For example, Dodge and Crutcher (2015) implement all three elements in their text-selection practices, combining the higher levels of taxonomic thinking and incorporating LGBTQ young adult literature into the curriculum through a unit already utilized in the classroom. These two introduce the unit with an "essential question: How do country, culture, government, or socially enforced gender roles influence romantic relationships?" (p. 100). This question touches the taxonomic levels of both analysis and evaluation as it encourages students to think critically about the texts they engage with. They go on to offer a list of text titles, one being the canonical text Romeo and Juliet where two children are engaged in a forbidden love. They also placed an LGBTQ YAL novel on the list, If You Could Be Mine by Sara Farizan. This novel takes place in Tehran, Iran. In this text, "Sahar is in love with Nasir, but because they are both female, their love is illegal and punishable by death" (p. 99). All texts in the list share thematic and character elements that can be addressed by the overarching question for the unit, but a LGBTQ YAL novel is incorporated into the text set which will assist to scaffold understanding when the students approach the canonical text by Shakespeare. By incorporating this LGBTQ text, Dodge and Crutcher are bringing representation to the LGBTQ community within the school setting. Such representation can be used to facilitate discussions among the students concerning the LGBTQ community and could help lead to a more accepting classroom and school environment.

Restrictions on Teachers

While there are several compelling reasons to integrate LGBTQ YAL into the ELA classroom, there are also many obstacles that can prevent teachers from doing so. As Dodge and Crutcher (2015) state, "teachers worry about the repercussions of introducing LGBTQ issues in their classrooms, from pushback from parents to concerns about losing their jobs." They "also concede, from research and personal experience, that teachers may face communities, cultures, policies, and even laws that impede or prohibit inclusion of LBGTQ YAL or validation of LBGTQ experiences." With all this in mind, it is hard to "imagine how novice middle and secondary teachers can do antihomophobia work without professional risk… This work is risky, and as long as heterosexism and homophobia are institutionally supported forms of oppression, it will continue to be so" (pp. 103-104). While these points are all true, and pose a real challenge for teachers, we must remember that as teachers, it is our duty to create a safe, inclusive, and effective learning environment for all our students.

Because parents, community members, and even members of school administration or other teachers often challenge the texts we select for use in our English Language Arts classrooms, teachers must have clear justifications for their text selections ready. Fortunately, Dodge and Crutcher addressed this in their article, offering a seven-step plan for being ready to do so. First, one should "think about existing unit themes, curricular goals, and anchor texts" being utilized in the classroom. After this, one should consider how to incorporate "experiences and identities of LGBTQ persons, particularly through high-interest YAL, multimedia, and popular and digital culture." Third, one must explore "resources for identifying award-winning LBGTQ YAL, for strategies in integrating that YAL and other high-interest media…, and for addressing challenges from parents, communities, and policies." Fourth, one needs to read these texts "and identify essential questions that can guide" one's unit. Fifth, one should "research how the school and community need and support equity, and plan integration accordingly"; this could include familiarizing oneself with "school antibullying policies, multicultural/culturally relevant teaching policies, suicide prevention initiatives, Title IX, student organizations, LGBTQ community events, [and] social and political activism." Sixth, one needs to plan their "unit using the Common Core, …other text resources, and student prior knowledge, including learning from across the subject areas.". Finally, one must "plan for authentic, student-led, summative projects" (p. 103). While there might still be parent, community, and other forms of backlash when incorporating LG-

BTQ young adult literature into the curriculum, following these seven steps prior to incorporating these texts into the classroom may help diminish this backlash and will also allow the teacher to ensure that their own practices are justifiable, in order to prevent possible repercussions.

Conclusion

In conclusion, LGBTQ young adult literature should be incorporated in the adolescent and young adult English language arts curriculum. In general, students relate well to YAL to this age group, because they can identify with the characters and their struggles more than they can with characters from the canonical texts teachers implement in their classrooms. By incorporating LGBTQ young adult literature in the classroom, teachers can not only offer representation to this underrepresented group, but can also foster empathy and understanding for LGBTQ students. For this reason, the integration of LGBTQ YAL might help our schools become safer, more accepting, and more productive learning environment for LGBTQ students.

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Multigenre Projects
A Better Alternative to Teaching Research

Stefanie Neuman

Abstract: Research and research reporting skills are an essential part of learning in and beyond school. While most teachers recognize the importance of teaching research, traditional research teaching methods are less effective than they might be. Multigenre research projects offer a more authentic and engaging way of teaching research in the classroom. Using a variety of writing genres as tools, students are able to create layers of meaning in writing and unite multiple genre artifacts to build a holistic and real-world model of information found in research. This project-based approach gives students the opportunity to use critical thinking and inquiry skills in order to problem solve their way through high-level thinking challenges. The multigenre project's authentic and challenging nature make it a more effective model than traditional methods for teaching research in the classroom.

Introduction

The traditional research paper has long been a staple in English Language Arts classrooms. The ultimate objective of the traditional research paper is to develop students' skills in research and ensure students can clearly and effectively report their findings. Teaching students the ability to research, to learn how to learn, is an important goal, especially in a world evolving as quickly as ours in both technology and context. As educators, however, we ourselves need to constantly adopt new ideas and to reevaluate traditional teaching methods in light of those new methods, even tried-and-true traditional methods like assigning students to write typical research papers.

The traditional research paper, though popular, presents several big problems. An over-emphasis on form when using a traditional research paper discourages student synthesis and creativity. As Hillocks (2005) writes, "teachers of writing in the schools still appear to rely heavily on teaching the forms and devices of writing while neglecting how to work with content" (p. 240). Rather than processing the material they have researched, traditional research papers too often encourage students to provide a summary of that material plugged into a required format, which requires little more than paraphrasing research.

This single-format instruction is both unchallenging (for the reason described above), and also inauthentic (Mack, 2002). In the real world, students will use letters, memos, emails, presentations, phone calls, and many various methods to communicate personally and professionally, but the ability to write a traditional research paper is useless outside of academia. Without personal interest or relevance, even students who are motivated to do the paper well are likely externally motivated, working only for a grade or other reward. To create lifelong learners, if our goal in teaching research is to teach students to learn for themselves, we need to find a better alternative method, one that challenges students and is more intrinsically motivating, because it is more linked to real-world writing practices.

One alternative to the traditional research paper is the multigenre project. Originally presented by Romano (1995), it has been explored and expanded since by many teachers looking for better ways to teach research. I used this type of research project in my own teaching with much success. If you're a teacher who has not seen multigenre projects before, I encourage you to look at examples; a google search or google image search will yield myriad results to give you a clear idea of what a published multigenre project looks like. Multigenre projects focus on the writing (read: "creating") process, which involves inquiry, critical thinking, and creativity (Hillocks, 2005). Students must begin with an idea synthesized from research and use genre as a tool, evaluating merits of different communication strategies to find how to best make their points. A multigenre project requires creativity and challenges students to juggle abstraction and plurality in problem solving and writing (Styslinger, 2006). It engages students in the writing process from multiple different perspectives and challenges them to evaluate not only what to say, but how to say it. Authentic and relevant classroom work helps motivate student work, which results in deeper engagement with challenging material. The research backs up what I found in my personal experience, which is that multigenre projects are truly a better alternative to teaching research. "It's time for us to join the future and support all forms of 21st century literacies, inside and outside school" (Yancey, 2009).

The Multigenre Alternative

Working on a multigenre project, students research a topic using online and offline sources, but report research in an exceptional way. Students choose multiple different reporting methods, depending on their findings. They begin by synthesizing ideas from their research, then choose whichever genre most effectively makes their point, and create an artifact to impart what they learned. Each artifact should communicate its own independent point, but all should fit together under a unified theme or idea (LeNoir, 2002). Teachers determine the number of resources and genres that are required of students and how they'll be graded, but students determine all else about how the project turns out.

Students develop voice in a multigenre project (Styslinger, 2006). It requires them to become active researchers, researchers who not only find information, but organize it, evaluate it, and report it in authentic and effective ways. Finding this voice and putting together a portfolio of different genre artifacts that unify into one project is cognitively challenging and requires creativity, problem-solving, and commitment.

Challenging Students to Think

It often happens when writing a traditional research paper that students simply summarize their sources together and don't synthesize, evaluate, or think about the information. In a multigenre project, research becomes an inquiry process (Hillocks, 2005). Students must think about what is important, why it's important, and what it means in the big picture. In order to do this, they must pay close attention and dig deeply into research. This inquiry is the beginning of the writing process. Once the students have an idea, they move on to synthesis. The focus on content before form ensures that students engage with research beyond simple summary.

Multigenre projects not only require students to assess value of information from research, but also to evaluate how those points can best be presented. This part of the writing process involves many high level cognitive functions, and gives students the opportunity to address communication as real-world problem-solving (Dickinson, DeGraff, & Foard, 2002). Genre can add layers of meaning to text, so encouraging students to take advantage of using genre properly can give them writing tools for success in the future (Mack, 2002). Technology also is used as a tool when using various genres for reporting. Students in my classroom used technology not only to research their topic of choice, but also to research various genres and to create various genres. Looking ahead, it seems natural that multigenre projects will evolve along with technology as students become more comfortable using technology and technology becomes an even more capable tool (Beach & O'Brien, 2005). These opportunities to use genre and technology to aid communication are not possible with more traditional approaches to teaching research and are one of the great advantages multigenre projects have to offer.

Plagiarism of course becomes a concern in this project because in-text citations are not always possible, and often would interfere with the authenticity of the artifact (Moulton, 1999). Many teachers, myself included, have addressed this by using reflection paragraphs or endnotes associated with artifacts. In these short explanations, students justify their thinking in genre selection, clarify any purposeful deviations, and cite and expound on the resources they used when creating each artifact. These reflection paragraphs are valuable for a number of reasons: they encourage reflection on the writing process, ensure students are thoroughly considering where their facts came from, and encourage metacognition throughout the research and writing process. The scenario below, is an example of a reflection paragraph from my Freshmen English I class.

> *When I began this project, I told one of friends my topic. They said "Why, you aren't going to change anything." This is an example of trying to keep a woman quiet. Even powerful women have to deal with silencing. Senator Elizabeth Warren was shushed whilst reading a letter written by Coretta Scott King (Dame Magazine) which shows that even powerful women have to deal with silencing. "If a woman utilizes her voice ina powerful way, or shakes up systems that are firmly in face, she will be subject to an abysmal, hack, silencing-method known as punishment." (Dame Magazine) I used a poem make the idea I am sharing sound powerful and strong because that it was feminism is all about.*

The text above is an example of a student's reflective writing. The artifact she is reflecting on in this paragraph is a poem she wrote, entitled "Be Quiet," in which she uses the refrain "Be quiet. / Be silent," to drive home a message about the silencing of women's voices. While her poem makes a powerful point, her reflection shows that she carefully considered how to use genre as a tool to help communicate what she found important in her research. She was inspired by a personal connection, and effectively used her research and creativity to express herself.

Challenging students to engage in higher-level thinking throughout the process of research and reporting gives them opportunities to practice essential problem-solving, critical-thinking, and inquiry skills. Encouraging student creativity and building layers of meaning using genre creates an authentic authorial experience. Metacognition and reflection are also an important part of the writing process in multigenre projects and help students grow as learners. These cognitive challenges that students face throughout multigenre projects aren't a part of more traditional methods, and are challenges that help students develop research and reporting skills beyond simple summary.

Motivating Research

One of the biggest problems with traditional research papers is that many students won't engage; even students who complete the papers often simply fill in a formulaic document without much thought. While multigenre projects give students ample opportunities to engage deeply with research and production, they also encourage students to want to engage with the challenge presented to them.

Multigenre projects give students opportunities to express their own voices and connect with learning on a personal level. Authentic work on artifacts that are found in real life motivates students to create professional-quality pieces. Producing authentic artifacts that one might see in the real world is important and exciting for students (Yancey, 2009). When a student in my class struggled with choosing a genre I would ask, "Where in the real world would you find information like this?" This question inspired the creation of artifacts including a doctor's office brochure, a dance studio flyer, a fan letter, a juxtaposed weekly schedule, and a blog post. Traditional research papers aren't seen in the real world and are written according to a formula provided by a particular teacher. In contrast, when a student has an idea for a doctor's office brochure, the audience becomes a waiting room of people; a student creating a dance studio flyer is writing for potential customers; a student writing a fan letter is writing for a favorite celebrity. Real world artifacts created for real world audiences are relevant and exciting (Brimi, 2012). When a student successfully creates a real world professional-looking memo or pamphlet, he or she is (and perhaps more importantly, feels) ready for the real world. When the work is authentic, then the work is important, relevant, and exciting.

In addition, the multigenre project motivates and encourages students with built-in differentiation (Hughes, 2009). Because there are unlimited options for reporting the results of their research, individual students can find ones that work and that play to their strengths. Students are able to choose genres that they're comfortable working with, and so are more likely to take risks in using those genres unconventionally, which increases their own understanding of how to work with that particular type of writing, and leads them to be confident in their own learning. Beyond this, giving the class time for independent work frees the teacher to engage in writing conferences and interventions, and at the same time puts students in charge of their own learning, which gives them ownership and encourages them to invest in their education (Hughes, 2009). With scaffolding and support, every student can succeed in this kind of project, no matter his or her strengths or weaknesses. Figure 1 offers another example from my English I class.

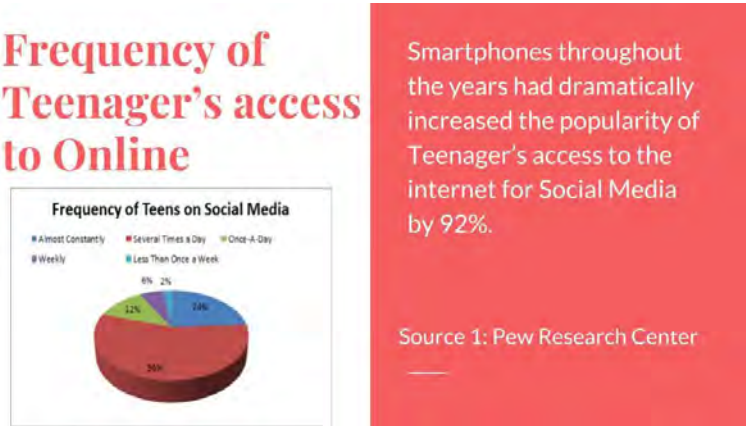
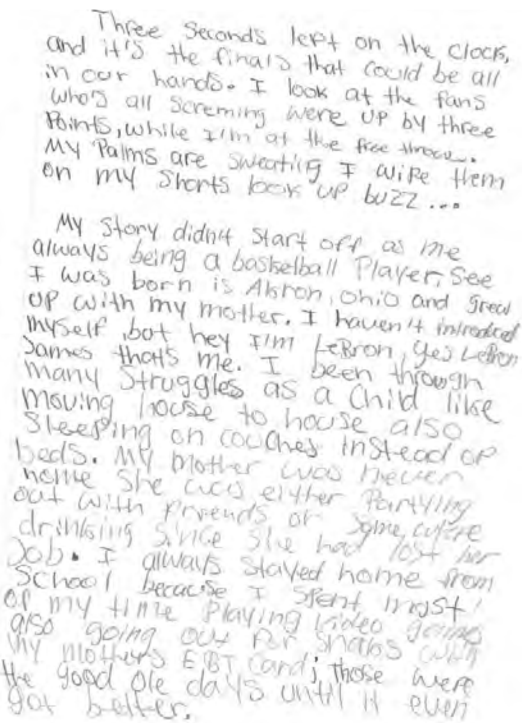


Figure. 1. A slide from a presentation about teens and social media. The student who made this slideshow, who is cognitively disabled and on an IEP, used statistics from his research to create graphs which he presented in a slide show. This figure demonstrates how scaffolded learning guided by student interest can motivate students to achieve at high levels.

Giving students the opportunity to use their strengths and preferences to report their research can encourage them to take risks. When students feel confident and comfortable, they are more likely to try something new. When those attempts succeed, with the assistance of teacher guidance and scaffolding, students gain confidence in their abilities to learn, and so become more likely to take risks in the future and to continue to grow. For example, in my English I class, one student who struggled with reading and writing but was a strong math and science student, was excited by the fact that she could use a graph to convey information in her project. Taking charge of the project for herself, she sprang into action, surveying the class about their musical preferences, asking what kind of music was their favorite.

Allowing students the freedom to explore this project for themselves and do what they feel confident in encourages them to invest in their own learning (Allen, Swistak, & Smith, 2004). Their successes and excitement over well-made artifacts will snowball as they take ownership of their project and it becomes about more than just a grade. While it requires teachers to give up some control, the reward is well worth it. Students who invest in their own work are motivated, engaged, and a joy to work with (Bailey & Carroll, 2010).

The multigenre project is also student-centered in allowing students to choose their own topic to research. This topic should be something they have personal interest in or background with (Allen, Swistak, & Smith, 2004). We spent an entire hour in our classroom discussing topic choice in small groups, doing a topic accountability activity. When a student has a personal interest or connection to a topic, he or she is intrinsically motivated to engage in and sustain research, and willingly looks deeply for information. This motivation can also help students to make connections outside the classroom and encourage them to take their learning with them (Bailey & Carroll, 2010). Figure 2 shows an excerpt from a 5-page narrative written by a freshman student who had personal interest in her topic and found connections between her research and personal life.


Three Seconds left on the clock, and it's the finals that could be all in our hands. I look at the fans who's all Screming were up by three Points, while I'm at the free throw. My Palms are sweating I wipe them on my Shorts back up buzz...

My Story didn't Start off as me always being a basketball Player, See I was born is Akron, Ohio and greed up with my mother. I haven't introduced myself, but hey I'm LeBron, Yes LeBron James that's me. I been through many Struggles as a Child like moving house to house also Sleeping on couches instead of beds. My Mother was never home She was either out with friends or Partying drinking since She had lost her Job. I always Stayed home from School because I spent most of my time Playing video games also going out for snacks with my mothers EBT card; those were the good ole days until it even got better.

Figure 2. An example of student work, "How It All Started." This example shows how student creativity can be sparked when a student truly becomes an expert on a topic. This student researched LeBron James. Her narrative begins with an attention-grabbing introduction at the center of the action during a basketball game, then flashes to an aside in which LeBron tells the reader all about his childhood. In her reflection, this student explains parallels she sees between her own childhood and LeBron's. At the end of the narrative, the reader is pulled back into the game, LeBron makes the basket and reflects on how his difficult childhood made him who he is and how he is thankful for his life. She used the flashback structure to demonstrate her own personal interpretation that LeBron probably didn't appreciate his childhood except in retrospect. It's an impressive example of a student digging deeply into research and relating facts from information reading in a personal, creative, and powerful way. Her motivation for creativity began with a topic she enjoyed personally and continued to evolve as she found personal connections with her research.

Making research and reporting relevant to students' lives, strengths, and interests makes the multigenre project not only a great way to get even reluctant students to engage, but also a lot of fun for both students and teachers. Students can create high quality artifacts with real-world relevance, use genres they're comfortable with as risk-taking launching-pads, and sustain their interest through personal connections with their research. With all these advantages over traditional research papers, multigenre projects can inspire intrinsic motivation in students to encourage lifelong learning.

Conclusion

As educators, we aim to inspire students to grow into lifelong learners. Research and reporting skills play a big part in students' abilities to continue to further their own education outside of school, but traditional methods aren't challenging or motivating enough to give students the best opportunities for growth. Multigenre research projects challenge and inspire students, and should be used in any classroom as an alternative to traditional research papers in order to give students an authentic (and fun) authorial experience.

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Mathematics

Using a Blended Learning Approach in the Secondary Mathematics Classroom

Anne Aronson

Abstract: Blended learning combines aspects from the traditional face-to-face setting and an online learning environment. This type of learning environment provides a variety of benefits to students that are not otherwise available in purely face-to-face classrooms or online learning environments. Secondary mathematics teachers can utilize a blended learning set-up that incorporates the characteristics that make up an effective classroom specifically by looking at the National Council of Teachers of Mathematics (NCTM) Mathematical Teaching Practices. There are many aspects of the blended learning environment that allow for these teaching practices to be incorporated into the classroom and even enhanced when compared to what the traditional classroom can offer.

Introduction

With the increasing use of technology for the delivery of educational content, there is a need to take a deeper look into how we can best structure classrooms that incorporate technology, yet still not lose the important features that face-to-face instruction provides. Blended learning, like other applications in education, has a variety of definitions. However, Alebaikan and Troudi (2010) provide a useful general summary of blended learning as referring to "an integration of online activities and traditional face-to-face class activities" (p. 50).

Due to the variety of definitions and models of blended learning, this article will use the term "blended learning" to refer to the general concept of a combination of both online and face-to-face learning experiences. It will begin by describing the benefits that any general form of a blended learning environment can provide to secondary mathematics students when compared to learning in either the traditional face-to-face or completely online classroom setting. Next, it will explore how a blended learning environment can still allow teachers to utilize what research has shown to be the most effective teaching practices by specifically looking at the National Council of Teachers of Mathematics (NCTM) Mathematical Teaching Practices (2014).

Along with the variety of definitions offered to describe blended learning, there also are a wide variety of learning models that can be described as blended learning environments. For example, Harding, Kaczynski, and Wood (2012) studied a blended calculus course where students accessed the course website at least 2-3 times per week, completed assessments both online and in a classroom, and communicated both online and in course sessions. In contrast, Staker and Horn (2012) described a blended learning setting where "students rotate on a fixed schedule or at the teacher's discretion between learning modalities at least one of which is online learning" (p. 8) These are just a couple of the various ways a blended learning classroom can be created. Research has not shown there to be any one best way to organize a blended learning environment. Instead, it is more effective to look at the specific students and resources available when deciding how to specifically structure the blended learning environment.

Historically, secondary mathematics education has utilized a traditional structured setting where the students and teacher met at a scheduled time and location. Such a system meant that the teacher was constantly present during the class to monitor student progress and answer questions that arose while students are working on their material. This setting allowed for collaborative group work and discussions during which the teacher was always nearby to monitor and assess progress. Despite its strengths, this setting can produce challenges both for students who need extra remediation on a topic and for those students who are working at a faster pace than the majority of the class.

One response to this challenge has been the implementation of online learning, which is asynchronous, and thus offers students much more flexibility to work at their own pace and not be confined by time and location meeting constraints. Not only can this be a good solution for students who both need extra time with a skill or those who want to learn at a faster pace, it also is beneficial to students who are dealing with other situations that prevent them from being able to attend school on a regular basis, such as having a physical or mental illness, raising children, or holding down a job. Yet online learning has several drawbacks as well. For example, one concern with students working in an online environment is the inability of instructors to track whether students are doing the work themselves, or if any cheating is taking place. Solutions are being developed for this problem; for example, one school in China is piloting a facial recognition program to make sure students are paying attention during class, and a similar program could potentially be used in the future to also track students working outside of school in an online program (Fussell, 2018). However since this technology is still in the early stages, the current best solution to this problem is for teachers to provide students with open-ended questions and assess their learning when they are in the physical classroom to ensure the student is able to accurately demonstrate knowledge of the material.

Learning in an online environment also means that one needs to have the self-drive or motivation to continue working on their school work even if not in an actual classroom. Also, there may not necessarily be immediate communication or interaction with the teacher when assistance is needed, which can stymie students' progress and lead to frustration. The concept of blended learning takes the benefits of both face-to-face instruction and online learning and combines them to achieve the best of both.

For example, Horn and Staker (2011) described one of the benefits of blended learning as the ability to "allow students to progress at their own pace and work on their individual learning needs" (p. 10). Since blended learning also includes a face-to-face component, they argue that the face-to-face time can be used most effectively for the teacher to "pull together small groups of students struggling with the same content" (p. 11). Horn and Staker examined a program at Carpe Diem Collegiate High School in Yuma AZ which used software in a blended learning course that would alert an assistant coach or teacher if the program found a student struggling for more than three minutes on a given concept. Utilizing this form of technology learning allowed the teacher to become aware of struggling students much faster than waiting for assessment results in a classroom. With this information the teachers could more easily group students depending on specific needs.

Similarly, Harding, Kaczynski, and Wood (2012) evaluated the outcomes of a calculus course by holding focus sessions with the enrolled students. The students described the flexibility of the online aspect of the course as its major advantage, and saw themselves as more able to participate in cooperative learning, and only needing to use the instructor as a last resort. Harding Kaczynski, and Wood also found that "the blended learning model cultivates self-discipline" (p. 60). In this way blended learning provides benefits to students that derive from aspects of both online learning and a live face-to-face classroom.

An Effective Math Classroom

When looking at how a teacher can create an effective mathematics classroom, one helpful resource is the NCTM Mathematical Teaching Practices. NCTM (2014) offers eight practices that describe what a teacher should be doing in an effective mathematics classroom.

1. Establishing mathematics goals to focus learning
2. Implementing tasks that promote reasoning and problem solving
3. Using and connecting mathematical representations
4. Facilitating meaningful mathematical discourse
5. Posing purposeful questions
6. Building procedural fluency from conceptual understanding
7. Supporting productive struggle in learning mathematics
8. Eliciting and using evidence of student thinking

For a blended learning environment to work in the secondary mathematics classroom setting, instructors need to ensure that all of these teaching practices will still be present. To show how these practices can be incorporated in a blended learning environment, each of these practices will be briefly explained and an example of what the practice could look like in a blended learning classroom will be discussed.

Establishing Mathematics Goals to Focus Learning

This practice is described as establishing goals that fit within learning progressions and are used to guide further instructional decisions (NCTM, 2014). Whether providing instructional content directly to students or through online content, the teacher should be creating goals that are directly related to the learning task, so this is a teaching practice that in no way should be affected by adding an aspect of learning through an online medium into the classroom. Additionally, the use of a blended learning approach allows for students to have more flexibility in how quickly they progress through learning tasks, so as soon as students accomplish a certain learning goal, they would be able to move immediately on to the next and not need to wait for the rest of the class before moving on.

Implementing Tasks That Promote Reasoning and Problem Solving

This practice centers on the idea of providing students problems that allow for multiple entry points and varied solution strategies (NCTM, 2014). Even when students are learning through an online medium, they can still work on tasks that allow for a variety of ways to approach and solve the problem. Online learning does not mean only taking multiple-choice quizzes on a computer. For example, Illuminations.com provides a wide variety of activities for students to work with concepts and solve complex problems. Discussion boards can also be utilized through the online medium where students can share their ideas and strategies for solving posted problems, so that they can read and respond to other students ideas.

Using and Connecting Mathematical Representations

This practice refers to providing opportunities for students to make connections between various representations of concepts or procedures to deepen the mathematical understanding and use while problem-solving (NCTM, 2014). This can be accomplished for students both when learning online and in face-to-face classroom settings. Students can create and view representations through technology, and even when using technology representations can still be written down on paper. Students could even share how they would mathematically represent a problem with a group or an entire class through an online platform.

Facilitating Meaningful Mathematical Discourse

Students need to be able to discuss their ideas and approaches to solving problems with others, and to be able to argue for or against other students' problem-solving approaches (NCTM, 2014). As previously mentioned, discussion boards offer one way to accomplish this practice that incorporates technology. However, a blended learning environment also is at times a face-to-face classroom, so live classroom discussions can still take place, in which the teacher would be more able to direct and lead the discussion compared to if it was through an online discussion. A specific strategy that has been used in blended learning mathematics classrooms is Khan Academy, which contains "instructional mathematics videos … aligned to practice problem sets and a real-time discussion board" (Cargile, 2015, p. 35). Cargile argues that the features provided by Khan Academy can also be adapted and used by "teachers who strive to improve their craft and who want to blend instruction effectively."

Posing Purposeful Questions

The questions posed by teachers need to be directed towards assessing students' thought processes. These questions should also serve to expand students' abilities to make sense of the mathematical concepts and discover new relationships between concepts (NCTM, 2014). Since an online platform allows for discussion groups or blog postings, the teacher can easily post questions for students to think about or to discuss either individually with the instructor, in pairs, or as groups. One concern may be that if students are working online, the teacher may not always be able to immediately provide the most appropriate questions for individual students. However, when students are in the classroom the teacher has much more time available to work with students individually since they typically will not be using class time to provide full-class lessons. This setting allows for the teacher to provide appropriate questions to individual students based specifically on where they are at in the learning progression and what types of challenges they are facing.

Building Procedural Fluency from Conceptual Understanding

To be successful mathematics learners, students need to have a strong foundational understanding of a concept and then learn how to utilize different procedures based on the type of problem and context (NCTM, 2014). Following this reasoning, learning progressions should be structured so that students do not move on to practicing procedural fluency before deep conceptual understanding is present. For example, Ahmad, Shafie, and Janier (2008) studied the learning of students in an Engineering Math Foundation 2 course using a blended learning method, and the summary of student comments they reported revealed that the various delivery methods of the content allowed them to better visualize the concepts since they had the ability to work at their own pace. These student observations demonstrate that the blended learning environment provided opportunities for students to work with and fully understand the concepts in a more complete way than a traditional classroom may have provided since they could make sure they fully understood the content before moving on.

Supporting Productive Struggle in Learning Mathematics

Teachers need to provide students opportunities to engage in productive struggle both individually and as a group while they work through mathematical concepts (NCTM, 2014). Since the blended learning environment also allows for class time where students can work together on problems, students will also be able to engage in collective productive struggle in groups or as an entire class. Harding, Kaczynski, and Wood (2012) examined calculus students participating in a blended learning course, and the students they interviewed shared that they were more able to participate in cooperative learning, and to support one another as they struggled with concepts and problems. In this setting students were able to both work individually and collaboratively on problems, but the teacher also had the ability to provide immediate feedback and work individually with students.

Conclusion

Even though there is no one standard way to set-up a blended secondary math classroom, by ensuring that the blended setting draws on the strengths of face-to-face learning and online learning, and drawing on best practices in mathematics teaching, instructors can create their own blended model that supports and strengthens student learning By looking at the NCTM Mathematical Teaching Practices, we can see how a teacher can create an effective learning environment for students that encourages them to grow and develop as mathematical thinkers. If anything, these practices can be enhanced through the addition of the online learning component to the classroom, because it gives students additional flexibility and freedom to work at their own pace on the material. Since the blended learning environment still has a face-to-face component, the students also will not miss out on direct instruction from the teacher or on collaborative, face-to-face group work.

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How Educators Can Increase and Improve Family Involvement in Mathematics Homework

Anna Barnes

Abstract: In order to explore the role of parental involvement in mathematics learning, this paper will begin by presenting a profile of a fifth-grade student, here called "Amber," at an urban K-8 public elementary school in Northwest Ohio who was observed during mathematics class throughout the 2017-2018 school year. Amber's academic performance, the role her family plays in her education, and their interactions with educators all are described below. Amber's achievement will be defined through both in-class and homework grades. The amount and quality of assistance she receives from family members during mathematics homework is also discussed, with the goal of determining ways that family involvement in mathematics homework can be improved for this particular student. The goal is to explore the implications and conclusions which can be drawn from this example, with the aim of exploring how family involvement in mathematics homework can be increased and improved.

Scenario

Amber is seemingly attentive during whole-class discussion in my fifth grade mathematics classroom. When a question is posed to the entire class and she is confident in her answer, she raises her hand. Sometimes after raising her hand she puts it down soon after. If I call on her when this occurs, she says she does not know the answer.

After whole-class discussion, I hand out a worksheet and instruct students to complete it independently for a grade. Immediately, Amber raises her hand. She tells me, "I don't get it." I help her think stepwise by asking, "What should we do first to solve this problem?" Amber replies, "I don't know." I tell her to consult the notes she just took. She looks through the unorganized, poorly written notes and slowly figures out how to begin the problem. She asks for clarification and I confirm the first step she has chosen. After walking around the classroom to assist other students, I come back to Amber and find that she is stuck on the second step. She declares again: "I don't get it." I tell her to consult her notes, and the cycle continues.

At the end of class, I give homework out of the textbook, but I know this assignment might be too challenging for some students. The next day, Amber turns in her completed homework and receives an A. In fact, her average homework grade is roughly 90% throughout the year, while her average test grade is approximately 50%.

One of Amber's other teachers reports that Amber receives a great deal of homework help from her mother. However, this teacher and I communicate infrequently with Amber's family. When communication does occur, it is typically initiated by her family seeking advice to help Amber improve her mathematical abilities during the school day. Some of the educators involved in Amber's schooling imply that her family tries *to control too much of what happens in the classroom. Similarly, Amber's family may be over-helping during mathematics homework assignments in an attempt to have more control over Amber's grade.*

Throughout the year I wonder – is the type of assistance that Amber is receiving from her family hindering her achievement? Specifically, is Amber's mother providing too much guidance when assisting with these assignments? Additionally, Amber's classmates may be experiencing various amounts and types of homework assistance from their own families, which may be impacting their performance, for better or for worse. The aim of this manuscript is to discuss the importance of family involvement in mathematics homework, the perspectives of educators and families about family involvement, and to explore potential solutions for increasing and improving the quality of family involvement in mathematics homework.

The Importance of Family Involvement in Mathematics Homework

With the varying levels of family involvement in mathematics homework and Amber's situation in mind, I began my research by considering whether mathematics homework could simply be eliminated. I wondered whether it is fair to administer take-home assignments and grade them when students experience differences in familial help. Students like Amber receive a large amount of assistance from family members, while other students experience little to no family involvement. Some students may also experience higher quality help than others, regardless of the amount of help provided by their families. Ultimately, a graded homework assignment might simply reflect the amount of effective family involvement a student receives – not his or her mastery of the subject. Studying this topic further, I found that much research agrees that mathematics homework is essential to the academic success of students, regardless of the impact family involvement has on students' grades. In particular, the research supports the use of effective homework assignments coupled with effective family involvement.

For example Knapp, Landers, and Liang (2016) discovered that when homework was combined with effective family involvement – in this case, fostered by using mini-courses attended collectively by students, families, and teachers – student achievement via standardized test scores increased. Additionally, the mini-courses promoted positive student, teacher, and family interactions, thereby increasing enjoyment for all involved. Further, students who experienced more enjoyment from homework and saw the adults around them doing the same were found to have increased motivation to perform the tasks. The learning that occurred during the mini-courses empowered both students and their families and improved the sense of community surrounding the educational system. This type of homework intervention allowed families to feel better connected with educators because there were more opportunities for cooperative communication between school and home. Increases in student enjoyment, motivation, empowerment, and a sense of community resulted in enhanced academic success and improved standardized test scores,. Students who participated in the mini-courses better met learning objectives and had improved attitudes towards school. Since involving families in mathematics homework has the ability to improve both student achievement and attitudes, elimination of these types of assignments is out of the question.

Educator and Family Beliefs About Family Involvement

Although the combination of family involvement and mathematics homework can promote student success, educators often do not effectively apply homework tasks to foster family involvement and meet these goals (Lopez & Donovan, 2009). This may be because many educators believe that some families are simply uninterested or fail to prioritize their children's education (Lopez & Donovan, 2009; Hem, 2017). Following this logic, if families do not demonstrate interest in helping their children, why bother trying to force involvement? Ironically, some of the educators described in the scenario above not only believe that some families do not care about their children's education, but also view Amber's family as being too involved and attempting to control what happens in the classroom. From those educators' perspectives, there seems to be no correct way for a family to be involved. The negative feelings that educators often have about families take a toll on their interactions. Consequently, family involvement in mathematics homework is negatively impacted.

Despite the beliefs of some educators, most families perceive their own involvement in mathematics homework as important. Drummond and Stipek (2004) found that families "rated the importance of helping their child with academic work very high" when interviewed (p. 197). Although not all families place their children's education as the first priority or are completely dedicated to helping with mathematics homework, educators often misjudge families' interest in involvement. This may be due to Drummond and Stipek's (2004) finding that families who do not have adequate resources, mathematical knowledge, or confidence in their mathematical abilities can face "difficulty turning their beliefs into specific behaviors" (p. 210). Even though families wish to be involved, they often do not know how to contribute effectively. As a result, the ways that families are currently involved in mathematics homework are not always beneficial to students.

There is a dissonance between the beliefs of educators and families. In addition to the factors listed above, a lack of communication with the school can further alienate families from providing effective support as their children complete their homework. Some families provide inadequate help or feel they are not qualified to help. It is our job as educators to take the initiative to communicate with families about mathematics homework and bridge the gaps between school and home. We must suggest strategies that will provide more meaning to children's mathematical experiences by effectively collaborating with families.

Solutions for Increasing and Improving Family Involvement

Educators can apply specific techniques and tools to increase and improve the quality of family involvement in mathematics homework. As a starting point to increase the amount of family involvement, simple verbal or written prompts from teachers or students have been successful: families are more likely to get involved in homework when they are explicitly asked to do so (Balli, Demo, & Wedman, 1998; Drummond & Stipek, 2004). Additionally, educators should consider whether homework tasks invite families in or push them away. Problems that involve specific mathematical procedures unique to a certain class or teacher may be foreign to many families. In these cases, it would be helpful to prompt families not only to help, but also to suggest how to help by providing them with the necessary procedures. Drummond and Stipek (2004) further suggest that educators teach families "the difference between assisting their child in completing work and telling their child the answers" (p. 211), to promote higher quality homework help. This idea is important for parents like Amber's, who may be over-helping with the aim of improving their daughter's grade, but at the cost of Amber's own development of problem-solving skills. Educators can teach families to ask their children probing questions instead of providing answers. If a child says that combining two numbers is necessary to solve a homework problem, a family member may ask, "What is it called when you put two numbers together?" instead of saying, "Yes, so add the numbers." When families tell children what to do mathematically, they do not provide opportunities to children for independent thinking, but they may not understand this unless educators provide them with guidance.

Another method that educators can share with families is to use children's incorrect homework answers as a "lens" for their misconceptions (Lopez & Donovan, 2009). For instance, a teacher may send newsletters home describing the most common errors students made during each unit. An answer of 5 to the problem 2 + (-3) can reveal that a student disregarded the negative sign and simply added the numbers together. Once families have discovered errors in their children's ways of thinking, misunderstandings can be explicitly addressed. In this scenario, a family member may prompt the child with, "Pay attention to the negative sign. What does it tell you to do?" anticipating that his or her child will answer, "Take away," and thus be guided to realize where they had made a mistake.

Educators can propose these suggestions for improving family involvement during "meet the teacher" night, home visits, and parent-teacher conferences (Drummond & Stipek, 2004). Additionally, mathematics clubs, family math nights, and evening family classes are all ways that families can learn both assistive strategies and mathematical content in order to better help their students with homework (Drummond & Stipek, 2004; Knapp et al., 2016; Lawson & Hodge, 2016; Lopez & Donovan, 2009). During any of these times, educators can also specifically ask families what resources they need in order to help students with mathematics homework more effectively (Drummond & Stipek, 2004). Families can also be informed about neighborhood resources such as tutoring centers and libraries for additional support available to them (Drummond & Stipek, 2004; Sad, 2012). Families will be able to provide higher quality help when they are more confident in the material and their own abilities to assist their students.

Conclusion

Some educators believe that involving families in education is important. Others see family involvement as an intrusion into their classrooms. Still others see family involvement as important, but believe that some families are not interested in being involved in their children's education. Moreover, when communication is difficult, typically educators quickly give up on making attempts to collaborate with family. However, research has shown that families think their own involvement in children's education is important, but that they often lack the appropriate resources to successfully get involved, including relevant mathematical knowledge and confidence in their own mathematical abilities, and therefore may not provide much valuable homework help. The conflicting beliefs of educators and families can be resolved through the application of the evidence-based practices outlined in this paper. Families can learn to apply a variety of assistive strategies, such as asking probing questions and using incorrect answers to learn about students' misconceptions. Educators can supplement mathematics homework and promote more valuable family involvement by prompting family members to help children with mathematics homework; by encouraging families to engage in mathematics activities during meet the teacher night and home visits; by providing families with advice at parent-teacher conferences, mathematics clubs, family math nights, and night classes; by recommending neighborhood resources; and by asking families what additional assistance is needed (Balli et al., 1998; Drummond & Stipek, 2004; Knapp et al., 2016; Lawson & Hodge, 2016; Lopez & Donovan, 2009). Implementing some of these techniques can help ensure that families feel less alienated and have a better understanding of how they can help their children. Communication between school and home will drastically improve as families and educators begin to feel more comfortable with each other.

The evidence-based practices discussed in this paper can be applied as potential solutions to the issues Amber experienced. One problem that Amber faced was that teachers did not frequently communicate with her family. Based on the findings outlined in this paper, a possible solution would be for the school to apply an intervention, such as a family math night, in order to promote communication between Amber, her family, and her teachers. This would provide opportunities for the family and teachers to see each other's perspectives and reach compromises about how to help Amber with her education. Amber's teachers and family members could come to realize through this intervention that they all have her best interests in mind. And of course Amber would not be the only student who benefitted from such an intervention.

The other issue that Amber faced was that she received a great deal of mathematics homework help from her mother, but the quality of that help seemed to have a lot of room for improvement. A conference could be set up so that Amber's mother could learn assistive strategies, such as the use of probing questions, from Amber's teachers. This would allow Amber's mother to ask questions during homework that would eventually lead Amber to the correct answers, but would ensure that the thinking done would be largely Amber's own. In this way, Amber's mother would learn how to better assist her child with mathematics homework instead of giving her the answers. Using these suggested strategies, educators could work with Amber and her family in order to improve the quality of homework help she received, as well as to increase her comfort in school and her academic success.

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The Teacher's Role in Students' Math Anxiety

Rebecca S. Birchall

Abstract: It is a well-known fact that math can become a disliked subject once students begin to approach more complex topics. Students associate anxiety with the subject and their confidence decreases as a result. This unpleasant emotional response prevents students from successfully learning math. Educators need to dismiss this apprehension towards mathematics. Each teacher has their own way of looking at mathematics. The question is, how do we accomplish this anxiety reduction when all teachers perceive math differently? Teachers' attitudes towards math can also have an enormous effect on how their students will perceive math. How much do educators' perceptions of their own subject positively or negatively affect mathematical anxiety?

Introduction

It is commonly accepted that math is a subject that is not embraced by a good majority of the population. To many, "math" is a scary word. When one person tells another that she enjoys math, there is a common response of almost disgust. "People are very happy to say they don't like math. No one walks around bragging that they can't read, but it's perfectly socially acceptable to say you don't like math" (Beilock, Gunderson, Ramirez, & Levine, 2010). But why is this? Why does math have such a negative stigma? This negativity only intensifies when the curricula gets more complex in the upper grades. Frequently, students associate anxiety with the subject and as a result, their confidence decreases. This apprehension can be deeply ingrained in educators as well. It is our job as educators to implement effective strategies to positively change students' outlook on the subject. However, teachers must first examine the relationship they have with mathematics. Educators must understand how this relationship affects their students' outlook on the subject and, in turn, their performance. In other words, educators must look at their own comfort with math and mitigate any of their own issues before teaching the subject, in order to not create more anxiety in their students. Otherwise teachers' own math anxiety can in turn create an avoidance of math altogether from their students.

In our culture there is a stigma attached to women and math which keeps them from attempting math careers. Why is this? Do teachers have the ability to help our female students change their outlook? It is hard to motivate one's students on any given day. It is even more difficult to help students when there is a stigma against a subject. How far does their anxiety go? Teaching mathematics needs to overcome the many negative perceptions. It is important to take these perceptions into consideration and work through these hurdles to best benefit our students. In order to do this we also need to untangle the difference between disliking mathematics and having anxiety of that dislike; we need to do this for both teachers and students.

When teachers indicate their own discomfort toward anything, students often pick up on these unspoken cues. And such math anxiety is pervasive: "Math anxiety functions as a disability in the sense that there are well investigated—and negative—personal, educational, and cognitive consequences of math anxiety. Unfortunately, these negative consequences affect a substantial percentage of the population" (Ashcraft, & Moore, 2009, p.198). This anxiety can have a major impact on the different views a teacher has about different subjects. If a teacher shows a dislike for math even as they teach it, students will begin to avoid pursuing the subject.

A lack of self-efficacy often begins to become a problem with students in math early on. It pushes the students to retreat and avoid the subject all together. These students can also form a learned helplessness toward the subject. Methods need to be put in place to help keeping students from developing these feelings. But, exactly how much does math anxiety affect overall performance in a student? And how much do teacher's feelings about math impact their students' performance?

Educators' Impact

Just as many students have anxiety about math, so to do many teachers. Each teacher has their own way of looking at mathematics. Educators' need effective methods need to fully accomplish the students' needs. The question is, how do we accomplish this phenomenon when all teachers perceive math differently? Educators have to find a common "math-culture" in their classroom that is healthy and comfortable for all students, and for themselves as well. A certain type of positive discourse needs to exist in each classroom. Teachers are to support and encourage our students, while creating a safe space for mathematical conversations and discovery. It is also important for teacher to find a support system for themselves and take advice from fellow math teachers that perhaps feel more comfortable about the subject. This will help boost the confidence of educators who were once apprehensive towards teaching math. This is a step in the right direction to reduce the anxiety a student may feel, as well as their own.

The evidence is strong that the vast majority of students lack this confidence. "Internationally, on average only 14 percent of eighth grade students expressed confidence in their mathematics ability" (Mutawah, 2015, p. 242). And there are strong relationships between this lack of confidence and students' performance in math classes. The saying, "we are our own worst enemy" rings true in this case. Because students' mathematical achievements are negatively affected by their own perception of how well they are at math, we must help distinguish between students not understanding math and thinking they do not understand math. It is a tough concept to think through as a teacher. Our own worries can show through and, in turn, create new worries for our students. There needs to be a positive approach to the curriculum so we can show the students it is okay to have an incorrect answer; just as long as we work together and learn from it. Educators have more power than they think when dealing with students' receptiveness to a content.

Gender Influences

If we look at the percent of female elementary teachers versus male, we find female elementary school teachers make up 87% of our educators in the country, leaving males with the remaining 13% (The World Bank Group, 2018). And because of the cultural factors mentioned earlier, a large percent of those female teachers themselves have math anxiety. The effect of having female teachers who have math anxiety as role models has been found to contribute to the gap between male and female achievements in math. Gender performance differences can arise when female elementary school teachers convey they are not successful at or comfortable with math to their students.

Because elementary educators are not required to have much mathematical mastery in order to attain certification. Ironically, these females often have the highest levels of math anxiety out of any college major. The problem with this reality is that children are more likely to emulate the behavior and attitudes of same-gender vs. opposite-gender adults (Beilock, Gunderson, Ramirez, & Levine, 2010). Thus, math anxiety regularly begins earlier for girls than for boys due to the anxiety their female teachers possess in elementary school. Beilock, Gunderson, Ramirez, and Levine found that the more math anxiety a female teacher had, the lower her female students' math achievement would be, and the more math anxiety those female students would develop. "Teachers with high math anxiety seem to be specifically affecting girls' math achievement—and doing so by influencing girls' gender-related beliefs about who is good at math" (Beilock, Gunderson, Ramirez, & Levine, 2010, p. 1861). They found that this specifically played out in that "[f]emale teachers model commonly held gender stereotypes to their female students through their math anxieties" (Beilock, Gunderson, Ramirez, & Levine 2010, p. 1861).

Another relationship to consider when dealing with gender is self-efficacy. Self-efficacy is the belief in oneself of achieving academic goals set for oneself. According to Vakili and Pourrazavy (2017), the variables of self-confidence, learning self-efficacy and emotional self-efficacy are respectively the strongest predictors of mathematics anxiety in students. The more self-efficacy one has, the more she will achieve. Studies have found that the self-efficacy of male students is generally greater than that of female student, and that test anxiety in female students is higher than for male students. This offers another reason as to why females could be affected more than males. In fact, the research suggests that students "goal orientations" and self-efficacy "can predict about 45 percent of math anxiety" (Vakili & Pourrazavy, 2017, p. 757). Thus, a lack of self-efficacy is a strong indicator of a student's probability of having some sort of anxiety when dealing with mathematics.

Society has also built up a stereotype that females are not good at math. This assumption alone can create this lack of self-worth in female students. Children are typically aware of this stereotype as early as second grade, and it can begin to affect their academic success even at that age (Sorvo, et al., 2017, p. 321) According to Vakili and Pourrazavy (2017), "[t]he notion that math talent is innate, boys perform better in math than girls, or [that]math is a logic course" affects the performance of female students (p.760).

Remedies

A teacher's understanding of creating mastery-oriented classrooms can help them to prevent or reduce the anxiety students experience learning mathematics. As students increase in age from grade 4 to 12, generally their math scores begin to decline. Some research has suggested that creating a better environment in the math class can help alleviate some math anxiety. Thus as teachers move into more complex material, they must introduce it in a calm manner in the classroom. This can include using dim lighting, but more importantly requires both modeling and developing positive attitudes toward math. It is also very important to keep the math classroom as low-stakes an environment as possible (Ashcraft, 2009). Cohen (2017) found that students that were less anxious were more likely to have positive attitudes toward mathematics, such as enjoying mathematics and liking their mathematics teachers. The study also found the opposite, that students who were more anxious had extremely negative attitudes towards the subject. Therefore, it is important to teach every math lesson with a positive attitude and to promote healthy discourse in our classrooms.

Not only can the attitude a teacher has towards mathematics affect the way students may perceive math, but so to can the way in which they teach the content. Newstead (1998) studied children from ages nine to eleven. She compared the mathematics anxiety of pupils taught in a traditional manner with pupils whose teachers adopted an alternative teaching approach emphasizing problem-solving and discussion of pupils' own informal strategies. The "traditional" approach, in contrast, uses standard, pencil-and-paper methods of computation, and typically uses teacher demonstration followed by individual practice. The alternative approach asked students to develop and discuss their own strategies for solving word sums, which became the principal vehicle for learning. Students worked in groups and came up with different conclusions and shared their findings with one another through conversation. Solving non-routine problems and discussing strategies in small groups was of primary importance. Students learning through this discourse-centered approach had lower math anxiety and improved performance.

Conclusion

Mathematics is a vital subject for everyone. We must make sure not only that our students see this, but that their teachers do as well. It is easy for a student to sense a tense atmosphere due to the teacher feeling negativity towards mathematics. Thus, the more ease we make our students feel about mathematics, the better everyone will be. Students depend on their teachers to create a healthy discourse when teaching any subject. We must teach to promote self-efficacy in all of our students. This can begin with confident teachers.

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Proof and Discourse in Mathematics Teaching for Competency

Bratche A. Eldred

Abstract: Recent changes to the standards for mathematics education have shifted focus towards the importance of proof, reasoning, explanation, all of which are essential components of understanding, recording, communicating, and doing mathematics. Yet research continues to show that American students (high school and beyond) struggle to understand the idea of proof in mathematics. The research demonstrates the importance of teaching mathematics through the lens of proof, and how meaningful mathematics discourse can be the catalyst for learning mathematical proof. Evidence shows that students become more capable learners and doers of mathematics when they understand and can construct mathematical proofs. Additionally, research shows that through engaging in mathematical discourse, students can learn the process of developing mathematical arguments more effectively.

Introduction

Historically, proof has been confined to a small corner in high school mathematics, only showing up regularly in geometry classes. Proof, however, is considered an essential component of understanding, recording, communicating, and doing mathematics (Knuth, 2002; Martin, McCrone, Bower, & Dindyal, 2005). Unfortunately, research also has shown that American students at the high school level and beyond struggle to understand proofs in mathematics (Martin, McCrone, Bower, & Dindyal, 2005; Miyazaki, Fujita, & Jones, 2017). With American students ranked just 38th globally in 2015 for mathematics achievement, nine spots below the OEDC average (DeSilver, 2017), it is time for us to take a serious look as to when, where, and how we teach proof in mathematics.

One method which has been proven to develop students' abilities to complete and understand proof in mathematics is engaging students in mathematical discourse. Stylianou & Blanton (2011) link the ability to argue mathematically to well-organized classroom discourse. Such mathematical argumentation lays the groundwork for mathematical proof, because through argument students explain, justify, and rationalize their answers to questions. Therefore it is essential that teachers facilitate meaningful mathematical discourse in their classrooms. Far too often though, students in the United States are not provided with opportunities to engage in meaningful mathematics classroom discourse (Ryve, Nilsson, Pettersson, 2013).

This paper highlights the importance of teaching mathematics through proof, and explores how fostering meaningful mathematics discourse can enable students to gain competency with proofs and proving techniques. Additionally, it will argue that it is important that proof and discourse take place at each grade level and in each mathematical domain (e.g. algebra, geometry, trigonometry).

Proof

When

Jerome Bruner, a renowned 20th century educational psychologist, argued that any subject can be taught with a degree of rigor to any student at any stage of development. This notion underlies the idea of the "spiral curriculum," in which students revisit a concept at various points throughout their schooling, with increasing complexity; through this spiraling new learning is connected to old (Gibbs, 2014). While many concepts in math are generally taught following a spiral curriculum (for example, functions are introduced early, then revisited), proofs have somehow been left out of the early grades, and even in secondary school, aside from geometry. As Hung-Hsi Wu (cited in Knuth, 2002) states, one "glaring defect in present-day mathematics education in high school" is "the fact that outside geometry, there are essentially no proofs." According to Wu, this "presents a totally falsified picture of mathematics itself" (p. 228). With so few experiences with proof, it is no surprise that many secondary mathematics students find the study of proof difficult (Knuth, 2002).

The struggles students experience when studying proof need not be so great. Applying Bruner's idea of "readiness to learn" along with appropriate scaffolding, even the youngest students can be asked to provide simple justification and explanations for their mathematical work. Since proof is a process of arguing, questioning statements, and using evidence appropriately, when young students are challenged to justify and defend their work they will be more prepared for the rigor and variation of the proofs that can be expected at the secondary, and even post-secondary, level (Stylianou & Blanton, 2011). The techniques used in younger grades may not appear to be 'proofs,' but any time students are challenged to explain their work, communicate their ideas, or critique their misconceptions, they are developing the reasoning skills that will be applied to more rigorous proofs later on.

Where

Just as proof, or some form of reasoning or explanation, should be required of mathematics students at all grade levels, the same requirements should be in place across the various branches of mathematics (Gonzalez & Hinthorn, 2003). One explanation for why proof has historically been contained to geometry is that the foundation for geometric proof is given in geometry classes, including postulates, axioms, definitions, and theorems. This is in contrast to the traditional Algebra class, for example, where the foundational properties -- such as field properties, properties of equality, and properties of real numbers -- are not formally given or explored with students, (Gonzalez & Hinthorn, 2003). If we equip our students with the rigorous tools of the discipline of mathematics, not only in geometry, but all areas of math, the students can then be given rich mathematical tasks that require them to justify their solutions and gain experience with mathematical proof, in any branch of mathematics at any grade level (Knuth & Elliott, 1998). Proof can no longer be contained to just geometry, because it has been upgraded to be its own standard in recent curriculum legislation, rather than being linked to a specific content domain

(Knuth, 2002; Council of Chief State School Officers, 2010). For this reason it is paramount that we provide our students opportunities to engage in rich, thought provoking proofs throughout each subject in their mathematics education.

How

This section attempts to answer the question of how teachers should select proofs which will provide meaningful understanding for students across grade levels and mathematics subject areas. The research presented will explain the nature of the proofs, or proving techniques, teachers can employ in their classrooms that will most enable their students to gain significant conceptual understanding, regardless of grade or mathematical domain (i.e. pre-algebra, geometry, calculus, etc.).

Knuth (2002), mathematics education researcher, suggests an approach that attempts to solve, or at least to mitigate, the problems surrounding teaching and learning proofs. In his work, Knuth examines the pedagogical function of proofs and their explanatory nature. He states:

> Mathematicians recognize that the primary role of proof in mathematics is to establish the truth of a result; yet perhaps more important, particularly from an educational perspective, is their recognition of its role in fostering understanding of the underlying mathematical concepts (p. 478).

This notion of 'explanatory proofs' is what Knuth and other mathematics education experts credit as the most valuable learning and level of understanding of mathematics (Weber, 2003). As Hanna (as cited in Knuth, 2002) explains:

> True understanding demands that students see why it is the case, and furthermore why it must always be the case, and this understanding is best engendered by explanatory proofs.
>
> A proof that proves:
>
> Prove: The sum of the first n positive integers is $n(n + 1)/2$.
>
> For $n = 1$ it is true, since $1 = 1(1 + 1)/2$
>
> Assume it is true for some arbitrary k, that is, $S(k) = k(k + 1)/2$. Then consider:
>
> $$\begin{aligned} S(k + 1) &= S(k) + (k + 1) \\ &= k(k + 1)/2 + k + 1 \\ &= (k + 1)(k + 2)/2 \end{aligned}$$
>
> Therefore the statement is true for $k + 1$ if it is true for k. By induction, the statement is true for all n (p. 8).

Hence, as teachers, we must enable our students to be exposed to a variety of proofs and proving techniques that allow for an explanatory element in order for significant understanding of the underlying concepts to take place. Above is a proof which illustrates the nature of explanatory proofs.

This is one example of a proof with a variety of ways to explain and justify the underlying mathematical principle. It is then the responsibility of the teacher to select those problems in which their students will be exposed to explanatory arguments and counterexamples. This challenge need not be so great. Educational researcher Russo (2018) identifies 3 principles for developing explanatory 'proof-type' problems. His work focused on teaching proof in primary grades and his principles can be applied at any grade level, for any branch of mathematics.

For his first principle, Russo (2018) states that, "The problem should be worded as a statement, followed by a follow up question. 'True or False? Prove it'" (p. 35). Presenting the problem as a conjecture which can be proven or falsified is the first step in forcing students to take a side and begin gathering evidence to support their claim. This method is in stark contrast to traditional methods of posing mathematics questions (Russo, 2018). The second principle states, that the "mathematical knowledge required to engage productively with the problem is accessible to most students beforehand" (p. 35). The nature of any proof-type question is cognitively challenging, especially for students with little proof-making experience. Since proof-like arguments often require a synthetization of various mathematical ideas and principles, it is important to ask questions that the students have the tools to answer. Finally, principal three states that an "important mathematical idea should lie at the heart of the problem" (p. 35). This is the stage in which teachers consider how to take concepts their students know and work them into a problem that will help them transition to understanding the principles which make the property or principal valid (Russo, 2018). This can be accomplished in a variety of manners, such as discovery-based problems, visual representations of arguments or principals, and in group presentations. Following these three principals, and keeping in mind the importance of having an explanatory nature, teachers can create meaningful opportunities for students of all ages, in any branch of mathematics, to engage with proof and proving techniques.

Once the material is selected, the next question is, "How should it be taught?" Insight as to how teachers can orchestrate lessons which provide their students opportunities to engage in a variety of meaningful proof investigations will be provided in the next section of this paper.

Discourse

When

The importance of meaningful discussion in mathematics has been clear for some time now, with the overwhelming majority of the research demonstrating the benefits of discourse in mathematics education, especially as it pertains to understanding and constructing proofs (Knuth, 2002; Mueller, Yankelewitz, & Maher, 2012; Russo, 2018; Ryve, Nilsson, & Pettersson, 2013; Stylianou & Blanton, 2011; Weber, 2003). Furthermore, the importance of allowing young, primary school students opportunities to engage in meaningful mathematics discourse is also well-supported by research (Mueller, Yankelewitz, & Maher, 2012; Russo, 2018; Ryve, Nilsson, & Pettersson, 2013). Therefore, it is important that students be given opportunities early on in their education to discuss the mathematical ideas they are presented with in order for them to begin to formulate an idea for what mathematical argumentation is and is not. This knowledge of argumentation, born from discourse with classmates, teachers, and even themselves, is the groundwork for understanding and constructing mathematical proof (Stylianou & Blanton, 2011). This is not to say, however, that one should expect the same level of complexity in conversation, reasoning, and argumentation from a third grade class as one would a ninth grade class, but rather that teachers must consider students' readiness to learn and tailor discussions and activities to meet their students at an appropriate level of rigor and difficulty (Russo, 2018; Stylianou & Blanton, 2011).

Where

Again, as with proof, discourse should be taking place in a variety of mathematical courses. Mueller, Yankelewitz, and Maher (2012) studied students engaging in discourse related to a variety of mathematical applications (including geometry, probability, and arithmetic) and concluded that "the reasoning that emerged from their shared discourse was useful in the formation of each student's individual understanding" (p. 384). Regardless of the specific mathematical subject being taught, students should be provided with opportunities to collaborate, share, discuss, and engage in all other manners of discourse in order to develop a deeper personal understanding of the content which will be required to complete mathematical proofs.

How

We now seek to answer the more challenging question of how teachers can utilize discourse to assist their students in understanding and constructing explanatory proofs across grade levels and mathematical domains. A problem many teachers encounter when teaching proofs is students' instincts to develop empirical arguments, or to rely on a small set of examples to verify or disprove a conjecture (Stylianou & Blanton, 2011). Of course, sound mathematical proofs need to be generalized, to hold true for infinite iterations. So how do teachers assist their students in transitioning from empirical arguments to more general, explanatory proofs? For simplicity's sake, imagine a lesson in which students work in cooperative groups to complete an explanatory proof (the manner of instruction doesn't matter). In these cases, the use of "transactive prompts," a practice in which the instructor repeatedly asks for clarifications, explanations, criticisms, and elaborations has been shown to assist students in constructing more comprehensive and valid arguments (Stylianou & Blanton, 2011). This practice can be employed regardless of the manner of instruction and will assist in developing deeper content knowledge if appropriate proof-type problems are assigned. As Stylianou & Blanton (2011) explain, "This type of discourse then became the avenue by which students learned to construct proofs" (p. 144).

The role of the teacher as a facilitator and provider of structure is also important in the process of mathematical discourse. Teachers can support the direction of students' thinking, organizing involved summaries of discussion, pacing the classroom conversation, and redirecting the focus of students' ideas and thinking as necessary (Stylianou & Blanton 2011).

Finally, it is important that the teacher maintain accountability amongst their students. The idea of fostering meaningful discourse is not to simply present ideas, but rather that the class should engage in scrutinizing and critiquing the reasoning and logic presented in arguments. As explained by Stylianou & Blanton (2011), students:

> propose ideas that, once approved by the group, will become part of a common culture and, subsequently, building stones of future proofs. Thus, it is the group's responsibility to vet these proposed ideas, examine them, and take full responsibility for accepting them (p. 144).

The need for accountability lies with the whole group. It is the teacher's responsibility to maintain and challenge the accountability of the class.

Conclusion

Teachers must understand the importance of teaching proof from the early grades on, across the various branches of mathematics, in a manner which attempts to explain a mathematical idea. Additionally, teachers should be aware of the benefits that utilizing discourse strategies has on learning to construct and understand mathematical proof. Proof-type questions should be of an explanatory nature and offer students a variety of ways to express their mathematical ideas. When engaging in classroom discourse, the instructor should be utilizing transactive prompts, providing structure for and facilitating conversations, and maintaining the accountability of the class in regards to their arguments.

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What is Error Analysis, and How Can It Be Used in a Mathematics Classroom?

Tyler Mallue

Abstract: Everyone makes mistakes, but the important part of mistake making is learning and growing after having made the mistake. Mistakes can reveal a lot about the thinking process, and this is valuable information for educators. Instead of treating mistakes as negative events in a student's progress, they can instead be thought of as helpful and critical tools in the learning process. The important question to answer is how teachers can use student errors to successfully create learning opportunities for their students. Teachers can use error analysis in several ways, to diagnose misunderstandings, initiate discussions, and as a starting point for revealing and clearing up misconceptions. Error analysis can create unique learning opportunities for students and should be utilized by teachers.

Learning from Mistakes

I once observed a 7th grade mathematics classroom with varying levels of student achievement. The class started out with a review of the previous night's homework. In other classrooms I had observed, students would typically ask few to no questions at all about problems they missed. This classroom was different, however; here the students were raising their hands left and right to volunteer their mistakes! First, the teacher would ask the student if they knew what they did wrong. If the student was unsure, the teacher would invite the student up to the board to show the work they had. Once the problem was up on the board, the teacher would invite the other students to analyze the error they had made. Other students would then raise their hands to explain what they thought the student had done wrong. The teacher would facilitate the discussion in the class and allow students to reach their own conclusions about where the mistake had been made. The teacher would also provide prompts to students if the discussion stalled, such as "What would happen if the student had done this…?" I was amazed at how, given the right setting, students were able to brush off the negative stigma of getting a question wrong so that they could learn from their mistakes. At this moment I knew I had to learn more about error analysis so I could incorporate it into my own classroom.

Defining Error Analysis

Radatz (1979) was one of the first researchers to look at error analysis in the mathematics classroom. Radatz defined error analysis as specifically looking at the arithmetical errors a student makes and trying to analyze what went wrong with the student's information processing. Radatz looked at error analysis purely from a diagnostic perspective; that is, looking at student errors as a teacher and figuring out what they revealed about where students need the most help. While Radatz was the first to formally describe doing this in his research, this concept is nothing new to any teacher, as many use formative assessments to take note of where students are struggling and how to adjust instruction based on the errors made in the student work. If teachers do not pay attention to student mistakes and what they mean, those teachers will have a harder time diagnosing learning difficulties in their students.

Analyzing these errors gives the teacher an area of focus of where their students are struggling. For example, the patterns of errors that a teacher may notice include errors in understanding spatial relationships, errors due to language difficulties, and errors due to the misapplication of rules. Finding out which of these (or other) categories a students' errors falls under makes it easier for the teacher to come back to an individual student and help them understand where they went wrong in a productive way.

While Radatz (and many teachers) focused solely on the diagnostic power of error analysis, error analysis takes on multiple forms. This article will discuss the importance of and ways to use each form, in the service of empowering students to use discourse in the mathematics classroom in order to master mathematical concepts.

The Springboards of Discourse

Many teachers already know the benefit of looking at student errors without labeling it as "error analysis." Once we focus in on error analysis as a specific concept and practice, however, we can look deeper into how it can be used to further mathematical learning. Borasi (1987) suggests not only that student errors can be used for a diagnostic purpose, but that they can also be used by the students to create discussion. In Borasi's research, students were expected to discuss different types of errors with one another in class instead of just solely correcting their errors and keeping their reasoning to themselves. This in turn created vibrant discourse among students in which the teacher's role became that of a facilitator as the students worked together through what went wrong in one another's work. Borasi explained that teachers should "make use of the potential mathematical errors, both as springboards for problem solving and problem posing and as a grist for critical thinking on the nature of mathematics itself" (p. 2). Errors spark a cognitive dissonance in the mind, and individuals are motivated to relieve the discomfort of that dissonance by fixing the error. Students are thus naturally motivated to correct incorrect work once they are able to move past the negative stigma surrounding errors in the classroom. This type of discourse surrounding errors precisely matches the atmosphere I saw in my initial observation.

In another study, Borasi (1994) set up a quasi-experiment in which students partook in a math class that was treated like a humanities class. At the conclusion of the activities, students were asked to remark on how they felt the learning of the material was affected by error analysis. Borasi found that students had gained a new appreciation of the field of mathematics, and many commented that they had never known that mathematics could be treated like humanities classes, with discussions flowing back and forth. Borasi also found that students were able to grasp some significant mathematical concepts through the use of error analysis. They were able to see their own mistakes and attach meaning to those mistakes which was then readily remembered. Students that discuss what they are thinking through discourse are able to practice articulating their ideas and to think about whether their reasoning makes sense, as well as to challenge and support one another in doing so. The climate in which this educational discourse takes place is much different than the traditional mathematics classrooms that have students learn procedures, take notes, and practice problems. This type of discourse requires a rethinking of what a mathematics class can be.

Lerman (2000) argues that this cultural change in the math classroom is already happening. He explains that there has been a shift in mathematics education from the transmission of mathematical knowledge to a cognitive focus on student thinking, which is ultimately good news for proponents of error analysis. In part this shift has come about as a response to an ever-changing global market in which U.S. math scores have slipped behind other world powers, which has led to the adoption of a more cognitive approach, following the lead of those other countries. As a result, mathematics classrooms are becoming more centered on how students make math meaningful to themselves, rather than on just the transfer of knowledge through the memorization of equations and rules.

Similarly, Eggleton and Moldavan (2001) specifically examine how error analysis can make discourse in the mathematics classroom meaningful to students. They found that students who work through their own errors were better at recognizing misconceptions in their work later in the year. When students are pre-taught misconceptions, they will not always remember to avoid the same mistakes when taking an assessment. However, these researchers found that when students look at their own mistakes and misconceptions, they attach meaning to that learning because they are learning from their own errors. Not surprisingly, students who worked with analyzing their own mistakes performed better on a follow-up assessment than those students who were warned about misconceptions independent of error analysis.

Eliciting Errors

In order to arrive at the kinds of learning-nurturing discourse described above, students need to make meaningful errors that make visible their misconceptions or misapplications of concepts. To do this, teachers can use a technique developed within the framework of error analysis by creating error-eliciting questions. Lim's article "Error-Eliciting Problems: Fostering Understanding and Thinking" (2014), focuses on creating discussions from problems that are designed specifically to challenge students and to encourage them to make errors. The article explains that showing students common mistakes through their own experience can be a great start for students to understand mathematical concepts at a deeper level. Lim defines an error-eliciting question as a "mathematical task[]… designed specifically to bring forth among students common mistakes pertaining to a particular mathematical concept" (p. 107). Lim described three different types of tasks that can elicit an error. These include tasks that elicit a misconception, tasks that elicit a misapplication, and tasks that elicit an overgeneralization. All three types of tasks are specifically designed to elicit errors from students that show their misunderstandings, and all three of these tasks can be used to create discussions centered on the errors that students make. When a teacher tries to teach against a misconception in a conventional way, such as by describing the misconception to their students, the student may not develop a meaningful understanding of that misconception. Lim's argument is that the error-eliciting questions can show the student their misconception firsthand and allow them to address the misconception in class before any assessment will take place.

There is now a general three tiered framework in which teachers can use error analysis in their classrooms. The three tiers include the use of error analysis for diagnostic purposes and for the fostering of discussion, and the use of intentional error eliciting to stimulate discussion and learning. Teachers should use the diagnostic side of error analysis to check student progress and remediate any lingering misconceptions. They can also use the diagnostic side of error analysis to evaluate the effectiveness of their lessons and where some conceptual holes may lie. Teachers should use the discussion side of error analysis to create rich discourse in their classroom, so that students are able to address their mistakes explicitly and turn the negative experience of making an error into a positive learning opportunity for themselves and for other students. To create these discussions a teacher may turn to the use of error-eliciting questions, which offer a starting point from which to talk about common misconceptions students have. These three methods make up the totality of what error analysis can look like in a mathematics classroom.

The Importance of Error Analysis

Teachers have a limited amount of time to make their instruction the most effective for their students. Error analysis deserves a chunk of time in the mathematics classroom because of the important discourse it will bring about. The research on error analysis does not lay out one correct way of performing it, but allows teachers flexibility in how they utilize this instructional device. Teachers can therefore tailor their error analysis to fit the diverse needs of their own students.

In Borasi (1996) states that "it is necessary that a compatible learning environment be established in the classroom. Among other things, this may require a change in emphasis from "product to process" (p. 7). This means that for error analysis to occur there must be an attitude of acceptance towards student errors and students must not be afraid to share their mistakes with their peers and their teacher. While this change in student attitudes towards errors may take some time to establish, the payoff will result in deeper conceptual understanding for students and unique learning opportunities that they would not have if they did not analyze their mistakes.

Supporting this attitude toward making mistakes, Kapur (2014), examined whether students would learn mathematical concepts better if they were first taught how to perform the operation or if they were first allowed to try to problem solve without any formal guidance. Kapur found that those who were allowed to problem solve first had a better conceptual understanding of the mathematics, and he also found those students learned from their errors in problem solving. The implications of this study again point towards "productive struggle" as being important for students as they learn mathematical concepts. Teachers, therefore, need to start letting their students explore problems in their own time, and let the process of learning come from a place of exploration and trial-and-error instead of focusing only on getting the correct answer.

Conclusion

The usefulness of error analysis cannot be understated. The method allows students to gain a deeper understanding of concepts and leads to productive discourse. The research completed thus far has not given insight into one "correct" way of performing error analysis, therefore teachers have many options when it comes to bringing error analysis into their classrooms. Teachers can use error analysis as an important tool in their toolbox for helping students learn effectively. Error analysis can lead to a rich interaction among students that helps foster perseverance and offers them opportunities to eliminate misconceptions in a meaningful way.

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Science

Incorporation of Culture in the Science Classroom

Mariah Guthrie

Abstract: Few science classrooms incorporate an understanding of the effects of culture into the way science is taught. Yet few minority students continue onto careers in hard sciences, and the methods of instruction of these courses throughout primary and secondary years may be contributing to this. With the rising recognition of and respect for diversity within classrooms across the country, the teaching styles of many schools need to be revised to recognize and account for the cultures which students bring with them into the classroom. The practice of culturally inclusive instruction for all students is called Culturally Responsive Pedagogy (CRP). Culture is central to learning. It plays a role not only in communicating and receiving information, but also in shaping the thinking process of groups and individuals. For this reason, Culturally Responsive Pedagogy is necessary if we wish to include all students in science education.

Introduction

Science is not seen as a viable career path for many of our young students, especially those from groups that have been historically underrepresented in scientific fields. Numerous reports confirm that minority members rarely enter fields requiring advanced science and mathematics degrees. If we wish to break this pattern, teachers need to improve the way they incorporate culture into their science classrooms. As schools become more diverse, they must develop a curriculum which reflects the needs of their diverse students, and must focus more on how the various specific school subjects may be made relevant to all their students. Using Culturally Responsive Pedagogy (CRP) in the teaching of science may encourage these young minds to continue or increase their interest in the field. Teachers should think about the needs of all their students and consider the distinct backgrounds and situations that may change how the student views science. Science classrooms should incorporate student cultures into the curriculum to build upon the pedagogy for all students.

Addressing Diversity

Why is there a need to address diversity in the school community to begin with? There is a growing recognition that schools must meet the needs of students from all types of backgrounds and cultural upbringings, as described by Quinton (2011). New, more effective methods should be brought into classrooms in order to teach and engage these students. Classrooms already contain students with varying cultures, languages, abilities, and many other characteristics. The way that the students are being taught needs to mirror and connect to their lives. Richards, Brown, and Forde (2007) states it best:

> To meet this challenge, teachers must employ not only theoretically sound but also culturally responsive pedagogy. Teachers must create a classroom culture

where all students, regardless of their cultural and linguistic background, are welcomed and supported and provided with the best opportunity to learn (p. 64).

School cultures and those cultures that students are a part of outside of the classroom can conflict, which can cause a disconnect in the learning process. In order for students to fully grasp learn and comprehend, teachers need to look for bridges between the culture of the home life and the school life. Moreover, according to Heath (1983) a culturally responsive instructional environment minimizes the students' alienation as they attempt to adjust to the different world of school. Culturally responsive pedagogy is a tool that can be used to bridge these gaps, one which is especially useful in the science classroom.

Cultural Responsive Pedagogy in Science

According to Richards, Brown, and Forde (2007), in a culturally responsive classroom, effective teaching and learning occurs in a culturally supported, learner-centered context, whereby the strengths that students bring to school are identified, nurtured, and utilized to promote student achievement. Culturally responsive pedagogy is meant to foster the inclusion of students of any background and ethnicity. This inclusion is seen in the science classroom in three different ways. As Butler (2017) describes, culturally responsive pedagogy in science education takes the form in demonstrating care for the students, getting to know your students on a meaningful level, and responding to ethnic diversity while delivering instruction. To connect with students on a purposeful level, teachers need to identify what each student is interested in and what they value in the subject. This can start from learning about their home life, traditions, or even styles of communication. By getting to know their students, teachers develop caring relationships that acknowledge both school and home cultures, and which respect the ways in which these students learn. This helps make the classroom a safe place for pupils to learn and achieve. The last step is responding to students' ethnic diversity by actively seeking out ways to integrate the students' lives and cultures into the curriculum. These three steps build a foundation for using the students' cultures as entry points to teach science.

Incorporation into the Science Classroom

Though culturally responsive pedagogy belongs in every classroom, the focus here is on how it can be applied in a science course. Because science courses are often perceived as challenging subjects for many students, it is particularly important to create inclusive, culturally responsive science classrooms. When teachers make real-world connections that build on the diversity of students in their schools, they can make the learning process feel more worthwhile and comfortable for students. For example, Wallace and Brand (2012) offers an exploration of how to properly represent and incorporate culture in the science classroom. Her research revealed that teachers' ability to grapplw with the sociocultural and political realities of diverse groups requires those teachers to develop a framework of pervasive social constructions of race. In particular, her analysis revealed that the teachers' beliefs and practices were informed by their critical awareness of social constraints imposed upon their African American students' identities. Though African American children are not the only historically underrepresented minority group in the school system, they are the group of minority students most common in many urban school districts. Wallace and Brand found that the teachers with more connection to the student's cultures outside of school were more successful at engaging those students in the study of science inside of the classroom. The hands-on tactics used by these teachers simulated those that could be used in the community of their students. Some of these approaches were as simple as listening to the students in ways that felt more responsive to them. One teacher from the study used the approach of showing her students that even though she was of different ethnicity, her students should feel safe in her classroom. She addressed the fact that her home life may be different from her students, but that she empathized with each of her students' situations. These teachers' philosophies were built from the culture of their students. As Wallace and Brand explain, the teachers needed three types of "sociocultural awareness" to be able to develop these approaches:

> (1) Teachers' background experiences provoked a critical awareness of societal constructions of race;
>
> (2) Teachers' critical awareness of the influence of societal constructions of race influenced their teaching philosophies; and
>
> (3) Teachers' sociocultural awareness informed their perspectives of students' needs and behaviors (p. 354)

As these teachers gained more experience, they developed better understandings of the culture that surrounded the students, meaning these teachers were better prepared to serve their students' needs. Cooperating with the outside world of the students helped to keep them engaged in the science.

Brand (2014), also explored this subject, examining the pressing issue of how best to prepare teachers to effectively teach students from culturally diverse backgrounds. She also focused on the development of teachers' sociocultural consciousness, which she defined as "understanding that people's ways of thinking, behaving, and being are deeply influenced by such factors as race/ethnicity, social class, and language." (p. 61). She advocates for a type of culturally responsive pedagogy that asks teachers to enter the classroom with a non-judgmental attitude, and drawing no prior conclusions about their students. Brand argues that this is key if teachers wish to understand the needs of students who have been socio-culturally disadvantaged and to develop and employ strategies that align with their students' needs. Incorporating these struggling students' needs into the equation can make the difference between engagement and disengagement, and success and failure. Understanding their background gives these students a leg up in the competition of the science field.

These two articles begin to show what culturally responsive pedagogy can look like in a classroom. But how can it be put into action by classroom teachers? Two examples of methods that teachers can use in their classroom while considering the culture of the students are (1) place-based education and (2) targeting specific science content.

With place-based education, the focus of student's science experiences is made relevant to the community that the students are living in. This also creates the opportunity for science classes to engage in scientific inquiry, as students develop their own scientific questions about their communities. Science teachers can use place-based instruction to provide opportunities for students to establish connections between their own knowledge and basic science concepts, to challenge and develop their own theories, and to communicate their ideas to others, as noted by the National Resource Council (1996). Giving students a chance to improve their critical thinking skills while finding solutions to problems in their own communities can strengthen their bond with how science is conducted and accomplished. A prime example of this in the science classroom is having the students learn outside of the classroom. A lesson that deals with the issues in the community connects the students to their social culture and the science needed to fix a particular issue. For example, a school may be in the vicinity of a watershed that supplies drinking water for the community. Having students learn about the water quality of their community's watershed and the potential problems that may be occurring in that watershed can allow them to use their critical thinking skills to develop a possible solution to help their community. Place-based education can be as easy as monitoring a local issue that students can identify and explore resolutions for.

Targeting specific science content can be as simple as showing students that the field of science is a viable career path for them. Despite the underrepresentation of minorities in scientific fields, role models and historical figures are available as models for students. Bardwell and Kincaid (2005) advocate for making these figures visible to students. As they explain "[m]inority students will identify with these role models, and thus begin to personalize the science concepts and consider careers in science." For example, teachers should discuss the diversity of scientists throughout history as well as major scientists presented in many textbooks. Teaching about African American scientists outside of Black History Month also falls under this category. Having concrete examples to show the students the cultural significance of science in their society can make the connections easier and show the variety of individuals in the field.

Real-Life Implications

To put this issue into a more real-world perspective, I present my own experience as a way to illustrate the need for culturally responsive science teaching of science in schools. As a young woman in the field of science, I can reflect on the things that happened in my schooling that made me want to continue into a science career. In fact, all through primary and secondary school, I never had a minority teacher, and I only had one female science teacher; the teachers I did have did not offer culturally responsive pedagogy. These factors alone made me feel as though I was not represented in the field and that this was not the best choice of career for me to pursue, despite my own interest in science. The event that changed my perspective on the science community was a summer internship at the University of Toledo. It was a three-month-long program where the students worked closely with doctors and researchers at the medical college. This was the first point where I saw role models who made me feel that science was open to me. There were plenty of female doctors and researchers, and the staff was more diverse than those I had encountered in my schooling. I was also assigned a mentor who was very helpful in supporting my journey into the STEM fields. She showed me many other programs and fellowships that connected science to my community, making it more interesting to me. This mentor did more to inspire me to stay in the STEM field than any of my teachers had done in the classroom. She showed me the cultural significance of the scientific work that she did, and why it was important to her community. This is what teachers need to be bringing into the classrooms.

Another example comes from a case study of a first-year teacher from Yerrick and Ridgeway (2017), who tells the story of first-year teacher Krista, who described feeling overwhelmed. Krista explained that:

> this is my first-year teaching and my first time even being in the city. Then there is also administration coming into see where I am in the curriculum pacing and always reminds me how poorly my students performed last year and important 'maintain structure' in the classroom. He always tells me to focus on the curriculum guide and maintaining structure that is what my kids need to perform better this year. I feel like my students aren't connecting at all with what I am trying to teach. It isn't working for our class. They want me to focus on procedures and curriculum materials but my students dislike both. Some have blank looks, others are trying to write down everything I say, others are having side conversations or putting their heads down. I am not connecting with my students. (pp. 94-95).

After Krista described these feelings to her mentor teacher, Emmet, Emmet mentored her as she worked to make her classroom more culturally inclusive. This came through a series of one-on-one planning meetings which including culturally responsive reading materials and follow up observations to view the implementations of their meetings. What happened next was that Krista began to re-shape and re-think her science instruction. Krista planned an outdoor ecology lesson in which her students would use the school's iPads for her students to take photographs, record sounds outside, and video record their experience in the park. She was excited to share with Emmet her students' images, which contained organisms that were a part of the ecology of the creek, and which provided the scientific evidence and data to help drive the classroom instruction. Student work, displayed throughout her room, offered evidence of environmental impact, interaction, symbiosis, adaptation, and much more. Emmet observed that her students were incorporating outside experiences and resources to constructively build knowledge and engage in science differently from their historical roles as school learners.

Before she had made these changes, Krista had had trouble connecting with her students, not only on the level of the school community, but also on a personal level. Without that connection, there was a loss of interest in the curriculum on the part of the students. This was because the curriculum was not tailored to the daily lives of the students. After incorporating more culturally responsive pedagogy into her curriculum, this young teacher started to foster connections for her students that made the learning of science more enjoyable and productive.

Conclusion

Culturally responsive pedagogy is the way of the future when it comes to education in the science classroom. To create a culturally responsive classroom, teachers must first understand why diversity is important in the curriculum. Reshaping the curriculum to reflect the lives of their students can have a great impact on these pupil's grades and possible career paths. Culturally responsive pedagogy is meant to include all walks of life, and to encourage educators to teach together with their students rather than to teach at their students. Incorporating this type of pedagogy into the science classroom can help students, especially those from historically underrepresented backgrounds, to pursue an interest or even a career in the STEM fields. For these reasons, designing the curriculum to fit the needs of their students should be the main priority of science teachers when formulating all lessons. Culturally responsive pedagogy may be the solution to the inclusion of all students in the science field.

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Using Biographies to Teach the Nature of Science and Science Content

Laura Hoesman

Abstract: Science content and concepts concerning the nature of science (NOS) are two key aspects of scientific literacy, the promotion of which is the primary goal of general science education. However, the NOS, which acknowledges the human and societal aspects of science, is often neglected in favor of the content teachers are required to cover. The result is what Duschl (1990) calls "final-form" science, which presents science as a string of decontextualized facts and as settled knowledge. This common form of instruction leads students to develop misconceptions about NOS concepts by obscuring how scientific knowledge is developed by people. This essay argues that biographies of scientists, when carefully selected and implemented within the classroom, can be used to effectively teach both science content and NOS concepts, without requiring additional instruction time.

Introduction

> *Alice is a fifth grader in a science classroom. Her teacher asks everyone to open the textbook and read about the Earth's rotation around the sun while answering questions on a worksheet. Alice reads through the information and hastily scribbles answers. None of the questions require her to do anything beyond copying a few words from the book, nor do they ask her to consider the origin of the scientific knowledge she is collecting. She puts almost no thought into the task at hand. The next day, Alice receives her grade on the worksheet – an A. She glances at the result, exclaims, "Yea! I got an A!" and drops the worksheet into the recycling bin. "Alice," admonishes her teacher, "You need that worksheet to study for the test! Put it in your homework folder." Alice complies. After memorizing the facts and acing the test, Alice asks the teacher if she may throw away her pile of worksheets. "The test is over, so you don't need them anymore," the teacher replies. Into the wastebasket goes the entire astronomy unit. Alice's recollection of astronomy facts is not far behind.*

Although the above scenario may be familiar to many teachers and students of science, it is an example of what Duschl (1990) calls, "final-form science," a method of science instruction which reduces science to a long list of facts to be memorized and experiments used to validate the facts being taught (Wang & Marsh, 2002). Final-form science takes the curiosity, creativity, frustration, and inspiration that comprise human scientific processes and sucks them straight out, leaving a bare skeleton of facts. Students are left to assume that these "facts" are certain and absolute, plucked straight from nature as if by magic. Not so. Every piece of recorded scientific knowledge has been developed by people through years of observation, experimentation, and interpretation. Just as importantly, established "facts" are subject to change, as new evidence becomes available; therefore just telling students what the "facts" are does not give them a comprehensive understanding science and how it works.

What final-form science lacks is instruction in the nature of science (NOS). Although different educational organizations including the American Association for the Advancement of Science (AAAS) (2010) and the National Science Teachers Association (NSTA) (2013) have varying definitions of what the NOS is, they generally agree on its main ideas and that it should be taught. The NOS is comprised of concepts which define scientific knowledge and describe how scientific research is conducted. Within their respective definitions of the NOS the AAAS (2010) and NSTA (2013) agree that scientific knowledge is tentative yet reliable, based on empirical evidence, and constructed through a variety of methods by people working within diverse social and cultural contexts.

Traditional, final-form science teaching may seem harmless, but requiring students to memorize information while neglecting to teach NOS concepts has dangerous implications for society. When the public lacks a firm understanding of the NOS and scientific knowledge, they lack the scientific literacy necessary to make informed choices (Clough, 2011). For example, misconceptions about vaccines and climate change can lead to serious public health and environmental consequences if too many people decline to vaccinate their children or reject policies designed to protect the environment. By neglecting to teach NOS concepts in the classroom, teachers set the stage for misinformed policy and funding decisions (McComas, Almazroa, & Clough 1998), and they ignore the people who worked to develop the knowledge we have today, thereby dehumanizing and decontextualizing science.

> *Imagine that instead of reading from a textbook, Alice reads a biography of Galileo Galilei. The biography explains how Galileo was intrigued by a device invented by a Dutchman which made it possible to see things far away; how he shaped glass lenses to improve upon the original telescope design; how he studied the movement of planets and moons through his telescope; how he took into account Copernicus' earlier work; how he used the data he collected to develop his own explanations; and how he published his findings in support of the idea that the earth revolves around the sun. The biography goes on to describe how Galileo was accused of heresy by the Catholic Church, threatened with torture, and imprisoned for the rest of his life for sharing what he had learned. Alice answers questions about what Galileo learned, how he made observations and developed conclusions based on data, how his findings affect people today, and why he persisted in his pursuit of knowledge despite setbacks and societal pressure.*

This text is far better suited to helping students learn about the NOS. By placing astronomy content within the context of how it was developed – the tools used to gather data (the telescope), the other scientists who influenced the subject and course of research (the Dutchman and Copernicus); the processes involved in the construction of knowledge from data (years of recording observations and constructing explanations); the societal influences upon research and dissemination of knowledge (the role of the Church); and the scientist's personal drive that led him to forge ahead into the unknown (Galileo's curiosity) – the biography of Galileo gives Alice a much more comprehensive and authentic understanding of what people know about the natural world and how they have come to know it. It encompasses several essential NOS concept, all by simply discussing the human aspects of scientific research. These NOS concepts include the understanding that science is a human and social activity, that scientists creatively develop knowledge to explain data, that science is affected by societal and cultural contexts, and that scientists' knowledge of the world can change based on new evidence. This essay will provide evidence to support the argument that biographical narratives about advancements in science, when carefully selected and applied, can be used to teach students essential NOS concepts by humanizing science, while actually enhancing science content learning.

Using Biographies to Teach NOS

Research indicates that biographies can be used to teach NOS concepts and science content, particularly when NOS concepts are presented explicitly. One strategy of integrating biographies into science instruction is the interactive historical vignette (IHV), proposed by Wandersee and Roach (2005). An IHV is a brief 10 to 15-minute "slice" of history presented in skit form by students. Each vignette focuses on one NOS concept and includes a dialogue between scientists researching a particular phenomenon. Prior to the end of each vignette, students are asked to predict what the scientists will do next. Finally, the teacher leads students in a discussion of the NOS concept featured in the IHV, in terms of its relationship to science today. Recent research on a variation of the IHV format conducted by Nur and Fitnat (2015) found that IHVs can be successfully implemented using an explicit-reflective approach to teach students NOS concepts at the high school level. This approach involves explicit instruction in NOS concepts followed by questions intended to allow students to reflect upon the NOS. As part of the study, which included 17 eleventh-graders, researchers administered a survey to assess students' understanding of seven key NOS concepts both prior to and after students read two different IHVs. The information collected through the survey was used to assess students' NOS knowledge as either naïve, transitional, or informed. Before students read the IHVs, most students' NOS understanding was assessed as naïve, but after students read the IHVs, only one student tested as naïve, and the majority of students (13) tested as informed. Of the seven NOS concepts targeted in the study, students' understanding of the tentative NOS improved most significantly, although students improved in all seven areas. The researchers concluded that combining information about real scientists with questioning and explicit NOS instruction increases students' understanding of the NOS.

Clough (2011) reached a similar conclusion after creating 30 historical short stories as part of a project partially funded by the National Science Foundation. The stories, written by a team including a science historian, science professors, and a reading specialist, were created in order to "humanize science, accurately and effectively teach NOS ideas, improve science literacy and entice more individuals to consider science careers" (p. 705). The stories incorporated explanations of how historical and contemporary understandings of scientific knowledge are related, sidebars which explicitly pointed out NOS concepts, and questions to help students reflect on NOS concepts. One such story, "Personalities and Pride: Understanding the Origin of the Elements," describes how multiple scientists worked to develop an understanding of how elements form (Williams, Kruse, Clough, Stanley, & Kerton, n.d.). The story begins with a scene in a laboratory, which gives students a view of the human nature of scientific research. Later in the story, the following question is posed: "How might science be different if scientists did not work together, debate each other, and use ideas that are already accepted?" This is one of four text-to-NOS concept links explicitly made within this particular story. Asking students to answer questions relating to the NOS within the narrative requires them to think about and formulate their understanding of the concept in their own words, which may account for the success of this method.

In a study using the stories described above, Vanderlinden (2007) found that post-secondary geology students who read the stories showed a statistically significant improvement in their understanding of NOS concepts compared to students who were not exposed to the stories. However, an unexpected outcome of the study was that students remained naïve in their view of the tentative nature of science, viewing past scientific knowledge as flawed and current scientific knowledge as concrete fact. This misconception may require more contemporary biographical examples or explicit instruction to dislodge. The study also showed that neither group of students showed any meaningful difference in their mastery of the scientific concepts taught, although it is notable that students' content learning was not negatively impacted by the stories, and there was an overall benefit for students who read the stories.

Using Biographies to Teach Science Content

Other studies have demonstrated the efficacy of using biographical texts to improve students' grasp of science content. A study of 209 seventh and eighth graders found that students who read specially designed "scientific discovery narratives" about Galileo and Marie Curie learned and retained more science content than students who read expository texts containing the same conceptual information, without biographical elements (Arya & Maul, 2012). Students with less prior knowledge and students from low-income backgrounds were found to benefit more from the biographical texts than students with some prior knowledge and students who came from higher socio-economic statuses.

Another study of ninth and tenth grade students examined the effects of portraying scientists as people who struggle with their work or personal lives (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016). Each student read one of three types of biographies, including biographies in which the scientists struggled with their research, biographies in which scientists struggled in their personal lives, and biographies in which scientists did not struggle, but were instead portrayed as highly accomplished individuals. Students who read the "struggle stories" showed greater improvement in their science content learning as measured by classroom grades, regardless of whether the struggle was personal or academic, compared with students who read the biographies which portrayed scientists as flawless. Also, students who learned about scientists' academic or personal struggles reported that they felt "connected to" the scientists. As Lin-Siegler et al. (2016) wrote, "The message that even successful scientists experience failures prior to their achievements may help students interpret their difficulties in science classes as normal occurrences rather than a reflection of their lack of intelligence or talent for science" (p. 323). The results of this study suggest that by presenting the failures and struggles scientists face, biographies humanize scientists, thereby motivating students to persevere in the face of difficulties. In turn, this leads to improved learning outcomes in science. Below is a list of tips for implimenting science biographies.

- Ask NOS-related questions as students read. Have students predict what the scientist will do.
- Explicitly draw students' attention to NOS concepts exemplified in the biography.
- Explicitly point out professional, personal, and societal struggles faced by scientists, as well as their reasons for persevering.
- Engage students in skits based on scientists' methods and findings. Students can write and perform their own skits based on carefully-selected biographies.

Selecting Effective Biographies

Although research has shown that specially-designed biographies of scientists can be used to teach the NOS and science content, with the potential to motivate students through their portrayal of scientists as flawed human beings, not all biographies are well suited to these tasks, and some can even reinforce misconceptions about NOS concepts (Allchin 2003). Therefore, teachers need to be careful when selecting biographies for the classroom. Biographies within textbooks typically eliminate any mention of scientists' failures and primarily discuss their successes (Lin-Siegler et al., 2016). In the process of trying to simplify biographical information and fit the scientific process to a narrative form, many writers distort events, exaggerate the accomplishments of individual scientists, and neglect the actual work and processes that go into scientific research (Allchin, 2003). This leads to what Allchin calls "myth-conceptions" (p. 341), which elevate individual scientists to "superhuman characters" (p. 342) who independently come to great realizations about science in seemingly predestined flashes of inspiration. Errors are erased, the time-consuming aspects of scientific processes are forgotten, and the creative interpretation of data is reduced to a single "aha!" moment (p. 345). Narrative devices may serve to make stories more engaging, but they often do not contribute to an accurate understanding of the NOS.

Dagher and Ford (2005) conducted a study of widely available historical and contemporary biographies of scientists for children and found that the twelve selected biographies focusing on eleven different scientists did not adequately describe the process of data interpretation. The researchers also found that biographies of contemporary scientists did a better job of describing the methods and tools involved in scientific processes than did the historical biographies. In light of these observations, when selecting biographical texts for the science classroom, teachers need to watch out for superhuman traits, for the absence of error, for science being conducted in isolation from other people, and for the oversimplification of scientific processes. Below is a list of characteristics teachers should look for when selecting effective science biographies.

- The scientist is described as a flawed human being – not as a superhuman character.
- The scientist's work is not portrayed as simple, straightforward, quick, or predestined. Errors made by the scientist are included.
- The scientific process is described, including some indication of how the scientist creatively developed explanations from the available data.
- The scientist's struggle and perseverance are included.
- Descriptions of the scientist's personal and societal hurdles (e.g. growing up in poverty, having to flee their country, not being allowed into academia due to gender) may be included.
- The scientist's involvement with and consideration for other scientists and societal norms is evident.

Conclusion

Research indicates that biographical narratives focusing on advancements in scientific knowledge can help students connect to science on a human level, learn science content, and develop a better understanding of NOS concepts. Evidence also shows that biographies may increase student motivation. That said, how those biographies are written and presented within the classroom plays a deciding role in their effectiveness, and there is still much potential for further study into the best ways to teach with biographies. In light of the research described above, there are steps teachers can take to productively use biographies in their classrooms. Teachers need to select biographies that present a realistic view of scientists, including their struggles and how they work within different societal contexts. They also need to explicitly explain the NOS concepts exemplified within biographical narratives and ask students follow-up questions about these concepts. When teachers follow these key guidelines for the selection and use of biographies in the science classroom, they can breathe life back into a decontextualized skeleton of facts, and help to nurture a more scientifically literate society.

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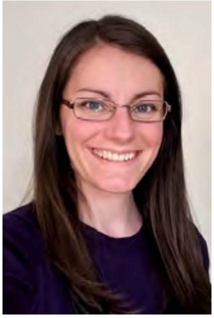

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Creating Civically Motivated Science Students Why Is It Important to Teach Civics in Science Education?

Elizabeth Laubender

Abstract: Only three of the State of Ohio American Government standards address the teaching of civic responsibility, suggesting that these standards somewhat overlook this very important aspect of education. However, both research in the field and the current state of global affairs suggest that we should be teaching students not only more ways in which they can be successfully civically engaged, but also that we should be teaching civic engagement in our science classrooms. This article identifies the relationship between civic activism and science education while addressing the contemporary world issues that intensify the need to merge both this sect of social studies and scientific disciplines.

Introduction

> *100,000 men, women and children fill the streets of our nation's capital on this cloudy day with signs and umbrellas. Today is Earth Day- but it is not a regular Earth Day. After all, we've had 47 official Earth Days. What makes today different? Stages and platforms are set up throughout the city. Speakers engage citizens all day in speeches about science, education, knowledge and the Earth -- speakers like Bill Nye and Michael Mann. Musicians play throughout the day. Among the many soggy signs are some reading the following:*
>
> *"S.O.S: Save Our Science," "Alternative energy = JOBS…alternative facts = LIES," "Up and Atom Time to March for Science," "Think while it is Still Legal," "Time to React," "Powered by Science & Strengthened by Diversity,"*
>
> *Why have 100,000 people come out today into the cold and wet? They're here to stand up for the promotion of the idea that science is a pillar of freedom and prosperity. They're here to voice their concerns and their support for citizens of this country, and in the global community, to vote for policy makers who are going to create and uphold legislation that uses scientific evidence and research to make the informed and educated decisions needed to further societal progress.*
>
> *Washington DC, April 22, 2017*

Civic Engagement and Social Studies Where Do We Find It?

In Ohio, civic engagement is taught in American Government classes, which are typically reserved for 11th and 12th grade students. Depending on the district, this course may only last one semester. Within American Government classes, civic engagement is part of only 2 or 3 of the 25+ state standards. It is apparent that teaching students to be civically literate is not a priority in our education system. Not only is there a lack of deep engagement with civic education within the discipline of Social Studies, but civic literacy is barely touched on in most other disciplines (e.g. English Language Arts, Math, and Science). In particular, science students suffer greatly as a result of civic education being absent from science education. By excluding civic education from the science classroom, we rob our students of an understanding of the deep interrelationship between citizenship and scientific understanding.

According to Ehrlick (2000) civic engagement is the process in which an individual works to make a difference in their community through the understanding of various values, skillsets and knowledge structures that help the progression of said community. Similarly, the New York Times uses Ehrlick's work to define a civically active individual as one, "working to make a diffference in the civic life of one's community and developing the combination of knowledge, skills, values and motivation to make that difference" (New York Times, 2007). Currently, Ohio's Standards for Social Studies 1, 2 and 20 for American Government are the only standards that directly address civic engagement and civic responsibility (Ohio Department of Education, 2010).

American Government Standard 1 promotes the development of a basic understanding of governmental powers and the processes by which decisions in government are made. The analysis of public policy processes allows for teachers to implement projects and assignments that have students address societal issues and engage in the advocacy for and creation of their own policies in ways that simulate their actual political potential. American Government Standard 2 promotes the examination of various views on public issues as well as into the interest groups and political parties who hold those views. Students may be prompted to select a civic issue to resolve through the defending of the viability of a position on this issue. For example, I dedicated a total of two weeks to civic engagement this year while teaching a semester long American Government course; according to my fellow Social Studies teachers, this was significantly more time that would typically be spent on civic engagement.

Standard 20 encourages the exploration of the various ways in which an Ohio citizen can impact their local government and therefore effect societal change. In particular, this area is one in which a real opportunity is missed. Given what little time there is to cover the various standards while implementing beneficial and data-yielding projects, teaching beyond the scope of the standard description can get tricky. It is not uncommon, while teaching about civic responsibility, for educators to fail to pull real-world issues into the mix, despite there being such profound and ready opportunities to do so.

Clearly, civic engagement is not at the top of the priority list when it comes to the Ohio standards in American Government, so it certainly is not a priority in our biology, physical science or physics classrooms. Why should it be?

Science and Civics
A Natural Fit

On April 22, 2017, an estimated 100,000 people participated in a march for science in Washington DC with an estimated 1.6 million people marching for the same worldwide, in over 500 locations. Its purpose was to promote evidence-based policy-making in government (Mervis, 2018). People took to the streets in an organized and efficient manor to protest antiscientific policies coming from our government. According to Sneed (2017) it has historically been unusual for researchers and scientists to become engaged in such advocacy, but recently this movement has gained enough traction to become a lasting one.

We've heard of the various social movement marches taking place over the last few years; the March for our Lives, the Woman's march, Black Lives Matter, PRIDE, and now, the March for Science. But what made the March for Science different from the others? Although these are all social movements, the movements I mentioned formerly are very clearly labeled as social justice movements, dealing with individual and group rights. So, where did the March for Science come from?

We don't often see scientists taking to the streets in protest of anything. Many in the scientific community have resisted doing so because they feel that such engagement may make science seem like just another interest group, something they wish to avoid. However, many scientists have begun questioning this inaction, given the reality that our policy makers have the power and legitimacy to accept or ignore scientific research and evidence that affects our daily lives, our health and our future. As Sneed (2017) argues:

> People who value science have remained silent for far too long in the face of policies that ignore scientific evidence and endanger both human life and the future of our world. Staying silent is a luxury that we can no longer afford.

A growing number of members of the scientific community agree with Sneed, and the science movement has been triggered by the civic activism awakening that has taken place within the scientific community. As with any movement, it is the result of fed-up citizens demanding change and reform.

The range of scientific issues currently in the news makes it clear that civic society and scientific progress are naturally linked and should be treated as symbiotic entities. We can see this by briefly engaging with the subjects of climate change and alternative energy. In terms of climate change, currently in our nation's capital, we have lawmakers drafting and approving legislation that is halting scientific research and progress. The head of our Environmental Protection Agency (EPA) doesn't believe that the Earth's climate is changing. As a nation, we've abandoned our involvement in the largest global environmental protection agreement that has ever existed.

As far as alternative energy goes, the biggest perceived enemy of the U.S. is called the Islamic State of Iraq and Syria (ISIS), or alternatively the Islamic State of the Levant (ISIL). They are bent on taking over territory by means of terror. If the Western countries did not need the oil that these terrorists control, the money that ultimately funds their operations would dry up. They could no longer operate as a terrorist state (Nye, 2016).

Bill Nye -- celebrity scientist, chief executive officer of the Planetary Society, and mechanical engineer – makes this assertion as one among example among hundreds, and marshals a range of issues to point out the clear link between our scientific progress (or lack thereof) and forward looking global politics and policy making focused on the preservation of the Earth and of humanity. We are living in a time where parents are choosing to let their children go unvaccinated, all because of an article published in the 90s that was later debunked and recanted completely. The number of people jumping on the bandwagon of flat-earth theory is growing. It is vital that those who are drafting and passing the legislation that makes or breaks our progress and our protection are knowledgeable about and accepting of the very basics of scientific research, theory and opportunity. This is why we need to be teaching our science students to be civically literate.

The *How* in All This

There is a simple solution that will allow for our education system to begin the morphing of the teaching of civic responsibility in science education. It begins with making the discussion of societal issues, particularly in science and health, a normal part of everyday discussion in our science classrooms.

Making connections to current events is a simple yet crucial part of engaging students in real-world scenarios and issues while allowing for the facilitation of critical thinking and problem-solving within the discussions of these topics. Beyond this, teachers can offer inquiry-based and project-based assignments that engage with the goal of connecting scientific thinking to civic engagement. This is much easier to do than it may seem. By connecting science projects and labs to objectives that have civic merit, such as investigating the water quality in a local stream or river, students build the connections between the two, making the science project or lab more relevant in their lives, which is an overall cornerstone of education. Communication is an important aspect of every subject, and is included in the standards for every discipline. In the 21st century, scientific issues have become more politicized than ever, and it is our duty as educators to teach our students, particularly in our science classrooms, how to communicate an ethical, cultural and scientifically-informed position in a way that promotes action and further civic engagement.

Integrating civic engagement and science education has further benefits. By doing so, we add justification to the already important scientific concepts being taught. We continue to build upon relevancy in bridging the gap between concepts, labs and projects and the student's daily lives, while encouraging civic literacy and critical thought. This also encourages teachers to offer high-quality instruction, because it precludes simply teaching from the text, instead requiring them to make the most out of current scientific events, findings, and research. In other words, this isn't something you can fake. This may make doing so daunting to some teachers, but it should also make it appealing to administrators and other educational decision makers.

Additionally, this integration will provide a vehicle for meeting the cross-curricular goals many schools and districts are striving for. Just as we understand that teachers across content areas are always also teachers of reading, so should science teachers be looked at in regard to the teaching and facilitating of civic literacy and responsibility.

I end my final points with another quote from Bill Nye's Unstoppable (2016):

> We can become a great generation that leaves our world—our home—in better shape than it is now while raising the quality of life for people everywhere. This will not be easy. We've already loaded the atmosphere with enough heat-trapping gases of various kinds to cause our planet to keep warming for many, many years to come. But the situation is far from hopeless. (p.2)

Although in this quotation Nye is specifically addressing climate change, his words can be applied to all societal issues that involve science, and as supporting the importance of teaching civic responsibility in science education. It is up to us as educators to assist our students in engage with and attempt to understand complex societal issues concerning scientific research and data while teaching them how to impact the world around them. Nye is right; the mission is far from hopeless; particularly if we begin making changes starting in our science classrooms.

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Considerations for Effective Laboratory Instruction in Science Classrooms, As Inspired by Metacognition

David Wilson

Abstract: There are many designs for laboratories that can be effective. Teachers should be able to design labs that are both grounded in methods identified by research as effective, and are efficient for their learning goals and context. Evidence of students' metacognition should be used to evaluate different lab components and styles. Some merits and limitations of full scale inquiry laboratory styles, simplified inquiry laboratory styles focused on scaffolding specific skills, and some major additions to simple labs are identified. Furthermore, essential components of good laboratory design which are necessary for "meaningful learning" are proposed. The reader will be able to identify what should be considered when choosing a lab style, and components that should be included for meaningful learning.

Introduction

The question of how to design effective laboratory experiences for students has been a topic of interest for decades (Coker, 2017; Dushl, 1994). Modern science standards require that students learn practices associated with scientific inquiry, and require teachers to inspire interest in science (Holmes, Hunter, & Schklar, 2011). However, the definition of inquiry is complex: it includes asking questions, planning and conducting investigations, finding solutions to problems, and analyzing evidence to help make predictions or give scientific explanations for outcomes. How can instructors best foster such a complex practice? The research suggests a few general lab instruction structures that can effectively scaffold students' learning of these practices, each having their own merits (Abdisa & Getinet, 2012; Bakker & Akkerman, 2013; Kung & Linder, 2007; Wong, Kwan, Hodson, & Yung, 2008).

One common method of supporting students' acquisition of scientific inquiry skills is through the promotion of metacognition (Kaberman & Dori, 2009; Kipnis & Hofstein, 2008; Kuhn & Dean, 2004). Metacognition has been defined as reflecting on your own thinking and reasoning. Students developing effective metacognitive skills are able to identify what knowledge they and their peers possess, to identify common strategies for applying, acquiring and communicating that knowledge, to plan the best practices, and to check for errors. Kung and Linder (2007) argue that the process of acting on metacognition to support reflection is the tool's essential function, so the final step in applying metacognition is taking action based on these abilities; the lab provides an environment in which students might do so.

Several different methods of evaluating lab effectiveness have been presented. Some papers suggest that educators focus on teaching the nature of science (Wong et al., 2008). Others suggest that labs are an effective way to teach scientific knowledge (Abdisa & Getinet, 2012), and a few propose using labs to support students' ability to transfer concepts to other scenarios (Bakker & Akkerman, 2013). The goals for developing good metacognitive skills align with the goals of both the modern teaching standards requirement to teach strong critical thinking skills, and the goals for labs presented above (Kaberman & Dori, 2009; Kipnis & Hofstein, 2008; Kung & Linder, 2007). Because of the alignment between the goals for labs and metacognitive skills, evidence of students appropriately applying metacognition will be used as a tool for evaluating a lab design's effectiveness in this paper.

Designing laboratory assignments for students can seem a daunting task. This is particularly true at the beginning of a teaching career as the standards often leave the task of determining the best teaching method to the teacher. This article will discuss the merits and limitations of a few general lab designs to help determine what the best style for different situations.

Essential Components

Although research disagrees on what the best lab instruction might be, there is agreement on certain components that need to be included. For example, regardless of which style of lab a teacher decides to use, it is important that they are clear about which learning goals they are trying to teach, and that they communicate those goals clearly to students (Davidowitz & Rollnick, 2003; Ottander & Grelsson, 2006). If the goals of the lab are not made clear, students will often focus on the wrong learning objectives while trying to perform the lab, and may even choose to focus on skills that were not in the original design (Ottander & Grelsson, 2006). Supporting this point, Davidowitz and Rollnick (2003) also found that students' interpretations of the purpose of the lab can influence how they perform it. For similar reasons, Dori and Kaberman (2009) also suggest that more directly modeling both scientific reasoning and metacognitive reasoning results in a greater probability of students developing effective reasoning of their own. As such, clear communication of the labs goals and preparation with metacognitive skills are an essential component of good lab design.

Another important components that should always be included is guided reflection. This includes questions designed to guide students' reflection on both their explanations of how a phenomenon works, and on what skills they used to find this information (Bakker & Akkerman, 2013; Coker, 2017; Kipnis & Hofstein, 2008; Kung & Linder, 2007; Wong et al., 2008). Reflection should be designed to allow students to use metacognition to evaluate their own perspectives and understanding, as well as to evaluate the results for completeness or errors through considering different perspectives (Kipnis & Hofstein, 2008; Kung & Linder, 2007). Additionally, reflection should be used to scaffold students' consideration of different methods of extending their understanding to new scenarios (Bakker & Akkerman, 2013; Kipnis & Hofstein, 2008; Wong et al., 2008). These extra connections help make the laboratory a more meaningful learning experience. In fact, the authors who support inquiry-based lab structures often also refer to reflection as the most important part of the laboratory experience (Kipnis & Hofstein, 2008; Kung & Linder, 2007; Pyatt & Sims, 2012).

Other research suggests that in order for students to appropriately practice scientific inquiry skills, they must learn and internalize certain components of the nature of science (Coker, 2017; Kipnis & Hofstein, 2008; Wong et al., 2008). Many components of the nature of science treat metacognition skills as essential to the general process of developing scientific knowledge. These include an understanding that scientific knowledge is tentative in nature, that there are several processes for practicing science which can be effective in different scenarios, and that scientific laws and theories must be supported by evidence and checked for consistency with observation (National Science Teachers Association, 2000; Wong et al., 2008). This research suggests that designing a lab to support some or all of these understandings of the nature of science will help students to understand the importance of metacognitive skills and will inspire students to practice those skills during reflection.

Finally, every lab should give students opportunities to collaborate with their classmates (Davidowitz & Rollnick, 2003; Kipnis & Hofstein, 2008; Kung & Linder, 2007). Students who are collaborating have access to additional perspectives and reasoning to help them construct deeper understandings of the concept (Davidowitz & Rollnick, 2003; Kung & Linder, 2007). This is necessary to support higher quality reflection. Additional perspectives also allow students to practice the metacognitive skill of comparing their explanation with those of their peers, to identify gaps in understanding (Kipnis & Hofstein, 2008; Kung & Linder, 2007). Moreover, to properly collaborate, students must rearrange their own understanding into structures that can be effectively communicated, another key metacognitive skill (Kung & Linder, 2007). In this way, the key components of any lab design – clear goals, guided reflection, a focus on the nature of science, a focus on collaboration, and a metacognitive focus -- build off each other to create a more effective whole.

Proposed Lab Structures

Full-Scale Inquiry Labs

Within full-scale inquiry labs, students enact the entire scientific method. They ask their own questions, create their own hypotheses, plan labs to test the hypothesis, collect data, and analyze the data to reach meaningful conclusions. Research has suggested that for high-quality learning, it is necessary for students to enact authentic lab structures, as students' successful scientific reasoning is correlated to "how science is taught, not how much content is taught" (Coker, 2017, p. 15). Full-scale inquiry designs explore one entire method of acquiring scientific knowledge and therefore are the most authentic design proposed.

There are multiple merits of this design including that it is the most effective for helping students to develop better planning skills, it supports better transfer to new scenarios, it can help improve students' self-efficacy, and it can be used to scaffold the entire range of skills required by the Ohio state standards (Coker, 2017; Holmes et al., 2011; Kipnis & Hofstein, 2008). To incorporate reflection and metacognition, such labs should be designed to allow students to reflect on their actions and to form understandings after each section of the scientific method is used (Coker, 2017; Kipnis & Hofstein, 2008). Furthermore, many of the actions that make up the components of the full-inquiry lab give students practice with skills that are part of the overlap between metacognition and the modern teaching standards. These skills include asking questions, correcting errors, justifying opinions and current methods, and planning new or alternative procedures (Kipnis & Hofstein, 2008). Research comparing several lab designs suggests that this style of lab has the greatest potential for meaningful learning (Abdisa & Getinet, 2012; Kung & Linder, 2007). In particular, Kung and Linder found that this lab design might result in the most common use of metacognitive practices that result in meaningful reflection.

Unfortunately, this style of lab also can be one of the most challenging to implement in the classroom. This lab design can be very effective, but can also be difficult to use. The first major concern teachers express is that having students perform all of the necessary steps of scientific inquiry is very time consuming. Coker (2017) suggests that only approximately four labs per semester could be done if this method is used properly. Furthermore, Coker found that the greatest improvements in scientific reasoning skills occur in the first two uses of the full-scale lab design, and thus that it should be used at least twice per year. Kipnis and Hofstein (2008) warn that the factors that impact the success of a full-scale inquiry lab are complex, and are strongly dependent on the students' motivation to use laboratory time effectively. The availability of materials may also restrict the options that students have in choosing what experiments can be conducted (Coker, 2017; Wong et al., 2008). Furthermore, properly communicating the purpose and scaffolding the improvement of skills in scientific reasoning can be difficult if students are unfamiliar with this style of lab (Kung & Linder, 2007; Ottander & Grelsson, 2006). Because of these challenges to implementation, although a full-scale lab is the most authentic, it is not the only design that should be considered.

Focused-Inquiry Labs

When using focused inquiry labs the scientific method may be slightly simplified or guided to focus instruction on one or more component or skill associated with the nature of science. Research suggests that these focused inquiry labs can still be effective at teaching the nature of science, provided that all components are addressed (Davidowitz & Rollnick, 2003; Pyatt & Sims, 2012). Further, some research suggests that focusing on specific components can reduce cognitive load (Pyatt & Sims, 2012), allow for more focused instruction on skills that need improvement (Kaberman & Dori, 2009), and include specific tools to support skill development (Davidowitz & Rollnick, 2003). The research generally offers examples of focused inquiry labs that effectively teach one component of metacognition at a time. For example, Kaberman and Dori (2009) found that focused instruction can be used to effectively scaffold generating questions that help students reach a deeper understanding, strengthened student's ability to construct models of compounds, and deepened students' understanding of scientific concepts. In another example, Davidowitz and Rollnick (2003) found that guiding students to diagram their own plan for completing the lab can significantly improve their ability to check for errors in their process and results. Once again, this is important as these metacognitive skill overlap with the inquiry process (Kipnis & Hofstein, 2008).

Focused-inquiry labs offer a great deal of flexibility in form, and in the style that the lab can take. However, research suggests that there are some limits to this approach, which cluster around the students' understanding and internalization of the skills on which the labs are focused (Davidowitz & Rollnick, 2003; Kaberman & Dori, 2009; Ottander & Grelsson, 2006). Because focused-inquiry labs focus on individual skill development, if students don't understand the purpose of a particular skill or believe that it is useful, this can negatively impact student learning (Davidowitz & Rollnick, 2003; Ottander & Grelsson, 2006). Moreover, research indicates that reflection and metacognitive activities that are externally imposed are often less effective than those generated by the students themselves (Kaberman & Dori, 2009; Kung & Linder, 2007). Research also suggests that skills must be presented through several different methods and tools to assist a wide range of students, which is not always achievable through these types of labs. A few effective strategies which can supplement focused-inquiry labs for this purpose include: the direct modeling of skills, the use of metaphors and case studies to explain processes and reasoning, the use of tables and flow charts to support planning and time usage, the use of physical modeling tools, and the use of group discussions (Davidowitz & Rollnick, 2003; Kaberman & Dori, 2009).

Additions to Typical Labs

Oversimplified laboratory experiences where students simply follow directions and answer questions are the least effective option for teaching both metacognitive skills (Kung & Linder, 2007), and supporting content knowledge (Abdisa & Getinet, 2012). Unfortunately, there is strong indication that this lab style is prevalent in science classes throughout the country (Coker, 2017). Furthermore, research on the effectiveness of simply adding components to oversimplified labs to support metacognition and reflection has shown mixed results (Kung & Linder, 2007; McInerny, Boudreaux, Kryjevskaia, & Julin, 2014). These results are often either conflicting, or offer data that fall within the study's margin of error (meaning it is ambiguous), which has resulted in calls for additional research (McInerny et al., 2014). Nevertheless, some research suggests that a broad range of additions to labs might better support transfer of skills to new scenarios and offer additional perspectives to help students identify gaps in understanding in these varying settings (Bakker & Akkerman, 2013; Wong et al., 2008). A few proposals include: having students reflect on their results with internship supervisors as part of a lab (Bakker & Akkerman, 2013), or preparing for a lab through conducting a review of related historical scientific events (Wong et al., 2008).

One addition to labs that has been shown to be effective is the use of simulations (Kaberman & Dori, 2009; Pyatt & Sims, 2012). Pyatt and Sims (2012) propose that simulations are equally as effective as physical labs for supporting students' conceptual change. Their research claims simulations can provide both authentic scientific experiences and remove some extraneous factors to allow students to focus more efficiently on practicing metacognitive skills. In specific, it has been suggested that the simulation environment can be effective for supporting the question-generation and error-analysis components of metacognition (Kaberman & Dori, 2009). However, simulations should not stand on their own; good labs should still follow the inquiry process when possible, and simulations should be used to supplement or ease the implementation of this structure (Kaberman & Dori, 2009; Pyatt & Sims, 2012).

Conclusion

The style of laboratory design should be grounded in what research states is effective, but should also be chosen to be the most effective option for your learning objectives and classroom setting. Although it might be the most effective design, not every lab needs to be a full-scale pursuit of the scientific method. Labs designed to focus on one or more skills and guide the inquiry process can be very effective as well (Kung & Linder, 2007). Whichever type of lab is used, in order to support strong scientific inquiry, all labs should incorporate the metacognitive skills of recognizing perspectives and background knowledge, finding strategies for applying, acquiring and communicating, planning the best procedure, and checking for errors. Furthermore, the vast majority labs should not be as simple as following a recipe, which is too often the case. When they are used, such labs should be augmented with other experiences to provide a broader representation of the nature of science, and are not effective on their own (Bakker & Akkerman, 2013; Wong et al., 2008). Within these designs, it is important to incorporate the time for students to reflect on their results, perspectives and actions, and to discuss these with groups. A clear presentation of the learning goals, useful reasoning strategies, and aspects of the nature of science is also necessary. Inclusion of these components into an appropriate structure will ensure a lab that is effective for practicing metacognitive and scientific inquiry skills.

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Social Studies

The Social Justice in the Classroom Framework
A Cross-curricular Approach to Integrate Social Justice Topics into the Classroom

Briton Moore

Abstract: Many teachers enter the field of education with a yearning to make a difference; they have a desire to teach from a social justice perspective to help promote a better society. Most often, educators are exposed to the theories, purposes, and, approaches of such educational philosophies in their pre-service programs (Delpit, 1995). However, while these philosophies often encourage a teacher to teach from a social justice perspective, when teachers attempt to do so, they frequently run into obstacles in implementation, resulting in social justice teaching staying more theoretical than actual (Picower, 2012). This manuscript explores current theories of social justice education in order to provide teachers with a framework for implementing key concepts of teaching from a social justice perspective.

Introduction

Ask teachers to define the influence they hope to have on their students, and most will ultimately say: "I want my students to grow into responsible citizens. I want my students to contribute to society in an active, engaged way." Or, "I want my students to change the world." But how many of us know how to make that happen? Can we explicitly teach students how to change the world? Maybe not, but we can teach our students about the injustices that we've seen not only in our past, but also today. Exposing our students to these injustices and showing how they were overcome may help cultivate these responsible, active, world-changing citizens. Historically, students and the schools have been a platform for social change, because they have provided an arena to explore, promote, and reflect on new and existing ideas. Beyond introducing relevant academic content, one of the most important roles as an educator is to help students develop critical thinking skills, collaborative skills, and self-reflection skills that can foster a better society.

If the purpose of education is to help students develop critical thinking, collaborative and self-reflection skills that can foster a better society, where does this fit into the curriculum? Curriculum is defined as the means, methods, and materials with which students interact for the purpose of achieving identified educational outcomes (Brown, 2004). If educational outcomes aim to create students who can foster a better society, something which is implicit in all curriculum, than what are the means and the materials? There is no manual for teaching social change, but the more awareness of social problems that we can bring students, the more informed and effective they will be in developing solutions. But what should this look like in the classroom, and what is the role of the teacher and school?

What Is Social Justice and Why Teach It?

The National Association of Social Workers defines social justice as "the view that everyone deserves equal economic, political and social rights and opportunities… social justice is much more than just a "view," social justice is both a goal and a process/product (Adams, Bell, & Griffin, 2007). This means that social justice isn't solely about teaching right from wrong and raising awareness of social justice topics, it is also about action. As Lucey and Laney (2009) explain:

> Teaching for social justice involves advancing children's moral and ethical development and helping children learn how to (a) value differences between people, (b) identify social injustices in the world around them, and (c) take collective action to remedy the social injustices they find. (p. 261).

As the diversity in the U.S. continues to grow, the importance of implementing social justice topics into instruction will follow. Social justice issues related to race, gender, sexual orientation, and religion (to name just a few), have been at the forefront of political and media agendas, and educating students on these topics is vital in helping them become active citizens (Adams, Bell, & Griffin, 2007). Teaching social justice issues in the classroom develops a sense of agency and responsibility within the students and assists them in discovering and exercising their own power as knowledgeable and critical citizens (Westheimer & Kahne, 2004).

The Social Justice in the Classroom Framework

Social justice issues don't present themselves in a singular manner, nor can engagement with them be taught through direct means of instruction. Doing so requires the critical examination of oneself, of others, and of events, in order to find patterns of inequality or oppression, and then requires an exploration of possible resolutions to the problems identified. Social justice advocates hope to create a society in which individuals have equal access to resources and receive equitable treatment regardless of their race, gender, religion, sexuality, income level or disability (Hackman, 2005).

The social studies classroom is a fitting environment for encouraging a social justice focused teaching style, since effective Social Studies instruction promotes open inquiry, in which diverse viewpoints and perspectives are shared and analyzed reflectively (Banks, 1985). In addition, the involvement of students in making sense of social issues of the past and present in order to inform future decisions has long been an important feature of social studies (Samuels, 2014). Further, since social justice is aligned with and can be woven throughout multiple aspects of the National Council of the Social Studies C3 curriculum (2013), Social Studies offers opportunities to foster this style of pedagogy and provide voices to marginalized populations (Banks, 1985).

While teaching for social justice is easily manifested in the social studies classroom through the C3 framework, taking such an approach is often too specific to social studies and cannot necessarily be applied to other subjects. A cross-curricular framework that addresses social justice issues is central to creating the "world changers" among their students that so many teachers hope to develop.

Bringing theory into practice however, can sometimes be challenging for classroom teachers and teaching for social justice is no exception. However, following a framework that creates a conscious environment, shows relevance, develops critical thinking skills, and creates plans for action can move instruction in the right direction, as described below in The Social Justice in the Classroom Framework (Figure 1).

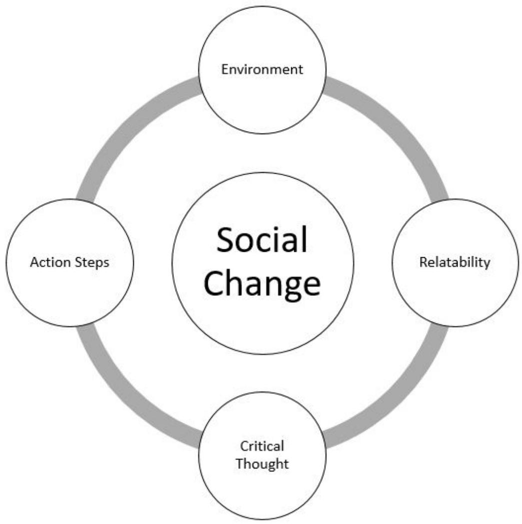

Figure 1. The Social Justice iin teh Classroom Framework.

First and foremost, a classroom environment conducive for social justice education needs to be consciously implemented. This can be done in a number of ways, but should begin by encouraging students to develop self-love, knowledge. and respect for others (Picower, 2012). Teachers should provide students with opportunities to learn who they are and where they have come from. In the process of doing so, students should study different characteristics of their identities and the histories associated with them and should deconstruct stereotypes about student identities.

Furthermore, teachers should provide students with opportunities to share knowledge about their own cultural background with their peers, and should create a climate of respect by learning to listen with empathy and kindness to the experiences of their peers. Helping students see each other as co-learners rather than as competitors is crucial to creating such an environment. If students don't view the classroom as competitive, they can move treat the learning process as a route to solving problems instead of as a path to achievement only available to a few students. By creating this sort of classroom environment, teachers enable students to build each other up in conversation and action (Hackman, 2005).

Beyond this, the content discussed in the class needs to be relevant and relatable. Once a proper learning environment is established, conversations about real-world topics can ensue. Both students and teachers need to be able to answer the question, "Why is this information important and how does it affect me?" (Delpit, 1995).

Here, teachers should provide opportunities for students to explore how diversity can be experienced as oppression that has marginalized populations, and should make links between that oppression and the impact it has on people today. Teachers may also showcase examples of movements addressing social injustices and help students understand that working together, ordinary people have united to create change. Students need to be able to recognize real world problems and engage with these issues (Picower, 2012).

Next, the teacher must focus on content mastery and critical thought. According to Hackman (2005), information acquisition is the basis for learning, and without complex sources of information, students cannot effectively advocate for positive, proactive social change. Furthermore, critical thinking skills need to be developed, because content mastery alone is insufficient to adequately prepare students to become active agents of change and social justice in their lives and communities (Hackman, 2005). Students need to be able to look at information and analyze, synthesize, and evaluate in order to develop a deep understanding of the topic. The gaining of information alone does not translate to this deep understanding, which in return does not create a pathway for action (Hackman, 2005).

In relation to this, Freire (1973) has argued that the presentation of information as truth without engaging in the questioning of that information runs the risk of creating strict and rigid environment that is not conducive to social justice learning. Freire argued that in a social justice-centered classroom, all content must be subject to debate and critique. This encourages students to move beyond passively accepting the messages they encounter in their lives, and to look at such messages in a more thoughtful and critical manner.

Finally, a social justice perspective on education is not complete without action. Action is a crucial and irreplaceable element of a social justice perspective on education (Brown, 2004). This type of pedagogy instructs future teachers to be proactive rather than reactive and to embrace conflict rather than ignore it (Brown, 2004). Here, teachers provide students with opportunities to bring awareness and action plans to social justice topics by allowing students to teach their peers about the injustices and advocate for action opportunities. Teachers may help their students gain the skills needed to create change firsthand by including activities such as creating petitions, protesting, or writing letters to officials.

Implementation

In my 6th grade classroom, I implemented The Social Justice in the Classroom Framework at the beginning of the year to help create the type of environment I thought to be most conducive to learning social studies. The students whom I taught were mostly from white affluent backgrounds, however, my classroom was also home to almost a half dozen different ethnicities.

Using the resources from the Teaching Tolerance (2018) program, I decided to use photographs to help teach students about social justice and oppression. Photographs may tell a story or make a statement about an idea and sometimes photographers use these ideas to convey messages. When students take a more critical view of pictures, real learning begins. In one lesson, I used a picture of a woman who looks like she was participating in a march (Teaching Tolerance, 2018). The women has a focused look on her face and she is holding both an American flag and a Mexican flag.

In trying to encourage a conscious and reflective environment before I showed students the picture, I asked my students to go home and ask their parents or relatives where they were from. Thus, the students began to explore their own identity, many for the first time in their lives. As the students began developing their sense of identity, I gave them opportunity to research their histories and to share their cultural background with classmates who background differed from theirs. This began creating a climate of respect by helping them learn to listen with empathy and kindness to the experiences of their peers.

Next, I showed the students the picture. I did not give any instructions or any explanation of the picture, but I allowed the students to study it and discuss their thoughts for a few minutes. I then read the caption to the students. The caption explained this was a Mexican woman holding the two flags during an immigration march in Detroit. Doing this brought relevance to the topic because their school is within 60 miles of Detroit, and several of the class members shared the same cultural background as the women in the picture.

Once environment and relevance had been established, I then prompted the students with the following questions to elicit higher order thought to create a deepening understanding of the topic through group discussion.

- Describe the person in the photograph. Just make note of what you see; don't draw any conclusions.
- Why do you think the person is holding two flags? One is a U.S. flag. See if you can figure out where the other flag is from.
- What do you imagine the person in the photo is thinking about and feeling?
- What feelings do you have when you look at the photo?

Finally, I asked my students how we could apply what we had learned to influence our classroom environment for the year. The students in the class recognized the diversity in our classroom and understood the importance of inclusion and celebration of those different cultures. The students did not want any of their classmates to feel oppressed or discriminated against, so they decided to create action steps to positively address the diversity their school. The students chose to take action steps including staying informed on current events by designating 10 minutes at the beginning of each class to watch CNN10; researching other cultures when they were first mentioned or discussed in the class; and learning about and breaking down stereotypes in the classroom through activities created by Teaching Tolerance Program.

Conclusion

An overarching goal of teaching from a social justice perspective should be to prepare students for participation in our democratic society. Whether we are exposing the students to these topics through the curriculum, through current events, through extra-curricular activities, or through spontaneous teachable moments, this exposure is vital to the development of active citizenry. The more awareness of social problems we can bring to our students, the more informed and effective they will be in developing solutions. However, implementing this type of instruction has proven to be difficult. Teachers often have the motivation to teach for social justice but lack a proper framework for follow through. By using The Social Justice in the Classroom Framework, a simple and clear framework, teachers can implement social justice topics into everyday lessons and conversations. Maybe then, we may help cultivate responsible, active, world-changing citizens.

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Game-based Learning
Teaching May Require Fun

Adam Rauscher

Abstract: This manuscript advocates for using game-based learning in the classroom. Some topics are difficult to teach because they require an entirely different mindset. Studies show that game-based learning can provide a new structure of learning to teach these new skills. Research from around the world demonstrates that using games in the classroom allows students to stretch to a new kind of thinking that improves their performance on assessments and their ability to think at higher levels. Particular attention must paid to game selection, which should focus on learning objectives. When no pre-made game fits the lesson, teachers can design their own games. Another focus must be the post-game discussion, in which the teacher can connect the activity to the core material.

The Object of the Game

Teaching the colonization of the Americas, I asked my 8th grade social studies class which continent was dominated by the French and English, expecting the answer of "North America." Instead, the class shouted, "America!" I sighed. "Not the country, the continent." I was met with blank stares. One student hesitantly ventured, "The United States of America?" This wasn't the first time I was disappointed in eighth graders' knowledge of geography, nor was it the last. It didn't seem to matter how many maps littered the room or how many Google images were imbedded in my slide shows, to my students, geography was an abstract concept.

Every content area has topics that are difficult to cover with conventional methods. In my social studies experience, geography and economics make my students' head spin. In English, it could be Elizabethan language or dreaded grammar rules. These are the areas that require an entirely new skill set to grasp, or which might seem to have the least connection to students' lives. These are the ideas that grind your curriculum to a halt. These are the questions that students meet with blank stares. Teachers who are tired of giving students lists to memorize, of nations or vocabulary words, need new methods to approach these challenging concepts and topics.

One of the most exciting new methods is game-based learning. GBL uses games in the classroom to teach new concepts or inspire deeper level thinking. Instead of reading a section in a textbook about the Land Ordinance of 1785, students became prospectors in an auction trying to buy the best plot of land for their needs, subdividing them for profit, and swinging wild trades. Just as in any game, the players are given goals to pursue and a set of rules that restrict how they pursue them. As they create strategies and change tactics, they have to analyze the subject matter in a deep and fundamental way. Some games are set in specific time periods and others may use fantasy to focus on a skill set. What all GBL activities have in common is a demand to make decisions and find novel ways to attain goals.

When you change gears in this way to approach one of these topics, you also change student attitudes to that topic. You switch from a traditional classroom to a game night. Multiple studies show that students love learning through games. In one experiment using games in the classroom, almost 95% of the 290 students said they enjoyed game-based learning and thought they learned a great deal (Jančič & Hus, 2017). A method that raises the level of engagement so high will be a welcome addition to any classroom. The students are happier. The teacher is less stressed. For this reason alone, every teacher should employ game-based learning in their curriculum.

Of course, the primary purpose of education is not for the students to have fun. Engagement without learning is recess, not education. Methods are best selected based on whether or not they help students learn. Thankfully, game-based learning is not only fun, but is also very effective at fostering learning.

For example, after just two months of playing a math video game, Dimension M, students showed improvement in confidence and motivation, but also on tests (Foster, Shah & Barany, 2017). Eighth grade classes that learned the French and Indian War through a strategy game showed a 5% improvement in test scores over those that did not-- even when re-tested six months later (Cicchino, 2015). Perhaps the most remarkable results were in a group of fifth and sixth graders who played Civilization III weekly in an afterschool program. Every student who played "earned an A in social studies, and their parents reported that their grades had gone up across all subjects" (Squire, DeVane, & Durga, 2008, p. 248). Every single student. Game-based learning gets results.

Many teachers are already using games without realizing it. No physics class is complete without a bridge building contest. Using popsicle sticks and glue, students build bridges, applying the information they've learned about weight distribution and force. They compete to build the bridge that holds the most weight. By turning this activity into a game, it becomes something memorable for students. (I came in second place in the eleventh grade in 1996 and I will never forget.)

Getting Started

So, let's get started! Just grab Monopoly to teach economics, Balderdash to teach vocabulary, and Portal to teach logic! This is going to be fun!

Not so fast. Picking games off the shelf can be very tricky. The advantage of game-based learning is that it forces students "to make decisions without traditional instruction" (Lasley, 2017, p.40). This helps promote critical thinking, raising essay scores by more than 50% in one study (Chee, Mehrotra & Liu, 2013). However, when selecting games you need to be careful to be sure that the majority of the decisions students make reflect your learning objectives. For instance, Assassin's Creed has often been praised for its attempts to replicate period architecture, clothing, and characters. However, the majority of players' decisions involve what route to use to approach enemies and how to flee. This is very effective in teaching architectural history, but will teach very little about everyday life in the time period (McCall, 2016). (Conceivably, it also could be useful in a school for assassins.) While it is possible to use already popular games, this should only be done if they effectively align with your learning objectives.

I'm proposing a different solution. This is one you need to be sitting down for. I want you to design your own games for your classroom. It is work. It will take time. But it can be wildly effective for the topics you need a change of pace for. Don't worry. I've done it myself and you can too.

The Rules

In order to design your game, you need to make sure you know the basic criteria of games, as well as of game-based learning. Games have objectives, whether it is to score points, make money, or physically take down your opponent. Games have rules. Players agree to restrict their actions to within certain bounds. Game-based learning requires players to make lots of decisions: what card to play, which property to buy, which territory to invade. GBL involves socialization. Players need to work together or against each other, or, at the least, be discussing their games. Lastly, GBL requires reflection. The time spent talking about the game is when the education happens.

An effective game needs an objective. In popular games, these are very familiar. In boxing, the goal is to knock your opponent down. "Effective GBL environments are designed with learning outcomes in mind" (Cicchino, 2015, p. 3-4), so choose your goal based on your learning objectives. One classroom introducing students to Shakespeare had an Elizabethan insult contest. The goal was to deliver a better "burn" against your opponent. The learning objective was to make students more comfortable with Elizabethan terms, and it built on the idea that teenagers are very comfortable insulting each other. In teaching geography, I challenged students to plan the fastest route from New York to Toledo in the year 1800. My learning objective was for my students to understand how geographic barriers kept southerners in the South and northerners in the North during westward expansion. In both of these games, meeting the objective of the game requires meeting the objective of the lesson. Picking a goal that aligns precisely with your learning objectives is the most important step.

Every game has rules. Rules are what separate games from real life. If the goal in boxing is to knock down your opponent, the easiest way might be to hit them with a chair, but boxing requires you do it with your fists. If you use a chair, then it becomes professional wrestling. As philosopher Suits (2014) wrote, "Playing a game is the voluntary attempt to overcome unnecessary obstacles" (p. 41). For some reason, in games, obstacles are what makes them interesting and fun. Perhaps because in games, success boils down to guile, aplomb, and moxie-- all words that will help you win at Scrabble.

In most games, the obstacles are arbitrary. In game-based learning, the obstacles should also be in line with the content you want to teach. In my geography challenge, students were restricted to traveling by boat, horse, or foot because there were the methods available in 1800. Because jets were not used in westward expansion, I did not allow them in this game. The restrictions you place on your students should either represent the restrictions of the history you are teaching or should push your students toward the kind of thinking you want to encourage. Choose your rules carefully.

Your game must be constructed to maximize decisions. These are the moments when students think. This is not a rule in actual gaming. The Game of Life is very successful in spite of players making five decisions the entire game—to go to college or not, which job to pick, and of three forks in the path to take. However, and consequently, it teaches almost nothing about real life in which we are faced with a myriad of decisions. In game-based learning, students "probe and experience the possible situations which may occur after making some decisions" (Hwang, Chiu & Chen, 2015, p. 15). Students consider the available information and create options, then as best they can, they evaluate which option will yield a better result. Finally, they act, and compare the results to their predictions. For example, in the Civilization series of computer games, players make multiple decisions each turn about whether to focus each city or unit on gathering resources, generating culture, or building armies. Making more decisions gives students more opportunities to try out and apply the skills you are teaching.

Game-based learning is most successful when it has a social aspect. Having students watch each other make decisions enables students to work together in what Vygotsky called their zones of proximal development (Lasley, 2017). Teams are an obvious, but not necessary, way to create socialization. The most common form of interaction in games comes through competition, which is also not necessary.

Some games step outside the box entirely. One successful activity had students create artistic representations of economic problems using a prescribed collection of recycled materials. The socialization came in presenting their projects and commenting on them (Rule, et al., 2012). So long as students can observe and learn from one another's decisions, game-based learning is taking place.

In fact, these moments of reflection, in which students reflect on whether their actions have led to successful outcomes, and considered why they have or have not, are essential to the success of education through games. "Eighty percent of the value of gaming lies in the postgame discussion" (Dorn, 1989, p. 11). Think about every game you've played. Picture the conversation afterward about who won and how. This conversation can be a lot of fun, but it also helps players understand what strategies work and why. I'm still frustrated by a game of Scotland Yard from March that I lost on the second to last turn. I expected my opponent to maintain the same strategy from the middle of the game into the endgame. I won't make that mistake again.

The last step in the reflection process is to connect it back to the core material. "It is all too easy to immerse oneself in play without reflection, especially reflection about connections between the game and history" (McCall, 2016, p.534). Students will be energetic and excited. They'll want to go home and talk about how awesome class was today. They'll call you their favorite teacher. But unless you explain, or the class discusses, how the game applies to the content, students will rarely make the connection on their own.

Making these connections can be easier than you might think. In my geography game, in every class, the winners rode a horse from Albany to Buffalo. Students discussed the fact that there was no better way to get west of the Appalachians except in the extreme South. This allowed me to segue easily into an exploration of the construction of the Erie Canal, and to link to the eighth grade standard that students understand how westward expansion contributed to sectionalism. The

English class observed that the most effective Elizabethan insults in their contest involved sexual euphemisms, which was a perfect introduction to Romeo and Juliet, which is filled wall-to-wall with sexual humor. During the post-game discussion, let the students find these connections organically. Then make sure that those connections become explicit to the entire class. One study earlier showed improvements in math when students played Dimension M. In that same study, they also played Physicus, but showed no improvement in physics. The biggest difference in the study was that the math teachers regularly discussed the game and how it connected to the subject matter and the physics teachers did not (Foster, Shah & Barany, 2017). Focus your planning on making connections.

These connections lead directly to higher achievement. A civics class of 15 year olds was divided into one group that used conventional methods and another that learned through playing Statecraft X. This game allows players to become the governors of a medieval village, weighing priorities and varying cooperation with each other. Afterwards, players debated when cooperating with other players was more successful (versus competing with them), as well as which priorities yielded the best results, and when it made sense to change tactics. Both groups were then asked to write an essay evaluating the effectiveness of their current national government. The group who played Statecraft X scored on average 50% higher than those who did not, with particularly high scores on analyzing multiple viewpoints and using supporting evidence (Chee, Mehrotra & Liu, 2013). In that case, playing a game that fulfilled the components of game-based learning led to very impressive results.

The Playing Pieces

Creating your game does not need to be overly complicated. An Elizabethan insult contest requires a Shakespearean vocabulary list. For my geography game, I provided students with two maps, a ruler, and a list of travel speeds (see Appendix). The bridge building lab requires popsicle sticks and glue. None of these are particularly more complicated than what you'd create for your average lesson.

Feel free to use pieces from existing games. Any game using money can borrow bills from Monopoly. For a game about how scarcity affects economics, use the resource cards from Settlers of Catan. Probability games might use dice, playing cards, or coins. Those with inspiration and money to burn can buy random game pieces online at The Game Crafter. Using different materials helps make the activity feel different to students, so find new something to introduce.

Winning the Game

The eighth graders at my school have been taking the same unit end test for seven years. There are two questions requiring students to read maps and one about geography. In most years, these questions are answered correctly by about 80% of the eighth grade. After playing my geography game, nearly 95% of the students answered them correctly. It's not a scientific study, but I knew it was a successful lesson when other teachers asked to use it.

Game-based learning improves student outcomes. In particular, it is suited to teaching the application of skills and evaluation of ideas, rather than the mastery of facts to recall. This is especially important for teaching skills that don't fit neatly into your lesson plans. With a few simple rules, it's easier to design games for the classroom than many teachers think. It is likely that many teachers are using a smaller form of game-based learning without realizing it. And it's a lot of fun. Given all of this, every teacher should be designing games for the classroom.

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Appendix

1800 Travel Times

Your group is planning to move from New York City to Toledo. You need to figure out the fastest way to get there. Use the River Map, the Topographic Map, and the charts below to figure out how long it will take to get from New York to Toledo in 1800. Whichever group gets the closest to the fastest time (accurately) wins a prize.

Travel Speeds

Method of Travel	Numbre of Miles Traveled Per Day
By Horse	16*
By Boat	45
By Carriage	12*
By Foot	10*

*Land speeds halved when traveling through mountains.

NewYork to Baltimore (By Land)

Step	From	To	Distance	Travel Method	Miles per Day	# of Days

New York to Baltimore (By Water)

Step	From	To	Distance	Travel Method	Miles per Day	# of Days

Planning Your Journey

Step	From	To	Distance	Travel Method	Miles per Day	# of Days

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A publication of the Department of Curriculum and Instruction
Rebecca M. Schneider, Professor and Chair

University of Toledo

Cover Designer
Margaret Schneider