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Learning to Teach

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

Editor in Chief
Rhonda Aguiton, Ph.D.

A publication of the Department of Teacher Education
Mark Templin, Ph.D., Chair | University of Toledo

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Section on Language Arts

Section on Mathematics

Section on Science

Section on Social Studies

Language Arts

Using Methods to Facilitate an English Classroom Environment that Motivates All Students to Learn

Joshua Snider

Abstract: In this paper, I delve into strategies that English teachers can use to build a classroom environment that inspires all students to learn, regardless of their backgrounds. I draw on motivation and belongingness theories to emphasize the significance of positive peer interactions and strong student-teacher relationships in cultivating a supportive learning space. Furthermore, I explore how community engagement initiatives can help tackle broader social issues that affect student motivation and engagement. By focusing on these elements, English teachers can establish a classroom atmosphere that motivates every student to excel.

Introduction

> *Jamal is a quiet student who recently moved from a rural town to a bustling city school. Initially disengaged, Jamal struggled with self-identity and connecting with his peers until his teacher, Ms. Garcia, recognized his passion for storytelling. Ms. Garcia noticed this by observing the detailed and imaginative stories he would write during free writing exercises. She also saw how animated he became when discussing books. Understanding the potential of his storytelling talent, Ms. Garcia encouraged Jamal to share his stories with the class and provided him with opportunities to further develop his narrative skills, thereby boosting his confidence and helping him connect with his classmates. Ms. Garcia transformed her classroom by including storytelling in her lessons and creating a safe space for students to share their ideas and experiences. This approach motivated Jamal to participate and improve his grades, and overall engagement.*

This story illustrates the importance of creating a classroom environment that values and motivates all students, regardless of their backgrounds. This paper explores strategies for English teachers to cultivate such an environment.

English teachers often face the challenge of motivating students with a variety of different backgrounds. One of the greatest challenges for English teachers is fostering a classroom environment that motivates all students to learn, regardless of their diverse backgrounds. This challenge becomes especially pronounced when students have varying backgrounds, each with its own set of experiences, needs, and expectations. As educators, our goal is not only to impart knowledge but also to inspire a love for learning. In this paper, I will explore strategies and approaches that English teachers can employ to create a classroom environment that motivates all students, regardless of their backgrounds, to engage deeply with the subject matter and become lifelong learners.

Establishing a Positive Classroom Atmosphere

In my student teaching, I had a student named Alex who struggled with motivation and often seemed disengaged during class. Alex rarely participated in discussions and his grades reflected his lack of interest. Determined to reach him, I focused on building a positive relationship with him. I started by learning about his interests and incorporating them into the lessons whenever possible. I also made a point to greet him personally every day and acknowledge his efforts, no matter how small. Gradually, I noticed a change. Alex began to participate more in class and his grades improved.

As I got to know Alex better, I learned that his home life was challenging. He lived in a foster home where the foster "parents" came in on shifts. So Alex never had a single foster parent that ran the house but had multiple people that would come in a day or week because it was their shift to be a foster parent. The stress and responsibility at his foster home left him exhausted and distracted in school. Coupled with the lack of support from his foster home this caused Alex to not focus on school. Understanding this, I realized that the support he needed went beyond just academic help; he needed to feel understood and supported emotionally as well.

This experience underscores the critical role of interpersonal opportunity structures. As Gray (2018) notes, "Interpersonal opportunity structures, such as positive peer relationships and student-teacher relationships, contribute to satisfying students' belongingness needs and subsequent competence motivation." Both types of relationships significantly impact student motivation. When teachers create these positive connections with their students, these students become more motivated to learn. Positive peer relationships foster a sense of community and support among students, encouraging collaboration and mutual encouragement. Similarly, strong student-teacher relationships are built on trust, respect, and genuine interest in students' well-being. Teachers can foster these relationships by showing empathy, providing personalized feedback, and being approachable. When students feel valued and understood by their teachers, they are more likely to engage actively in the learning process and strive for academic success. Therefore, fostering these interpersonal connections is essential for creating a motivating and inclusive classroom environment.

Teachers who establish warm, empathetic, respectful connections with their students create a positive learning environment. As Zainullah (2023) explains, "teachers who establish warm, empathetic, and respectful connections with their students foster a conducive learning environment." This environment is important for students' academic and emotional development; by showing empathy and respect, teachers can help students feel valued and understood. This can boost their confidence and willingness to engage in the learning process. Furthermore, a positive classroom atmosphere encourages collaboration among students, promoting a sense of community and belonging. For instance, according to Avery (2018) teachers who regularly incorporate group activities and open discussions enable students to share their thoughts and ideas freely, leading to enhanced social skills and mutual respect. Implementing strategies like positive reinforcement, active listening, and personalized feedback can further strengthen the teacher-student relationship, making the English learning process more enriching and effective.

Teachers must build positive relationships with students and it is important to see that motivation can also be affected by other factors within the school environment. For students like Alex, who have significant challenges at his foster home, school can be a place of stability and encouragement. In addition to fostering positive relationships, schools must address broader issues that impact all students. This can include introducing English programs that promote community engagement that can engage students and the community. By taking a holistic approach, educators can create an environment where all students, regardless of their background, can be engaged.

Introducing English Language Arts (ELA) Programs that Promote School Community Engagement

In my student placement, I encountered a teacher who recounted a poignant story about a student named Wesam. She shared that Wesam often sat alone during lunch, rarely engaging with his peers. Despite her persistent efforts to integrate him into classroom activities, Wesam remained withdrawn, resulting in a decline in his academic performance. The teacher later discovered that Wesam's family had recently relocated to the area and was facing challenges in assimilating into the community. This revelation illuminated the fact that Wesam's struggles transcended mere academics; they were deeply rooted in social integration as well.

Despite the teacher's attempts to implement a program pairing students with peers for support during classes, she faced obstacles due to administrative constraints. The administration, preoccupied with what they deemed more urgent matters, failed to prioritize initiatives that fostered inclusivity and support for students like Wesam. To address this gap, the teacher creatively utilized literature to cultivate empathy and forge connections among her students. Drawing from Stansfield's (2014) insights on the link between reading fiction and cognitive empathy, she curated stories centered around themes of belonging and resilience. Through discussions and sharing sessions prompted by these narratives, she encouraged her students to delve into their own experiences and perspectives, fostering a deeper understanding of Wesam's situation.

This experience shows the broader social fabric that influences students' lives. Spencer (2007) aptly notes the detrimental impact of social isolation and stigma on students' school adjustment, emphasizing the need for proactive interventions. Programs aimed at bolstering community support can mitigate social barriers and enhance student engagement, as evidenced by Wesam's notable improvement in participation and academic performance. While community programs play a pivotal role in fostering inclusivity, their efficacy hinges on institutional support. Schools must implement such initiatives and embrace complementary strategies to nurture a culture of acceptance. Initiatives like creative writing workshops or thematic book clubs can empower students to voice their experiences, hone their communication skills, and cultivate empathy and solidarity. These programs not only facilitate self-expression and critical thinking but also bring a sense of belonging through shared narratives and meaningful dialogues.

Schools need to prioritize staff training to identify and address instances of social isolation effectively. Ensuring equitable access to resources and support systems is paramount in promoting students' overall well-being and sense of belonging. By adopting a holistic approach that combines supportive community programs with inclusive policies and initiatives, schools can create an environment where every student feels valued and included. In conclusion, addressing social dynamics in education is crucial for fostering a positive and inclusive school culture. By learning from experiences like Wesam's and implementing proactive measures, schools can pave the way for a more empathetic, supportive, and enriching English learning environment for students.

Creating a motivating classroom environment involves strategies like community engagement, but there are challenges to consider. One big challenge is how resource-intensive community programs can be, needing funding, time, and logistical support that schools might struggle to provide. Personalizing lessons for each student is great for engagement, but it can make covering the curriculum and doing standardized assessments troublesome. Finding the right balance between personalized English learning and meeting academic standards takes careful planning. Building strong relationships between peers and between students and teachers can also be tough, especially in schools with high turnover or diverse backgrounds. Educators need to navigate cultural differences and communication styles effectively. Despite these challenges, proactive steps like ongoing professional development and working closely with stakeholders can help overcome barriers and make these strategies work well.

ELA Lessons that Connect with Students

Mr. Wagner, an experienced English teacher, noticed that Emily, one of his students, seemed consistently disengaged during their poetry unit. Despite his efforts to make the poems lively through dramatic readings and group discussions, Emily remained uninterested. Worried about her disengagement, Mr. Wagner decided to talk to her one-on-one. During their conversation, Emily shared her struggle with the poems, finding the language old-fashioned and the themes irrelevant to her life. To her, the poems felt like distant artifacts rather than meaningful expressions of emotion.

Listening carefully, Mr. Wagner realized the importance of connecting with students personally, especially in teaching English Language Arts. He understood that teaching poetry effectively meant bridging the classroom material with students' real experiences. This realization inspired him to adjust his teaching approach to help students relate to the poems they studied by creating different poems and assignments that students could choose from. Mr. Wagner's decision to talk to Emily after noticing her disengagement highlights the importance of creating lessons that resonate with students. As Abrahamson (2011) suggests, teachers should empathize with students' perspectives to create meaningful English learning experiences.

Customizing ELA lessons to connect with students personally is crucial for engagement and understanding. Mr. Wagner's insight into Emily's struggle with poetry due to its perceived disconnect from her life shows the need to make literature relevant and relatable. According to Eccles (2005), by creating multiple ways for students to complete an assignment that has different interests of students such as

incorporating modern themes, and diverse voices, and encouraging students to relate their experiences, educators can foster student engagement and love for English learning. Mr. Wagner incorporated the research brought by Eccles into his classroom which engaged Emily and his other students.

Conclusion

The strategies explored, including fostering positive peer and student-teacher relationships, implementing community engagement programs, customizing ELA lessons to connect with students' experiences, and promoting inclusivity, collectively contribute to creating a vibrant and motivating classroom environment for all students. By embracing empathy, understanding individual needs, and engaging with broader social contexts, English teachers can cultivate an inclusive and supportive atmosphere that not only enhances academic outcomes but also nurtures emotional well-being and a sense of belonging among students. This holistic approach celebrates diversity, promotes lifelong English learning, and empowers students from diverse backgrounds to thrive academically and personally, ensuring that every student has the opportunity to reach their full potential.

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Joshua Snider is a student in the Licensure and Master Program (LAMP) at the University of Toledo. He holds a bachelor's degree in criminal justice and is currently pursuing a master's degree in education along with licensure in Adolescent to Young dult (AYA) English. With a strong commitment to creating inclusive and engaging classroom environments, Joshua integrates interactive teaching strategies to support diverse student backgrounds and needs.

Writing Improves Reading Comprehension

Lisa Stokes

Abstract: Reading and writing are both critical skills students need to be successful both in and out of the classroom. Researchers have devoted much attention to understanding predictors of reading success and effective instruction. The purpose of this article is to provide teachers with information and research that supports using writing to improve reading comprehension. This article first examines the research as to why writing is such an important skill and how reading and writing correlate. It will examine different types of reading and writing instruction, and offer suggested approaches based on research findings. The article will conclude with a look into whether or not teachers are prepared to teach reading and writing the way research suggests it should be done.

Introduction

Despite much effort, many elementary students are still struggling to read and write. The 2009 National Assessment of Educational Progress (NAEP) reported that only 38 percent of twelfth grade students performed at or above the "proficient" level in reading. In younger students, only 33 percent of fourth graders and 32 percent of eighth graders performed at these levels. Due to this, an important policy question that must be answered is, how can schools strengthen students' reading? One approach to be considered is to utilize effective writing instruction as a tool to improve students' reading. Another aspect that must be considered is, are teachers prepared to effectively teach writing so that it supports reading comprehension?

Why is Writing an Important Skill?

If policy makers and school administrators are going to emphasize writing instruction, they need to understand why they should value it. One reason is that writing enhances student performance in other subject areas, such as, science, social studies, and math (Graham & Hebert, 2011). Students understand and retain material read or presented in science, math, and social studies when they are asked to write about it. Increasing how much time is devoted to writing also improves reading skills and how well students read (Graham & Hebert, 2011). Writing about something can improve the comprehension of it by providing students a tool to record, connect, analyze, personalize, and manipulate main ideas in a text. Making writing an integral part of the curriculum maximizes student growth in the classroom. Yet, as important as writing is to our everyday lives, according to the National Center for Educational Statistics (2012), writing is considered a neglected skill in American schools.

Those that do not learn how to effectively write can suffer limits to their academic, professional, and personal lives. Students who graduate from high school with weak writing skills are at a disadvantage in college and their professional lives. According to Graham (2018), while there are many factors that influence children's ability to write, many children do not receive the writing instruction at school that they deserve or need.

How Do Reading and Writing Correlate?

Writing is often recommended as a tool to improve reading. It is widely believed that writing about a topic improves comprehension, as it helps to make connections between what one reads, knows, understands, and thinks. Sawchuk (2023) suggests that students need varied opportunities to write and should be taught explicitly and systematically, the skills and structure to see the connections of reading, writing, and knowledge development. He describes four key reading and writing interlocks. The first is reading and writing are intimately connected. Research conducted by Steve Graham, and his research partners (2018) found that reading has a positive impact on writing and writing also has a positive impact on reading. The second is writing matters even at the earliest grades, when students are learning to read. Experts suggest that students be supported in writing as soon as they begin reading. The third is like reading, writing must be taught explicitly. Research suggests that students be guided on how to construct sentences and paragraphs. The fourth is writing can help students learn content and make sense of it.

Writing about something read can facilitate comprehension because writing provides students with a tool to record, connect, analyze, personalize, and manipulate key information in a text (Graham & Hebert, 2011). In addition, reading and writing can be used together to accomplish specific learning goals (e.g., reading a text to then write a paper about the content). The following table (Table 1) shows how reading and writing can correlate and work together to improve and enhance similar skills.

Table 1
Reading and Writing Can Work Together to Obtain Similar Goals.

Writing	Reading
States ideas explicitly	Read for details
Organize writing to be explicit, to make sense, to include reflection, manipulate text to put into own words	Use critical thinking to analyze, interpret, and evaluate material
Determine word choice	Introduces new vocabulary
Use proper sentence structure	Improved reading fluency
Persuade the audience	Must recognize the intended message
Phonics instruction	Improved word recognition
Response writing	Builds background knowledge
Formulate and phrase the main idea	Must identify the main idea
Provide support for the main idea	Find the support for the main idea
Use linking/transition words or phrases	Recognize the sequence of events
Shape inferences	Draw inferences
Arrange ideas in a logical, sequential order	Follow the organization of ideas
Support opinions with facts	Differentiate facts from opinions

Reading and Writing Instruction

With research showing that writing scores in our schools are low, one would assume that writing would be the main focus in classrooms. However, instruction and

time spent on writing is limited. With new reforms being implemented in schools, teachers may have felt as though there was no time for writing instruction, as their main focus may be reading instruction. What is considered an exemplary writing program? According to Graham (2018), teachers should devote an hour a day to writing, and use a variety of instructional practices to promote students' writing success and growth, including evidence-based practices. In elementary students, this hour should include writing for different purposes, teaching the writing process, and teaching foundational skills. A lack of writing instruction in schools may promote the idea that writing is unimportant.

For students to achieve high levels of achievement, educators need to use the most effective instruction. Comprehension is a critical component of reading instruction, and comprehension is the end goal of every reader. In Graham and Hebert's analysis (2011), they found that writing as an additional means for enhancing students' reading comprehension by writing summaries, answering questions, notetaking, or using more extended writing activities, improved overall comprehension of text by typical as well as struggling readers.

Coker et. al. (2018), evaluated the effects that direct and indirect writing instruction and student writing practice have on reading achievement in students in first grade. Throughout their study, researchers focused on skills instruction, composing instruction, and opportunities for students to practice (consisting of correct/copy tasks, and generative writing practice). Their goal was to investigate the direct and indirect effects of two types of writing instruction (skills and composing) and student writing practice (correct/copy and generative writing). It was thought that the effects of skills and composing writing instruction would have a direct effect on reading achievement, but the research did not support the assumptions. The second hypothesis included the importance of student practice through correct/copy practice, and through generative writing practice. The path from composing instruction through generative writing practice was positive and significant. Teachers have minimal time in the classroom to achieve a multitude of results. Knowing which types of instruction would provide the greatest results within the time constraints given is invaluable to teachers that teach reading and writing.

Recent work by Graham (2018) identifies evidence-based practices in writing instruction. His work draws upon empirical intervention studies and qualitative investigations with exceptional literacy teachers. He found that effective writing instruction involves:

(1) writing frequently for real and different purposes
(2) supporting students as they write
(3) teaching the needed writing skills, knowledge, and processes
(4) creating a supportive and motivating writing environment
(5) connecting writing, reading, and learning.

Graham also identifies three core recommendations on writing practices that improve reading comprehension: have students write about the texts they read; teach students the writing skills and processes that go into creating text; and increase how much time students write. This shows that teaching writing not only improves writing skills, but also enhances a student's ability to read a text accurately, fluently, and with comprehension. Finally, having students spend more time writing increases the student's ability to comprehend the writing of others.

What Does Research Show?

Although there may be a variety of reasons school reforms are failing, educators may feel as though it may be due to a gap between research and practice. Meaning, there is a disparity between the findings of scientific research and of effective instruction and what teachers teach in the classroom. With low student proficiency levels in reading, many teachers seem to be utilizing practices that produce little to no positive effect on student growth.

Beginning no later than the 2024-2025 school year, each Ohio school district must use core curriculum and instructional materials in English Language Arts and use evidence-based reading programs that follow The Science of Reading. The Science of Reading is an interdisciplinary body of scientific research that informs us how students learn to read and write proficiently, explains why some students have difficulty learning to read and write, and supports the ideas that students learn best from explicit and systematic instruction in phonemic awareness, phonics, vocabulary, fluency, comprehension, and writing. The Science of Reading research provides us with the information we need to gain a deeper understanding of how we learn to read, what skills are involved, how they work together, and which parts of the brain are responsible for reading development. There are a number of instructional approaches that have been found to increase reading comprehension through The Science of Reading, including teaching thinking strategies and enhancing written language performance. From this research, we can identify an evidence-based best practice approach for teaching foundational literacy skills called Structured Literacy.

How does writing fit into The Science of Reading? If students are doing work on phonemic awareness, they can put them on the page using letters. If students are learning how to decode, they can also encode (write the letters and words while they say the sounds out loud). Research on The Science of Reading suggests that students learn to write as soon as they begin to read (Sawchuck, 2023). Evidence also suggests that spelling and handwriting are connected to the ability to connect speech to print and to oral language development (Sawchuck, 2023). Writing can enhance foundational reading skills and student knowledge on how words and sentences work.

Despite great enthusiasm for structured literacy instruction, many educators are not trained in how to effectively implement the science of reading in their classrooms. An important step in seeing improved outcomes from following a structured literacy approach is that it must first be implemented. It must also be applied with fidelity and over time to see results.

Teachers may be hesitant to try a new approach for a number of reasons. One reason may be a lack of training. Teachers may also find the research to not be trustworthy or usable. Another reason may be that teachers do not find the research to match the realities of their classrooms and the unique needs of their students. Finally, teachers adapt to curriculum that is usable. Does the curriculum flow well with what they are already doing? Do they have the resources, support, and time to follow the guidance with complete fidelity?

Teacher Preparedness

Whether or not teachers teach reading and writing instruction together, integrated, or taught as separate subjects vary greatly. Many teachers integrate the two, yet many also teach them as separate subjects. According to the AACTE (2002), instruction requires some integration of the two, but from a solid base of competence in both. It is not clear that teachers have adequate preparation to provide needed instruction in reading and writing. Although, in recent years greater attention has been given to teacher preparation for reading instruction.

To deliver proper writing instruction, a teacher must have proper knowledge of syntax and morphology as well as a foundation of knowledge in multiple writing genres. Teachers are likely to teach writing more effectively when they are knowledgeable about different genres and effective writing in those genres, the writing process, and effective strategies for teaching the writing process, and are able to develop knowledge, strategies, and skills in their students (Graham & Hebert, 2011). Yet, many teacher preparations do not prepare teachers to teach writing effectively (Graham & Heber, 2011). Teachers' confidence to teach writing is dependent on professional preparation, as well as the time and importance they give to writing instruction. It cannot be assumed that pre-service teachers have sufficient knowledge or enough experience to effectively teach writing.

If students are to receive the reading and writing instruction they need and deserve, there must be an explicit, agreed upon plan for how reading and writing is taught in the classroom. This goal does not mean that every teacher in every classroom has to do exactly the same thing, but it does mean that there should be some sort of continuity. There should be common goals, and connection to the purpose of writing outside of the classroom. Such a plan should include knowledge of reading and writing and development, developed with the input of teachers, and be supported by administration and policy makers (Graham & Hebert, 2011). While individual teachers do make a difference, high quality reading and writing instruction should not vary teacher to teacher, or year to year. This means that teachers and administrators, and administrators and policy makers need to have open communication and be on the same page when it comes to expected reading and writing curriculum and expectations.

The curriculum expected to be taught in the classrooms should be easily understood by classroom teachers for ease and effectiveness of classroom application. It would need to be practical for meeting teachers' needs in the classroom environment.

Conclusion

The research concludes that there is evidence to support the importance of writing instruction for reading achievement. Engagement and instruction in either reading or writing, results in improvement in the other. Effects of various types of writing instruction on reading comprehension vary. For example, Graham and Hebert (2011) found that answering questions in writing produced small effects, whereas notetaking, summary writing, and more extended writing resulted in moderate effects. Graham also found that increasing how much students wrote and how much

writing instruction they received also had a significant effect on reading comprehension, and that sentence and spelling instruction had a moderate impact on improving word-reading skills.

Clearly, far more work needs to be done on acknowledging the effects reading and writing have on each when taught simultaneously as well as the teaching of reading and writing as separate subjects. Research has not effectively considered the specific features that make reading and writing similar, yet unique.

Although there is still much to learn about the reading and writing correlation, it is argued that the two should be integrated. Though, such instruction has been found to be uncommon and teacher preparedness is not adequate. If teachers are expected to integrate the areas of reading and writing together, there must be collaboration between policy makers and universities. In addition, society needs to view writing as a valuable and necessary skill so that expectations are high and writing is emphasized. If teachers acquire the needed knowledge, vision, and commitment, they are more likely to become more effective at teaching writing and devote more time to teaching it.

Reading and writing instruction is not adequate in many classrooms across the country. Changing this situation will require collaboration between teachers, administrators, and policy makers. However, it is important to mention that all changes related to better instruction, no matter how small, are a step in the right direction.

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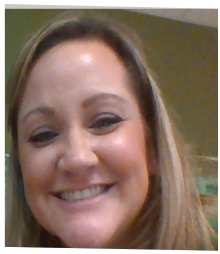

About the Author

Lisa Stokes is an 11-year veteran educator with experience teaching students grades PK-3rd grade. She possesses a B.A. in Early Childhood Education and is completing her M.Ed. in Curriculum and Instruction from the University of Toledo. Currently, Lisa is a 3rd grade teacher in the Sylvania Schools District.

Mathematics

Integrating Reform Math Instruction in the Special Education Classroom

Amy Rahal-Shelton

Abstract: Over the past twenty years, the goals of mathematics education have evolved. While procedural knowledge remains important, there is now a greater emphasis on reasoning, problem-solving, and discourse. The direct instruction approach, commonly used for students with learning disabilities, has not kept pace with these new expectations and does not adequately develop the conceptual knowledge and reasoning skills emphasized by the Common Core State Standards for Mathematics. By combining the reform-math approach, which is preferred in general education, with direct instruction, students with learning disabilities can achieve deeper understanding and improved generalization of their math skills, leading to holistic development. This paper will provide information on improved learning outcomes for students with learning disabilities when these two approaches are integrated.

Introduction

"The person who does the thinking, does the learning." This quote from a math teacher I recently worked with has stayed with me. While it seems obvious that teachers should encourage students to think about their thinking, this is not happening in all classrooms. Despite the math reform movement and a commitment to equity in education, the disparity in math instruction between students with learning disabilities and their peers without learning disabilities persists. In a typical special education classroom, students with learning disabilities have fewer opportunities to develop their reasoning skills. This is primarily due to the choice of instructional methods. The direct instruction approach, favored in special education classrooms, limits students' growth, and widens the divide between students with learning disabilities and their typical peers.

Why Math Matters to Students with Learning Disabilities

Conceptual understanding of mathematics lays the foundation for quantitative reasoning (QR). QR is the ability to apply basic mathematical concepts and skills to solve real-world problems. Failure to develop these skills will create shortcomings that will affect the student academically, professionally, and personally. More broadly, failure to develop quantitative reasoning has societal implications.

Beyond academic benefit, QR proficiency has everyday life applications including understanding nutritional information, budgeting, understanding terms of loans, interpreting medical results and cooking. Additionally, QR prepares students for the jobs of the future. With the evolution of technology, there is a high demand for workers with strong logic and analytical thinking. Currently, there is limited participation of students with learning disabilities in the science, technology, engineering, and math (STEM) fields, with limited time spent problem-solving and discourse potentially to blame (Lambert & Sugita, 2016). Improving student participation in

mathematical discussion and problem-solving can open doors to a new career path, which can empower a student to live more independently.

Furthermore, students with better developed QR skills will be better equipped to understand charts, graphs, and other data. As adults, they will also be better able to discern the validity of information, which will result in improved judgement and decision making. Implementing instructional practices that develop students' ability to apply and generalize math concepts will not only positively impact their lives, but also improve their contributions to society.

Two Instructional Practices

Direct instruction and reform math instruction, as shown in Table 1, are two favored instructional methods. In the special education mathematics classroom, where much instructional time is dedicated to algorithmic instruction, the method of choice is direct instruction. In the general education classroom where the focus is on peer interaction and creative problem-solving, the chosen method is reform math instruction. Highlighting this discrepancy, students in special education spend 70% of their time on algorithmic instruction, compared to just 30% in general education (Wilson & Hunt, 2022). While the direct instruction approach is effective in developing procedural understanding, it is less effective in developing critical thinking, creative problem-solving, and collaborative skills. By integrating reform mathematics instruction, which is based on the National Council of Teachers of Mathematics' Principles and Standards of School Mathematics (NCTM 2000), students with learning disabilities will have the same opportunities as their general education peers to develop a deeper conceptual understanding of mathematical concepts. The failure to integrate these practices in the special education classroom will result in limited opportunities for these students personally and professionally, especially in STEM fields.

Table 1
Comparison of Mathematics Instructional Approaches

Characteristic	Direct Instruction	Reform Math Instruction
Learning Theory	Behavioral Learning Theory: Teacher-Directed Example: worksheets, drills	Constructivist Theory: Student-Centered Example: student collaboration with peers, sharing ideas and reflecting on their learning and the strategies they used
Objectives	Mastery of skills, procedural understanding	Problem-solving, real-world applications, conceptual understanding
Teacher Role	Authority of learning; teacher explicitly teaches concepts, step by step	Facilitator of learning; the teacher guides the students and encourages discussion

Characteristic	Direct Instruction	Reform Math Instruction
Student Role	Students receive explicit instruction from teacher with student participation during guided and independent practice; limited opportunity for creative reasoning	Active participants in constructing learning through experiences; student-centered; creative problem-solvers
Discussion/Discourse	Work is mostly independent, with students verbalizing teacher-modeled ideas	Discourse encouraged in this collaborative classroom; students communicate and justify ideas
Methodology	Algorithmic instruction; learning outcomes performance-based; worksheets, independent work	Less time devoted to algorithmic instruction; project-based assessments; collaborative projects

Direct Instruction

Students with disabilities are traditionally taught using the direct instruction method based on the behavioral learning theory. In this approach, procedures are broken down into steps, with new steps not introduced until the student has achieved mastery. A concern with this approach is that students spend so much time working to achieve mastery that they have less time to dedicate to higher-order thinking and problem-solving activities. Another drawback of this teacher-centered model is that it gives the teacher the main voice, requiring students to conform to their teacher's reasoning, which leads to students verbalizing their teacher's reasoning, instead of their own (Wilson & Hunt, 2022).

The NCTM listed productive and unproductive beliefs about teaching and learning mathematics in their publication, Principles to Actions: Ensuring Mathematical Success for All (2014). Unproductive beliefs included characteristics of direct instruction such as: students should practice procedures and memorize math facts, all students should use the same algorithms, math should be taught sequentially with no progression until a concept is mastered, and an effective teacher guides students through problem-solving step by step. In contrast, productive beliefs more closely resembled reform math principles and included focusing on conceptual understanding, introducing students to a wide range of strategies, and teachers acting as a guide while the students' role is to construct their own understanding of mathematics through discourse.

Reform Math Instruction

In the early 90's the National Council of Teachers of Mathematics (NCTM) advocated for a change in mathematics instruction. In their publication, Principles and Standards for School Mathematics (2000), they outlined key elements of mathematics instruction, and standards. This publication not only influenced the reform math instructional approach, but it also influenced today's Common Core State Standards for Mathematics (CCSSM). This reform called for an increase in instruction that developed students' real-world problem-solving skills, while de-emphasizing algorithmic instruction. It also encouraged collaborative problem-solving which would

help deepen students' conceptual understanding and facilitate the generalization of their math skills. By engaging in collaboration, which is a principle of mathematics reform, students must explain their thinking and justify their methods through participation in discourse. This process not only fosters a deeper understanding of the content, but also contributes to student confidence, motivation, flexibility, and creativity (Bottge et al., 2007).

Integration

To grasp mathematical concepts, students must demonstrate tenacity in solving problems, actively engage in discussions, and apply quantitative reasoning (Lambert & Sugita, 2016). In one mixed-methods study, the authors developed a reform math instructional approach, Enhanced Anchored Instruction (EAI), to address the deficits in problem-solving skills in learners with disabilities. This method integrates technology, problem-based learning, and real-world contexts to make learning more meaningful and effective. Lessons are presented to students within a story or real-life situation using interactive software that has scaffolding built into it. This scaffolding addresses the students with learning disabilities' need for repetition to effectively grasp more challenging concepts. Students collaborate to find solutions to authentic problems, and instructors provide skill instruction as needed. The study, which was implemented in special education classrooms, found that students benefited from this type of instruction, and not only improved their problem-solving performance, but also retained skills that were taught (Bottge et al., 2007). The study found that teachers in special education classrooms are effectively able to instruct students in a way that aligns with NCTM standards (Bottge et al., 2007).

Another study looked at the impact of the Explicit Inquiry Routine (EIR) on students with disabilities. EIR integrates elements of direct instruction with inquiry-based learning. Beyond accurately solving one-variable equations, the goal was for students to express their thinking. The method involved explicit sequencing, moving from simple to complex problems. By beginning with simple equations, the students were able to establish the necessary background knowledge that enabled them to move on to more complex problems. After explicit instruction, students were guided through inquiry where they would explore ideas more deeply. Additionally, students' learning of mathematical procedures was scaffolded using the Concrete-Representational-Abstract (C-R-A) model (Scheuermann et al., 2009). The researchers concluded that the EIR method increased student scores on a word problem assessment, and that students not only retained these learned skills, but were also able to generalize these skills as evidenced in being able to solve textbook problems (Scheuermann et al., 2009). The results of this study demonstrate that combining direct instruction and reform math instruction can create an approach that is not only effective, but also aligns with the practices recommended by NCTM (2000), giving the students the opportunity to develop reasoning skills.

As a result of these innovative approaches, students with learning disabilities were able to engage in math learning in ways that resembled their peers. In both studies, the balanced approach of combining traditional direct instruction with math reform was effective in not only improving performance and retention, but also in generalizing new concepts.

Challenges

Wanting to improve math learning for students with learning disabilities is not a simple matter. There are challenges that educators face such as the lack of available research, lack of student readiness, and teacher knowledge.

One challenge educators face in closing the divide between students with disabilities and their peers without disabilities is the lack of research on the subject (Lambert & Sugita, 2016). Lambert & Sugita (2016) argue that we cannot assume that students with learning disabilities cannot meet the new math standards, but we also cannot assume that teaching students with disabilities using general education methods is effective either. What we need is to learn more about how to support these students to increase their math achievement through research proven methodologies.

The lack of alignment in teaching practices between the general education and the special education classroom presents another challenge. Students with learning disabilities may not be well-prepared to be successful with a more balanced instructional approach. They will have deficits in conceptual understanding and may have memory issues that affect their recall. To overcome this challenge, they will need instruction that combines both development of basic skills and problem-solving (Bottge et al., 2007).

In general education, student achievement has been found to correlate with the knowledge of their teacher (Hill, Rowan & Ball, 2005, as cited in Bottge et al., 2007). Teacher preparedness is another challenge that students with disabilities face. Their special education teachers may not be as well-versed in mathematics as content teachers. Special education teacher programs usually only include one math instruction course, and some programs may include none. Furthermore, this limited training does not prepare teachers to understand cognitive diversity, which refers to the various ways students with learning disabilities think. Having a better grasp of neurodiversity and how it affects mathematical thinking would help teachers better adapt their instruction, improving math outcomes for students with learning disabilities (Hunt et al., 2021).

Conclusion

Despite the challenges, we know that the different instructional approaches used in special education and the general education classroom develop different skills in the students. The objectives of math education have changed; it is no longer sufficient to merely remember formulas and calculations. As the world advances with technological innovations, student learning must evolve accordingly. Direct instruction has a place in special education, however for students with learning disabilities to reach their fullest potential, it should be integrated with the reform math approach. While students should learn procedures, they should also engage in discourse and problem-solving like their peers.

"Mathematics is a universal, utilitarian subject—so much a part of modern life that anyone who wishes to be a fully participating member of society must know basic mathematics" (Kilpatrick et al., 2001, p.15). This statement highlights the issue that we face today. By failing to integrate reform math instruction into special

education classrooms, we neglect to prepare our students for active participation in society. Integrating reform mathematics into our long-favored method of direct instruction is not merely a choice; it is a moral obligation.

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Teaching Reasoning within Mathematics to Students with Severe to Profound Needs

Pon Tsou

Abstract: Teaching reasoning within mathematics to students, specifically students with severe to profound special needs; requires student adaptive pedagogy, the use of discourse, and a focus on increasing motivation. This manuscript will explore some methods to promote and encourage discourse within mathematics, with a focus on how to do so in a practical and meaningful way for students with severe to profound special needs. This must be done by considering the individual needs of each student to increase intrinsic motivation which will help promote both generalization and maintenance of the skills learned.

Introduction

Mathematics can be considered as a universal language among the human species, and a deeper understanding of the subject matter can lead to a deeper understanding of the world around us. For this to be true, we must look beyond the surface level algorithmic approach commonly used in mathematics and dig deeper to understand the reasoning behind the approaches, the methods, and the formulas. To achieve this deeper understanding of mathematics, we as educators must focus on teaching reasoning of the subject matter. An effective way to achieve this is by offering opportunities for discourse within the classroom, which in turn allows the students to explore their own thoughts of the task at hand.

The best way to make this possible for all students is to use a student adaptive pedagogy which must be implemented at all levels. This student adaptive pedagogy approach is valuable to all students; however, it is especially important for students who have severe to profound needs. Finally, reasoning and other types of deeper learning are only achievable if the students themselves are invested in their own education. One of the best ways to do so is by fostering intrinsic motivation within our students. By installing the inherent desire to learn, the knowledge they will absorb will increase in both quality and quantity. In short, teaching students reasoning within mathematics, specifically to those with severe to profound special needs, requires student adaptive pedagogy, the selective use of discourse, and a focus on fostering intrinsic motivation.

Vignette

Throughout this paper, I will refer to the following vignette to illustrate and elaborate on the importance of each topic that may occur in real life.

The setting for the vignette will be a life skills room of a middle school. The students within this room all have severe to profound needs in either one or multiple areas of life. These areas include academics, adaptive living skills, and other health impairments. The subject being taught is math, specifically identifying and making purchases using money in practical circumstances. The classroom itself is a large room consisting of one teacher, two paraprofessionals, and eight students.

As this paper progresses, this vignette will be used to illustrate how reasoning can promote maintenance and generalization, how discourse could be applied in real life situations, examples of student adaptive pedagogy, and how intrinsic motivation may be increased through Maslow's Hierarchy of Needs.

Importance of Reasoning

According to the former president of the National Council of Teachers of Mathematics (NCTM), Hank Kepner "when you are looking at doing something in mathematics, there is always a reason behind doing it" (Kepner, 2010, p. 20). Reasoning within mathematics is arguably the most important and most effective way to teach mathematics. Reasoning helps facilitate learning the "why", not simply the "how". While the "how" is important, mere memorization has a tendency to be forgotten quickly and limited in scope. When learning the "why", students are better able to maintain and generalize what they have learned.

National Council of Teachers of Mathematics (2001) state:

> People who reason and think analytically tend to note patterns, structure, or regularities in both real-world situations and symbolic objects; they ask if those patterns are accidental or if they occur for a reason; and they conjecture and prove. (p. 56)

This ability to think analytically and note patterns can be generalized to other areas of everyday life outside of academics. It allows the student to take the same concepts that they learn in school and apply it to other areas of their life. Additionally, this deeper learning allows them to maintain their knowledge for longer periods of time. By understanding the deeper meaning behind the algorithms, why they are the way they are and not just memorizing the algorithms, students are more likely to remember what they have learned beyond the classroom. Perhaps most importantly, by performing the action of reasoning, students are able to strengthen their critical thinking ability.

Specifically for students with severe to profound special needs, the ability to use critical thinking is typically more challenging, in some cases, impossible. It is because critical thinking requires abstract thinking. The ability to ponder and question aspects of the problem that are not explicitly mentioned, nor inherently obvious, requires the student to think outside the box. This outside the box thinking, or abstract thinking is crucial to reasoning and the ability to reason. This is why reasoning is especially difficult for students with severe/profound needs, but at the same time, particularly important for them. Reasoning not only requires a certain amount of critical thinking to work, but it actively promotes critical thinking as an outcome. While it may not be completely possible for some students to fully obtain the ability to use critical thinking, any gains in that area are positive. Critical thinking assists with all areas of autonomy including self-determination, self-efficacy, and self-advocating. The ability to think for oneself, a crucial result of critical thinking, allows for all of these pivotal aspects of autonomy to bloom.

In relation to generalization and maintenance, the skills learned are a fundamental aspect of teaching students with severe to profound special needs. Referring to the vignette, students that are able to retain the ability to identify and make

purchases using money will be able to obtain a greater amount of autonomy and independence. They will be able to perform that skill in varying settings and with different people. Ultimately the goal of a life skills room is to provide as much autonomy as possible and to teach skills that their typical peers are capable of. To achieve that, a certain amount of generalization and maintenance is required. One of the more efficient ways to promote generalization and maintenance is through reasoning by promoting a deeper thinking within the students.

Effectiveness of Discourse

When students are engaged in discourse within mathematics, they are better able to engage in reasoning and other aspects of learning to further their education. A very important byproduct of discourse is that students tend to develop a certain amount of "ownership" over their own learning. Offering opportunities to take ownership over their own learning allows the student to figure out things their way, or in other words to "break down the barriers of ownership in the classroom" (Rumsey & Langrall, 2016, p. 417). In doing this, students have the opportunity to think for themselves, determine if they agree with another or not, and most importantly, rationally support their beliefs/ideas. The ultimate goal, to foster reasoning:

> Moreover, by having opportunities to confront such issues as being specific about the conditions of the numbers, critiquing the claims of others, and considering unfamiliar claims confidently, the students gained a conceptual understanding of the arithmetic properties, rather than only a procedural understanding. (Rumsey & Langrall, 2016, p. 419)

Essentially, students stopped merely memorizing formulas and problems, instead they went beyond to better understand the concepts, "to [understand] what they mean and why they are true" (Rumsey & Langrall, 2016, p. 419).

In addition to developing a sense of ownership over their own learning and reasoning, students can also develop a sense of confidence. According to Rumsey and Langrall (2016) "[W]e needed to provide opportunities for students to develop their own ideas and to have the confidence to validate or challenge the claims of others" (p. 417). To discuss those disagreements, a student must possess some level of confidence in their own opinions. If they lack that level of confidence, strategically providing opportunities to allow them to speak up will help build that confidence. Specifically allowing for multiple correct answers, or by asking open-ended questions allows the students to build confidence. Once they build that confidence, students that were originally hesitant will be more willing to step out of their comfort zone and take chances. This circles back to reasoning. By voicing their own opinions, by taking ownership over their own learning, by building confidence, the students are better able to think differently and think beyond what was explicitly taught to them.

Using the vignette as an example, students need to be able to tell not only when they make an error, but also when other people make errors as well - specifically, when receiving change back from a purchase. When performing this skill in real life, to live as autonomous a life as possible, the student must understand the value of money they are manipulating. If they give an amount larger than what is owed, they are then owed money. If what was returned is incorrect, the students must

understand that an error occurred and use discourse to correct it. This is useful in real life practical situations, and helps with self-determination, self-efficacy, and self-advocating in the form of increasing self-confidence.

Need for Student Adaptive Pedagogy

Student adaptive pedagogy is defined as:

> [H]ow teachers diagnoses and addresses his or her students' needs by (a) encouraging them to continue pursuing a productive problem-solving path or pointing out aspects of their current reasoning, (b) using questions or suggestions to orient student attention to useful resources with which to elaborate their thinking, and (c) re-voicing student's ideas to highlight key information or to reorganize their ideas for proper expression. (Xin et al., 2019, p. 43)

The term student adaptive pedagogy can essentially be switched out with "differentiation" or "individualized approach"; however, since the source I chose used "student adaptive pedagogy", that is the term I will use in this paper. Student adaptive pedagogy is important for effective instruction to all students; however, it is essential for students with severe to profound needs. In some cases, effective instruction is impossible without the use of student adaptive pedagogy. In other words, each student learns and demonstrates their knowledge differently. Additionally, each student has a different background which greatly affects their cognitive and emotional abilities. Finally, there are individuals who require accommodations and modifications to function at a similar level when compared to their peers. A great example of an individualized approach is Universal Design for Learning (UDL). UDL uses a three-tiered approach - focusing on delivering the lesson, assessing the students on said lesson, and motivating the students in general. The key component to UDL is that differentiation must be considered from the inception of the lesson, not added in after the fact. When differentiation is considered from the beginning, it is better distributed throughout the lesson plan and more effectively delivered to the students. Additionally, differentiation helps all students, not just the ones that require it. Different modalities, repeated exposure, and varying approaches help all students gain a deeper understanding of the subject matter. For students that require these approaches, they obtain a basic understanding of the topic, whereas for other students, they gain a mastery over the topic.

The fundamental need for student adaptive pedagogy can be illustrated with the vignette. In a room with eight severe to profound special needs students, there will likely be a myriad of accommodation and modification requirements. One student may have visual impairments, while another has auditory impairments. Many students will likely have fine motor skill difficulties, while others may be non-verbal. Other hurdles which are not physical may also occur. Social anxiety, learned helplessness, disruptive learned behavior, along with many other potential emotional and/or behavioral difficulties are common occurrences. These differences require a student adaptive pedagogy which takes into consideration the specific student, and their unique needs. The student with visual impairments may require a worksheet with larger fonts, pictures instead of words, and/or braille. The student with auditory impairments may require more visual references, subtitled videos, and/or special

headphones. Students with fine motor skill difficulties will require different types of assessments, instead of writing, they may need to use stamps or stickers. Students who are non-verbal won't be able to answer questions in the traditional fashion, they may need to approach the board, use speech generating devices (SGD), or use sign language. Students with emotional or behavioral difficulties are motivated differently. For example, a need for control is often common. Therefore, having them participate in a way which allows them to feel that sense of control is very helpful. Regardless of their capabilities, each student will learn in their own unique way.

Impact of Intrinsic Motivation

Motivation is important for several reasons. Examples include motivation pushes students, keeps their interests, and increases engagement. These are all important; however, our duty as teachers is not to merely get them through a lesson, but to prepare our students for an independent future. This is where motivation is paramount:

> Motivation is not only important in its own right; it is also an important predictor of learning and achievement. Students who are more motivated to learn persist longer, produce higher quality effort, learn more deeply, and perform better in classes and on standardized tests. (Hulleman & Hulleman, 2018, para. 6)

By fostering motivation, we can create citizens that push further, try harder and achieve more. This is true because with proper motivation, a greater amount of effort is produced, which will likely lead to greater accomplishments. These accomplishments may then lead to pride in said accomplishments. This pride in turn leads to further motivation. This is shown in Erikson's Stages of Psychosocial Development, most prominently with the fourth stage - Industry VS. Inferiority. Within this stage, the child has an internal struggle of competence vs. incompetence, that will determine their pride within themselves. It is claimed that "the child now feels the need to win approval by demonstrating specific competencies that are valued by society and begin to develop a sense of pride in their accomplishments" (Mcleod, 2024, What Happens During This Stage section). Furthermore:

> If children are encouraged and reinforced for their initiative, they begin to feel industrious (competent) and feel confident in their ability to achieve goals. If this initiative is not encouraged, if parents or teacher[s] restricts it, then the child begins to feel inferior, doubting his own abilities, and therefore may not reach his or her potential. (Mcleod, 2024, Success and Failure in Stage Four section)

Essentially, this has the potential to create a self-perpetuating cycle of motivation-fueled achievements, which can be carried into adulthood.

Going back to the vignette, motivation would come in the form of appealing to the student's desire for lessons that will affect them in a practical manner. Affecting their real life outside of academia, the students will realistically both care more and work harder in their lessons. Additionally, students with severe to profound needs often have a desire to act like and perform tasks similar to their typical peers. These students often live a life where they are seen as the "other". Being able to perform

tasks that are similar to those around them allows them to feel a sense of belonging which they may not otherwise achieve. This sense of belonging is exemplified in Maslow's Hierarchy of Needs, where a sense of belongingness is essential to meet higher needs such as cognitive needs and self-actualization. This intrinsic motivation not only makes them more attentive and engaged in the classroom, but can also permeate through to other areas of their lives as well, increasing their likelihood of autonomy.

Conclusion

Reasoning within mathematics is not only an effective way to teach mathematics but could be considered the ideal way to teach mathematics. To do so, we as teachers need to keep in mind how to best use discourse, focusing on targeted student adaptive pedagogy, and increasing intrinsic motivation. Discourse fosters the ability to use reasoning and a sense of ownership over their own learning and increases confidence. Student adaptive pedagogy allows for individualized, differentiated lessons which take into account the needs of the students and gives them the best opportunity to acquire deeper conceptual learning. Intrinsic motivation allows the lessons to take greater effect and promote a sense of autonomy which may not be achieved otherwise. With these factors in mind, teachers can best convey their lessons to all students in a manner that would be beneficial to them. These approaches are especially important for students with severe to profound special needs. This provides them with the best opportunity for a full and fulfilling life outside of academia.

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Science

The Importance of Scientific Literacy in Modern Classrooms

Samuel D. Graham

Abstract: To thrive in modern classrooms, students must be equipped with scientific literacy skills that enable them to understand, evaluate, and communicate scientific information effectively. The internet and digital resources present a unique challenge, as not all online information is scientifically accurate or unbiased. This article aims to demonstrate how the internet and digital resources contribute to misinformation and disinformation in the classroom. It will also highlight the benefits of increased scientific literacy for students and explore various strategies educators can use to enhance these skills. The primary goal of this research is to identify effective methods to boost students' scientific literacy and overall success.

Introduction

> *In Mr. Trussel's biology class students are assigned different fertility technologies, such as IVF, preimplantation diagnosis, CRISPR, and gamete cryopreservation, and then are asked to create a presentation based on their findings. Students are excited to begin research but run into a big problem, how do they know if a source is scientifically accurate and unbiased? Students feel conflicted as they find evidence they would like to use for their research only to discover contradicting evidence that seems equally credible. This idea stumps Mr.Trussell and he begins to contemplate how to solve this issue. With the emergence of personal electronic devices, AI, and the internet, students are granted access to countless amounts of information in an instant. This novel leap in access however can be a double-edged sword, as students' access to information is significantly greater than what it was, but not all of what they find is scientifically accurate and unbiased. Mr. Trussel thinks back to his pre-internet classrooms, where access to information was largely governed by educators and school resources such as textbooks, academic articles, library books, and other modalities, which were generally accurate. Most of the students in pre-internet classes had access to information that was curated by educators or reputable institutions such as libraries, but the classroom in the digital age faces a dilemma. "How can I ensure the accuracy of information my students find from online resources?" Mr. Trussel thinks to himself.*

In this article, I will describe the role of modern educators in guiding students through the landscape of information through the teaching and implementation of scientific literacy. Scientific literacy is a general understanding of science, scientific frameworks, and the ability to accurately convey scientific ideas. Some examples of these concepts are understanding the scientific method, cell theory, evolution, etc. I believe that science educators must accurately instruct students on scientific literacy in today's increasingly digital age.

Definitions

Scientific literacy is the ability to understand, evaluate, and communicate scientific ideas effectively. In most dictionaries, literacy is simply the quality or state of being literate (Merriam-Webster, n.d.) but scientific literacy is different as it requires a fundamental understanding of scientific processes, figures, and ideas. In science classrooms, students are seldom asked to not only understand texts but also to communicate their findings or research which also requires these fundamental understandings of science. One final piece that I included in this definition of scientific literacy is the ability to evaluate scientific information. I chose to include this to formally address the large body of misinformation, false or inaccurate information, and disinformation, false information deliberately intended to mislead, prevalent in the digital age (American Psychological Association, 2022).

Problems with Digital Media and the Internet

The primary issue regarding internet resources and digital media is a lack of regulation. While an obvious solution would be to regulate information, this is a nearly impossible and fruitless endeavor, not to mention these practices would violate First Amendment rights. The internet and digital media can be excellent and affordable tools for almost all scenarios but come at the cost of personal and corporate agendas. "The most egregious cases of scientific misinformation are typically deliberate efforts by monied interests or ideologues" (Allchin 2023, p. 266). Unfortunately, the free and open access to the internet lends itself to less than scientific ideas that can be presented as such for monetary gain and personal interest. Companies and other organizations often use or fund scientific studies that support their positions and in turn, present biased or falsified information to support their opinions.

Another issue with the information on the internet is that not everyone who claims to be an expert on a certain topic is an expert on that topic, and it can be difficult to find credentials or indicators that an individual is qualified to speak on certain issues. In a study that evaluated students' abilities to determine the credibility of online information, it was found that students from all grade levels struggled to accurately verify the credibility of sources, claims, and evidence (McGrew et al. 2018).

One final issue that needs to be addressed is the self-affirming nature of internet information. This phenomenon is commonly called confirmation bias, meaning people plan to find, support, and believe information that aligns with their preconceived ideas. As educators, this should be one of the alarming aspects of these resources as it can lead to a lack of critical thinking and alternative viewpoints. The internet is an invaluable resource in the classroom but educators and students need to be aware of these looming issues. Without these issues being properly addressed they will remain a problem in education and scientific discussion.

The Benefits of Scientific Literacy

In modern classrooms, scientific literacy is an essential skill that can help students understand and evaluate scientific materials. A 2018 study that looked at how well students could evaluate online scientific information found that most students were

not skilled at locating, understanding, or assessing the credibility of scientific information (Foranzi 2018). This is one of many studies that communicate this common idea; students typically do not have the scientific literacy skills that are needed in the modern classroom. One benefit of scientific literacy is it seems to help students distinguish between real and false information "A moderate and negative relationship was also observed between scientific reasoning and epistemologically unfounded beliefs. We proposed that the lower the level of scientific reasoning, the higher the tendency to succumb to epistemologically unfounded beliefs" (Synak et al. 2024, p. 169). I found this study particularly interesting because it looked at the correlation between the scientific literacy rates of students and their beliefs on unscientific ideas. One final benefit of scientific literacy is that it is correlated with cognitive learning outcomes (Mufida et al. 2023). In this study, students were subjected to inquiry-based models that were created to increase their scientific literacy and were then given tests that measured cognitive learning outcomes before and after this training, and it was found that the cognitive learning outcome scores were greatly improved. Scientific literacy has the potential to increase academic outcomes and students' ability to discern between scientific literature and misinformation and disinformation.

How to Teach Scientific Literacy

One potential way to increase students' scientific literacy would be to introduce scientific concepts at a younger age. Most forms of literacy are taught in the early years of a child's education as they are seen as a fundamental basis for finding and retaining information. Research has shown that learning experiences that are implemented for students in sixth-grade classrooms that emphasize critical thinking and scientific literacy contribute to increased levels of both (Viera & Tenreiro-Viera 2016). In this study, these lessons had an increased focus on questioning and debate, such as asking students to reflect on their ideas, debating conflicting ideas, and determining the credibility of claims. Encouraging these forms of thought at an early age is an effective way to promote scientific literacy by including scientific materials and scientific literacy.

Another possible solution to increase the scientific literacy of students would be to include students in real-world scientific research. This practice would give students hands-on experience with research and help familiarize them with these concepts and ideas. One such way to expose students to real-world applications is through research service-learning or RSL, which is when students engage in research in a service-learning context (Reynold & Adhern-Dodson 2010). The general approach to this practice starts by introducing a relevant community-centered project that can reasonably be completed by students.

In the 2010 study the authors focused on environmental-based projects such as monitoring populations and mapping invasive species. One method is to design assignments for students that encourage research and reflection on the current project as well as possible projects for the future. Another method mentioned in this study is determining what students need to learn in order to complete this project and achieve their learning goals. This practice can be very beneficial to help students increase their scientific literacy because it first allows teachers to properly address

misconceptions and flaws in students' thinking through the monitoring of their assignments. This practice also can help to increase scientific literacy by exposing students to real-world scientific practices and research, which can often be missing in traditional science classrooms. Although this practice requires extensive planning and collaboration, I believe that it can be used as a powerful tool to promote scientific literacy in classrooms.

One final study that I believe to be insightful looked at how post-test scores compared between middle school students who participated in online collaboration and students who received face-to-face instruction. This study from Wendt & Rockinson-Szapkiw (2014) compared the pre-test and post-test scores of these two groups of students using Misconceptions-Oriented Standards-Based Assessment Resources for Teachers, or MOSART, assessments that place a focus on addressing and testing for common science misconceptions that students may have. Unsurprisingly students who participated in the face-to-face collaborative groups demonstrated fewer misconceptions than those in the online collaborative group. I believe this article highlights the idea that teacher knowledge of misconceptions and in-class discussion is beneficial in eliminating scientific falsehoods and misconceptions for younger students. This article also mentioned that in these online collaboration groups, students often receive delayed feedback from teachers which can lead to them believing wrong ideas, as they are not immediately addressed like they are in traditional classrooms.

These unaddressed misconceptions can be harmful as students could communicate with each other online leading to more students having these false or misconstrued beliefs. Teacher knowledge of misconceptions and in-class discussion is essential for younger students because it allows their misconceptions and preconceived ideas to be addressed and corrected in real-time. For this, I believe it would be useful to provide primary and middle school teachers training on addressing scientific misconceptions and in-class collaboration, in order to eliminate scientific misconceptions for these students.

Conclusion

In conclusion, the digital age has brought both unprecedented access to information and significant challenges in ensuring the scientific accuracy of that information in classrooms. As demonstrated, students often struggle to discern credible scientific sources from misinformation and disinformation prevalent on the internet. Enhancing scientific literacy is essential in equipping students with the skills needed to navigate this complex landscape. Scientific literacy not only enables students to understand and evaluate scientific information but also fosters critical thinking and helps them avoid unfounded beliefs. Educators play a crucial role in this process by creating lessons that focus on debate, questioning, and reflection at an early age, and creating research-based service-learning projects that are designed to promote scientific literacy skills in their students. Ultimately, by prioritizing scientific literacy, we can better prepare students for a world where the ability to critically assess information is more important than ever. Increased focus on scientific literacy will lead to more informed individuals capable of making well-reasoned decisions in both

their personal and professional lives and contribute to a more knowledgeable and rational society.

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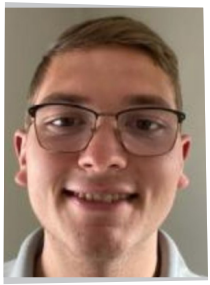

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Sam Graham is a Licensure and Master Program, LAMP, student at the University of Toledo. He received a bachelor's degree in university studies with a focus on biology and is currently pursuing a master's degree education as well as licensure in AYA science. He has a passion for teaching all life science and is particularly excited in the field of genetics and biotechnologies.

Social Studies

Divisive Subjects in the Classroom

Jordan Begeman

Abstract: This paper focuses on how social studies teachers can improve discourse in the classroom regarding controversial topics. Social studies is a subject that involves many different topics for educators to cover. This includes current events such as the presidential elections, the legalization of substances, bans on abortions, and border control. Teachers need to be prepared to have these conversations and teach these lessons in their classrooms. Things like professional development, modeling respectful dialogue, and making sure the discourse between students is respectful are all ways teachers can keep their classroom a safe and beneficial place for students to be.

Introduction

> *In a quiet, yet crowded classroom, tension was running high between two students. Emma, with her fiery passion for social justice, stood her ground against Rob, whose skepticism was overwhelmingly obvious. The topic: climate change, a divisive issue that polarized opinions. Emma's conviction was clear as she explained all of her scientific evidence, her voice shaking with determination. Yet, Rob countered with skepticism, questioning the researchers, and their values. As the debate escalated, classmates were silent, caught between discomfort and fascination. Finally, amidst the complicated discussion, a moment of realization came over them. Their arguments, though differing in perspective, shared a common thread of concern for the future. They met eyes, Emma and Rob softened, recognizing the value in each other's viewpoints. In a gesture of mutual respect, they agreed to delve deeper into the topic together, promising to seek understanding rather than discord. And as the bell rang, signaling the end of class, newfound respect and friendship blossomed amidst the clash of ideologies.*

Controversial subjects are going to arise in the classroom. Teachers, students, and guardians of students would all benefit greatly if they are all on the same page regarding what is taught in the classroom, and how it is being taught. Many questions go into this topic.

Educators are trying to prepare our students to be successful citizens of our country one day, and avoiding difficult topics in the classroom would do our students a disservice. The topic of divisive subjects, and how to successfully guide students in respectful dialogue is very important. Educating our students involve topics like current events of our world, and knowing how much we educate our students on those events as teachers is important; as well as how we protect them and at the same time show them how to overcome diversity. This conversation is meaningful now; I believe it has always been important and will always be. There is so much going on in the world around us, and our students deserve to be prepared and knowledgeable in regard to what shapes our world, on a large scale down to our cities. This topic is worthwhile to discuss because we are shaping the future citizens of our country. They need to be prepared to go out into the world after school and

be successful, empowered citizens. In my opinion, the better we prepare our students, the better the world around us will be.

Importance of teaching challenging subjects

Controversial conversation and how to represent it in the classroom is worthwhile because we are shaping the future citizens of our country. They need to be prepared to go out into the world after school and be successful, empowered citizens. The better we prepare our students, I believe the better the world around us will be. Even when teachers do not directly introduce controversial topics, they are likely to be raised naturally through activities related to historical, social, or scientific content; hence, teachers must be prepared to support these conversations (Kraatz et al., 2022).

What are controversial topics?

The topics of controversial conversations may include socio-political or other social topics (Muth et al., 2007). This can include topics that they believe will lead to differing viewpoints (religious, political, etc.). Some examples of these topics include but are not limited to critical race theory, immigration, war, religion, and sexism.

Why Some Topics Are Hard to Teach

There are a variety of reasons why controversial topics are difficult for educators to teach. Teachers may not be prepared in their education to feel comfortable teaching these difficult topics. Teachers may feel they need clarification on what topics are age-appropriate for students to discuss and comprehend (Kimmel & Hartsfield 2019; Oulton et al.. 2004). Students come from many different cultural backgrounds, they come into the classroom with a foundation of beliefs from their parents and families. Heated debates between classmates are likely to happen when controversial topics arise. While controversial topics may be challenging for teachers and students to discuss, the experience of engaging in these discussions aligns with educational goals and standards (Muth et al., 2007). Multiple states include standards for social-emotional learning, further making the case for discussing a broad range of issues in the classroom (National Conference of State Legislatures NCSL, 2021).

Strategies

There are many different ways to introduce and teach controversial topics in the classroom. This will depend on grade levels and specific topics. Teachers need to be well-equipped with many strategies to teach these topics successfully.

Differentiate Between Topic and Issue

Issues are a matter that erupts, often from a larger topic of discourse. Issues need attention and require resolutions. A topic could be gun control and the issue could be school shootings in the United States. Teachers need to make sure that students

understand that a topic is referring to a theme or a subject to discuss. The issue is a specific controversy within a broader topic.

Modeling Respectful Dialogue in a Safe Classroom Environment

Teachers themselves must model respectful dialogue. It is not a place for them to express their views, but instead an environment where students can express theirs. This does not necessarily mean teachers need to keep completely silent about their own opinions. Classroom discussion can be conducted both when teachers do and do not disclose their views (Hess D.E. 2009) The key is for teachers not to dominate the conversation, but instead maintain an open and respectful tone in the classroom (Cambell, D.E., 2018).

The classroom environment is a big factor when talking about controversial conversations. Classroom context comprises the learning conditions (policies, practices, relationships) in a classroom (Muth et al., 2007). Productive controversial conversations require a space where students feel safe and secure discussing tough topics. Students may feel differing levels of safety and security based on their social identities. Teachers should carefully consider their instructional approaches to ensure that all students, particularly those belonging to minoritized communities, feel safe and supported (Muth et al., 2007). The set-up in the classroom can also impact the effectiveness of controversial conversations. For example, desks arranged in rows may make discussions difficult, as students are not facing each other and cannot see someone's face when they are speaking. Similarly, when grouping students for controversial conversations, it is important to have a small heterogeneous group with diversity in abilities and opinions, and few enough people that everyone can be heard and understood (Muth et al., 2007).

Respectful Discourse Between Students

Helping students become knowledgeable and giving them respectful discourse skills to facilitate effective participation within the classroom and beyond should be a goal of educators (Why It Matters: Teaching Controversial Topics, n.d.). Specifically in social studies, debating is the recommended type of discourse. Facilitating controversial conversations in the classroom is one way teachers can highlight the value of discrepant perspectives (Muth et al., 2007). Teachers need to teach how to debate respectfully, not just do debates in the classroom. Argumentation is connected to social studies. When formulating arguments, students must be explicit about how reasons and evidence relate to their claims. Students tend to have a substantial amount of experience in informal argumentation, usually with siblings, parents, friends, and teachers. When students engage in debates for formal argumentation, they need to have explicit reasons for their argument. It is a much larger crowd, which makes it harder for the audience to ask for clarification. Respectful debate needs to be taught by educators so the students know how to debate educationally. When students are made to think more sociologically about norms and patterns of interaction, they can step back from the point at which disagreements are experienced as personal attacks (Lusk & Weinberg, 1994).

Students are also all very different individuals. They come into the classroom with their own personal norms, personality traits, and experiences. Their personalities will play a big role in classroom participation. Students who participate verbally in class discussions tend to be more extroverted, open to new experiences, and emotionally stable (Caspi et al., 2006). Students who stay quiet during class discussions cite shyness or nervousness as a primary reason. (Eliason & Turalba, 2019). Reserved students may be actively listening, and demonstrating participation in alternative ways, including posture, gaze, facial expressions, and written responses (Rosheim, 2018.)

Professional Development

Teachers being fully prepared to teach complicated subjects is key. Organizations and experts can help prepare educators to be knowledgeable and thoughtful about the classroom environment they create for their students. A supportive classroom filled with students who become a community over the school year is ideal. Having students who respect each other, trust each other, and feel comfortable exchanging ideas is where you want the classroom to be when these subjects are being taught. Teachers also need to help develop students with an appreciation for disagreement, the ability to disagree with each other respectfully, and strategies for dealing with emotional reactions constructively (Commentaries, 2023).

Teachers are less likely to foster an open classroom climate when their students have diverse racial backgrounds because they fear provoking controversy. Yet it is in diverse classrooms that these discussions are needed more than ever (Cambell, D.E., 2018). The Harvard Graduate School of Education is a great place to start for educators - giving advice and strategies on teaching controversial issues.

Communication with parents and guardians, and the community, is also key. The administration as well as the community need to support teachers fully because teaching controversial topics is immensely important. Of course, there is going to be pushback no matter how careful and thoughtful teachers are. Parents may react negatively, which is why administrators need to support their teachers. Teachers who are prepared to deal with backlash, and how to explain to parents and guardians why these subjects are important, will be much more successful in their endeavors with these subjects than teachers who do not have the tools to support their reasoning. If teachers avoid these topics in the classroom, this contradicts what education needs to be - models of civility in the classroom (Cambell, D.E. 2018)

Conclusion

Teachers are responsible for preparing their students in a well-rounded way. There are many reasons why controversial conversations are beneficial to students of all ages. Engagement in appropriately challenging dialogue can increase positive emotions in students (Schweinle et al., 2008). Also, focusing on controversial social issues makes students more likely to vote and engage with political news after their formal education (Tannenbaum, 2013.) Engagement with teachers and peers in conversations can support the construction of knowledge that is inclusive of multiple perspectives (Muth et al., 2007). This is what we as educators should be focusing on.

We want our students to be successful citizens who contribute positively to our world, and including conversation about controversial issues is a well-rounded way to create these types of citizens.

Engaging in academic conversations, especially those centered around potentially controversial topics, requires vulnerability. Educators must create safe spaces that allow vulnerability (Muth et al.,2007). Through the strategies I mentioned throughout, I believe teachers can be successful. This will lead to student learning and moral development.

When teachers are professionally prepared for controversial conversations and debates, the outcome will be a success. Teachers are well aware of topics that will bring on complicated and diverse feelings, and there are many resources out there to prepare educators before they take on those classroom conversations.

When teachers are open with parents and stakeholders regarding what is being taught and how it is being taught in the classroom, families and otherwise will be thankful. Teachers can and should reach out to families and their administration for support, this will help them feel more positive about difficult classroom conversations. Parents may have things they want the educator to add to these conversations and dialogues in the classroom. Different backgrounds that the students come from can be a very positive thing to help open the minds of classmates. When teachers are careful in considering and adapting to their classrooms, these recommendations can support the successful implementation of controversial conversations (Muth, et al.,2007).

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Jordan Begeman graduated from the University of Toledo in 2015 with a bachelor's degree in political science. Years later she discovered her love for teaching, returning to the University of Toledo to pursue a master's in early childhood education. She hopes to begin teaching professionally following graduation.

Learning to Teach

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