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IMPLEMENTATION OF INQUIRY AND PROJECT-BASED LEARNING IN A HIGH SCHOOL CHEMISTRY CLASSROOM: AN ACTION RESEARCH PROJECT

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Abstract This article summarizes one teacher's action research journey in adapting a traditional gas laws chemistry unit into one that utilized inquiry and project-based learning. Data was collected regarding students' understanding of chemistry content as well as their motivation to learn, and key findings were summarized. In comparison to data from a previous year, results suggested that inquiry and project-based learning generally resulted in increased understanding of content and increased motivation for some students.

Keywords: teacher action research, inquiry, project-based learning, chemistry

Introduction

In 2014, my school district began a multi-year, intensive process of training each of its kindergarten through twelfth (K-12) grade teachers in Direct Interactive Instruction (DII), a teaching model that emphasizes a gradual release ("I do," "we do," "you do") and places the teacher at the head of the learning, both literally and figuratively. The DII materials purchased emphasized the research of Klahr and Nigam (2004) to argue that direct instruction increased student understanding and achievement. However, a tension exists between the teacher-centered emphasis of Direct Instruction and the new Michigan Science Standards, which emphasize inquiry and student discovery of knowledge through a more constructivist approach.

In chemistry in particular, my students often struggle to see how what they are learning applies to their own life and can be used on a regular basis. When students fail to see the relevance, they become disengaged in the learning process and put in minimal effort. Although certain chemistry content knowledge may not always feel relevant to students not planning on going into a science field, the skills that students are practicing, including collaboration, communication of complex ideas, and application of critical thinking, are crucial. I saw the need to implement teaching techniques that involve students in these practices in order to motivate them and authentically engage them in science.

The purpose of this action research project was to explore the tension between direct instruction and more student-centered instructional techniques in an attempt to clarify the most effective approach for teaching science. This was accomplished by reviewing the literature and summarizing my experience in adapting a traditional unit to be inquiry and project-based in my own high school chemistry classroom.

The specific questions this action research project sought to answer were as follows:

1. How does implementing an inquiry-based and project-based learning unit affect student understanding of the content?

2. How does implementing an inquiry-based and project-based learning unit affect student motivation and interest in science?

Literature Review

Traditional science education places the teacher at the head of the classroom to instruct on content knowledge while assigning students a passive role. Allen, Duch, and Groh (1996) claim that this arrangement misrepresents the real process of science, which should be grounded in authentic inquiry and the actual practice of science. This structure lacks engagement, authenticity, and relevance for many students (Kolodner, Camp, Crismond, Fasse, Gray, & Holbrook, 2003), leading to boredom and disinterest in science classrooms across the country (Krajcik & Blumenfeld, 2006). Traditional science education especially disadvantages students of color and girls for whom science achievement gaps have been well documented (Buck, Cook, Quigley, & Prince, 2014). Moreover, as presented by Schank and Kozma (2002), our United States science education scores have been consistently mediocre in studies conducted by the Trends in International Mathematics and Science Study, lending evidence to the claim that a traditional model of science education is not working.

Problem-based learning has emerged as an alternative to this problematic traditional structure. Overlapping in many ways with project-based learning and inquiry instruction, Hmelo-Silver (2004) describes problem-based learning as an instructional framework in which students are presented with an authentic, complex question or problem to solve. In

contrast to traditional science instruction, in problem-based learning the teacher acts as a facilitator of learning and students may work at their own pace to learn what is necessary to answer their question and then apply their understanding (Hmelo-Silver, 2004). Rather than students gaining content knowledge, problem-based learning places emphasis on the skills and practices of science in action, such as problem-solving and collaboration (Hmelo-Silver, 2004). According to Hmelo-Silver (2004), this leads to the creation of lifelong learners with flexible skills that are crucial for today's information age.

Project-based learning and its cognates have been successfully implemented in many different contexts with positive results. Mahendru and Mahindru (2001) found that problem-based learning that was implemented in a college electrical engineering course increased scores in learning outcomes as compared to traditional lecture while also promoting problem-solving and self-motivation. Similarly, Yadav, Lundeberg, Subedi, and Bunding (2011) described how the switch from lecture to problem-based learning in an undergraduate engineering course led to an increase in learning gains compared to traditional instruction using a pre-test/post-test methodology. Students who were involved in project-based learning in an AP Biology context had similar benefits, including interpreting and applying knowledge, development of positive attitudes, promotion of problem-solving skills, and facilitation of a deeper understanding of issues relevant to them (Nguyen & Siegel, 2015). Through this project, Nguyen and Siegel (2015) reported that students collaborated with one another, persisted through the semester-long project, and were challenged to engage in inquiry and creativity, ultimately leading to an increased interest in science careers. For Kazempour and Amirshokoohi (2013), the inclusion of inquiry-based learning in a teacher education course resulted in deeper conceptual understanding for students and better application of learning. Kazempour and Amirshokoohi (2013) found that students better appreciated the nature of science through their own participation in the process as compared to traditional science education.

However, changing the status quo does come with challenges. As Kazempour and Amirshokoohi (2013) described, in addition to the learning benefits that came along with inquiry learning, students reported feelings of frustration and confusion. Likewise, Albanese and Mitchell (1993) emphasized that the benefits of problem-based learning may be outweighed by challenges such as slow implementation and poorer student test scores on content-driven exams. Kolodner et al. (2003) identified sequencing, science content, and classroom culture as challenges to successful problem-based learning facilitation.

To overcome these challenges, Kolodner et al. (2003) found that creation of collaborative groups and alteration between whole group and small group instruction provided scaffolding to help students feel successful. Ensuring that time was allocated for reflecting and practicing initial inquiry led to gains in learning, and emphasizing the iterative design and redesign process of problem-based learning was also found to be significant. Finally,

they established introductory activities and lessons and familiarized students with structures designed to provide them with opportunities to practice the collaborative skills they would need to develop to be successful in more challenging curriculum.

Schmidt (1983) and Allen et al. (1996) also offered recommendations for successful creation of problem-based learning curricula. The step-by-step guide provided by Schmidt (1983) included identification of key terms, definition and analysis of the problem, formulation of learning objectives, collection of information, and finally synthesis of learning. Allen et al. (1996) cited the importance of the learning facilitator, class format, collaborative group structure, and guidance through carefully constructed problems in the creation of problem-based learning curriculum aimed at engaging all learners in science. Specifically, Allen et al. (1996) recommended starting problem-based learning with an authentic problem that is engaging and relevant, open-ended, controversial, and complex.

With the wide body of literature that exists as a reference for teachers looking to make learning in their own classrooms more student-centered, the challenge is not whether or not to begin, but when and how to jump in right in. Many studies have demonstrated the benefits this instructional framework holds for student learners as compared to traditional science education. Although challenges do exist, recommendations for structures and strategies to overcome the limitations are plentiful, and teachers looking to move away from a traditional, teacher-directed classroom structure have only to look to the literature to appreciate the wide variety of inquiry and project-based resources that are available to engage learners in authentic, relevant, and engaging science practices.

Setting

I implemented inquiry and project-based learning over the course of a four-week unit in a tenth grade chemistry classroom. My high school is a medium -sized, rural school in southeastern Michigan with low diversity and middle socioeconomic status. Although the high school is fairly traditional, as a district we are moving toward a more modern approach to education that emphasizes interdisciplinary integration of content and authentic learning grounded in relevant experiences. With this in mind, there is strong support from administrators for teachers who are trying project-based learning and other non-traditional teaching methods.

Methodology

In three classes, each with approximately 32 students, I began this transition by rewriting the unit's 10 learning objectives as questions rather than statements. For example, the daily learning objective "I can describe the direct relationship between temperature and pressure," became "What is the relationship between temperature and pressure?" After

rewriting each objective, the next step was to find a phenomenon whose explanation would get at each topic. This chemistry unit included kinetic molecular theory and ended with gas laws, meaning that the phenomenon needed to be a physical change that involved pressure, temperature, and volume. A short video of a train car tanker imploding served to meet this need, and after watching the video students were prompted to brainstorm questions about the variables that could have caused the dramatic change that they witnessed.

For each learning objective that was introduced, students were told that they were receiving a small "piece of the puzzle" and that by the end of the unit they would be able to fully explain the tanker phenomenon. Each learning objective was taught using inquiry: from process-oriented guided inquiry learning activities to modeling instruction to data analysis, students were guided to answer the learning objective question by constructing their own knowledge with one another rather than being instructed directly by the teacher. At the end of each lesson, students took a short online multiple-choice quiz to assess their understanding of that particular learning objective.

The end of the unit culminated in a series of gas laws mini-phenomena that students modeled at a particulate level to relate back to the original tanker phenomenon. They were then challenged to work in small groups to create their own gas laws phenomenon demonstration as a summative assessment that they would be performing for an audience of elementary students who would be visiting our classroom. These demonstrations were preceded by a written proposal in which students described their procedure, the materials and plan for implementing the demonstration, including all safety notes, and a detailed explanation of the science behind their demonstration with a visual model included. In order to participate in the "demo day," students were told that their written proposal had to be officially approved by the teacher, who would be looking to see that they had anticipated and addressed all safety concerns and procedural issues and could thoroughly explain the science in a written report.

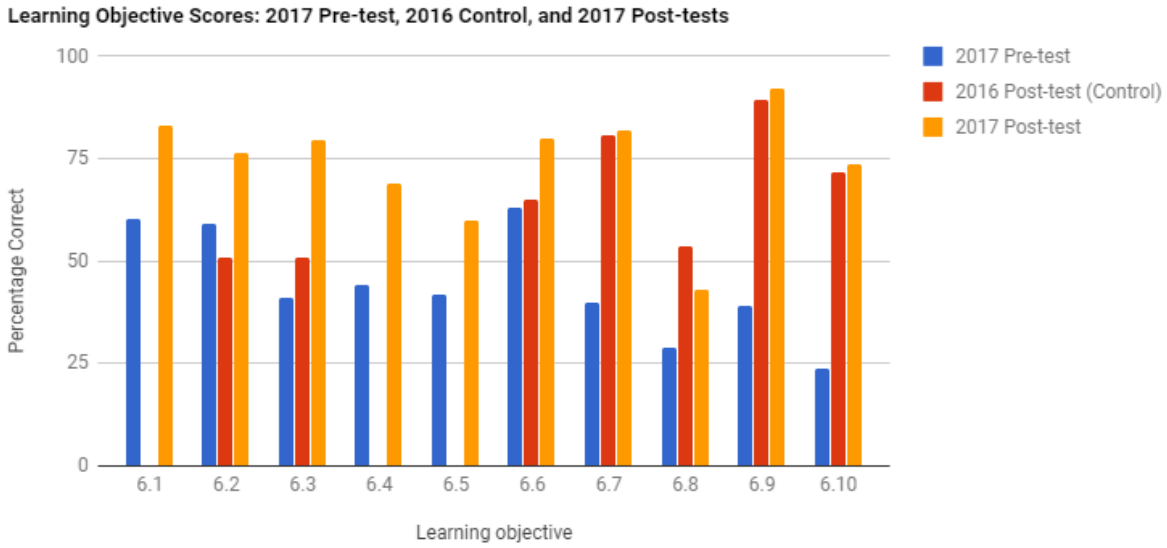
At the start of the unit, students took a pre-test to assess their motivation and initial understanding of the 10 learning objectives before engaging in the inquiry-based lessons and project-based learning final assessment. Across the unit, data was collected to document students' engagement and understanding, including videos of them interacting in small groups, pictures of their models over time, and their scores on the short learning objective quizzes. Because this unit was taught last year with similar learning objectives but a different teaching technique, the scores for students last year and this year's project-based learning unit were able to be compared to objectively document how implementation of these different learning techniques impacted understanding. A post-survey was also administered to assess student motivation and reflect on the unit as a whole.

Confidentiality was the primary ethical concern, and in data analysis, names of participants have been omitted to ensure confidentiality of student participants.

Results

Action Research Question #1. To evaluate the first research question regarding student understanding of the content, average scores for each of the ten learning objectives were calculated across all three classes after the project-based learning unit was implemented. These scores for each learning objective were compared to pre-test scores for the same group of students and the data that was available for similar learning objectives in 2016, and the results are summarized in Figure 1.

Figure 1: Learning objective scores: 2017 Pre-test, 2016 Post-test (used as a control), and 2017 Post-test.

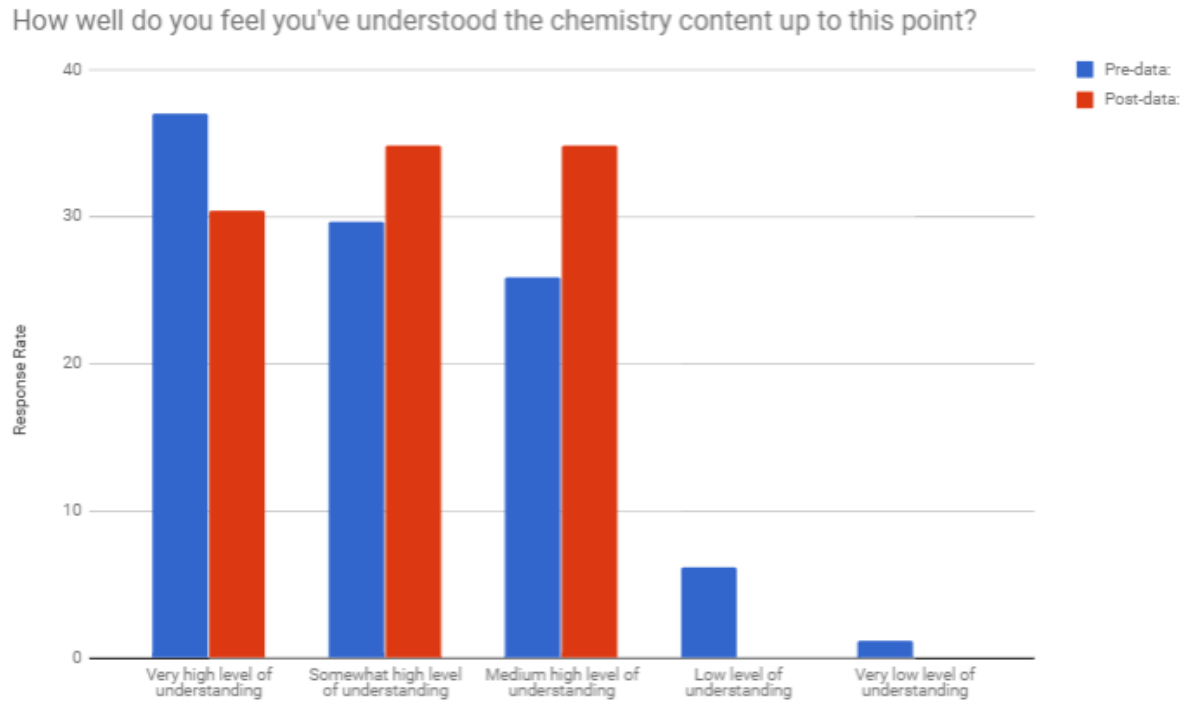


This bar graph shows the average scores for each of the unit's ten learning objectives for the 2017 pre-test, the post-test data available from 2016 students who were taught using traditional methods, and the 2017 post-test after students were taught using project-based learning.

For every learning objective, an increase can be seen in comparing the 2017 students' pre-test and post-test results. For learning objectives other than 6.8, the end-of-unit scores of the 2017 students were higher than those of the 2016 students who were taught using traditional methods instead of project-based learning.

In addition to objective data regarding their understanding, students were also asked to self-assess in a short survey, as shown in Figure 2. Before the implementation of the unit, students were instructed to reflect back on previous units in summarizing their understanding of chemistry content. After the unit, students were instructed to think about how project-based learning impacted their understanding. As Figure 2 presents, more students said they had either a "very high," "somewhat high," or "medium high" level of understanding with project-based learning, and no students reported feeling like they possessed a "low" or "very low" level of understanding.

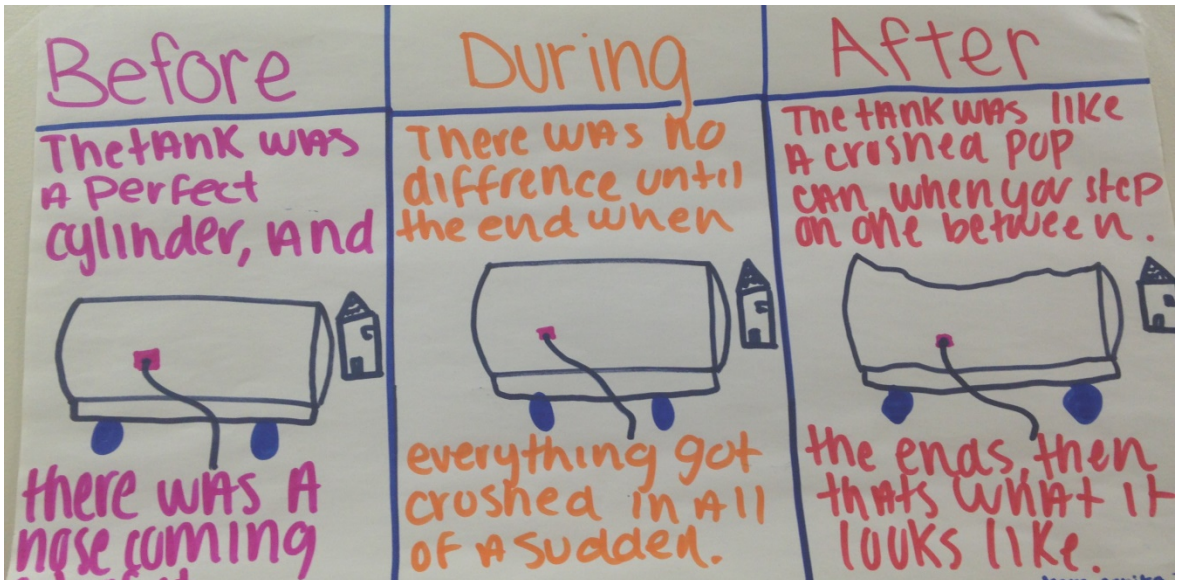
Figure 2. Student responses to "How well do you feel you've understood the chemistry content up to this point?"



This bar graph shows the percentage rate of each response category when the survey was taken before implementation of project-based learning and after implementation of the unit.

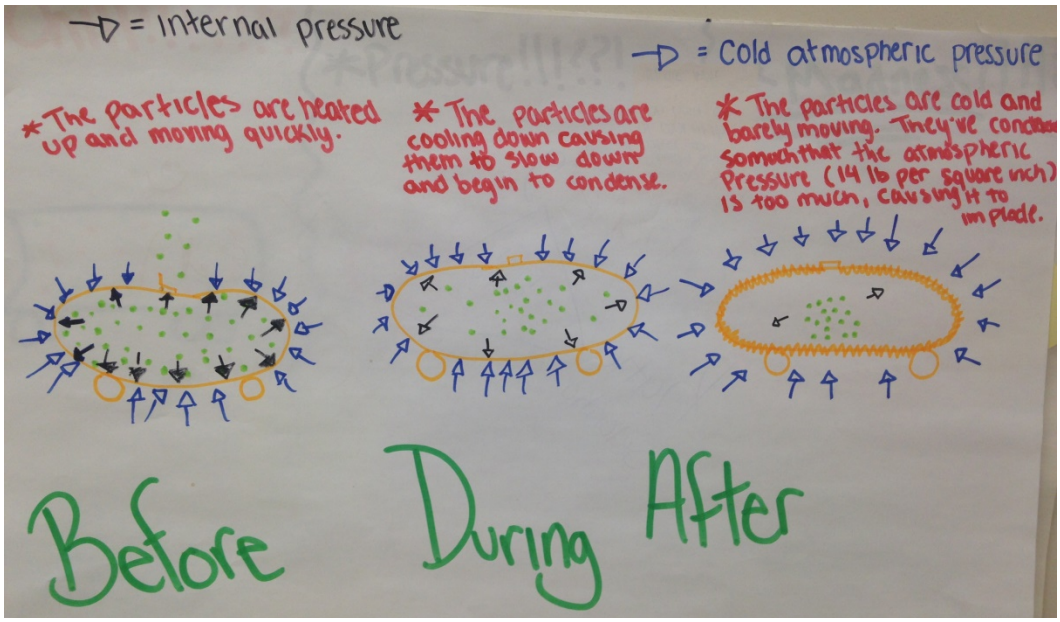
Student-generated models of phenomena were also considered as a third data set. Examples of student models at the start of the unit and end are included in Figures 3 and 4 below. Coding this data in a constant-comparative method highlighted several patterns between groups and across the unit.

Figure 3. One group's initial model of tanker phenomenon.



This model was created by a group of students at the very start of the unit before learning any of the learning objectives when they were instructed to explain what happened to tanker and why it collapsed.

Figure 4. One group's final revised model of tanker phenomenon.



This model was created by a group of students at the end of the project-based learning unit when they were instructed to explain what happened to tanker and why it collapsed.

Initial models described observations rather than offering explanations. Although students had been introduced to the idea of a scientific model, at the start of the unit these models were seen more as "poster presentations" that summarized observations of the phenomenon, as most groups simply represented "the what" rather than "the why" within their model. By the end of the unit, the models not only showed a summary of what was observed but also used a particulate model to explain why the tanker collapsed.

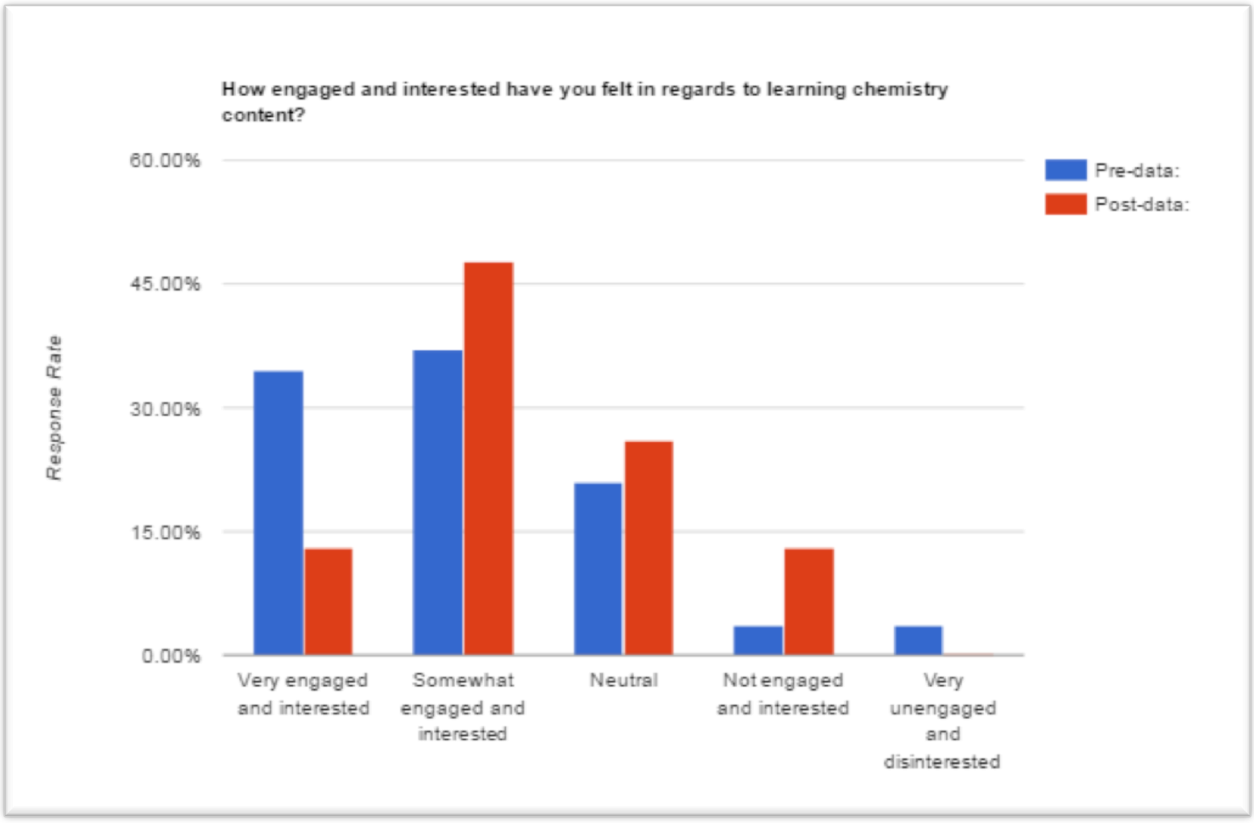
Initial models made knowledge gaps and misconceptions obvious. In many initial models, students either wrote or verbally used the word "suck" in their small group discussions to describe what was happening to the air in the tanker over time. Many assumed that such a dramatic change was an indication that a chemical reaction was taking place. Not one initial model included any mention of outside air pressure, instead focusing on what was happening inside of the tanker, but also failing to clearly represent that. Seeing these ideas represented in the works of so many students at the start of the unit allowed opportunities to directly and indirectly correct misconceptions.

Final models demonstrated understanding of the behavior of matter at a particulate level. Although students understood that matter was made of atoms prior to the start of this unit, groups did not add visual representations of these small particles of matter to their models until their final model. Final models showed that students realized matter, including invisible air, was made of small particles, and that these particles moved and behaved in predictable ways.

Relationships between temperature, pressure, and volume were clear in final models. Although some initial models failed to even mention these key unit vocabulary words, nearly all final models not only used them directly but demonstrated the direct and inverse relationships between these variables in the context of the tanker phenomenon.

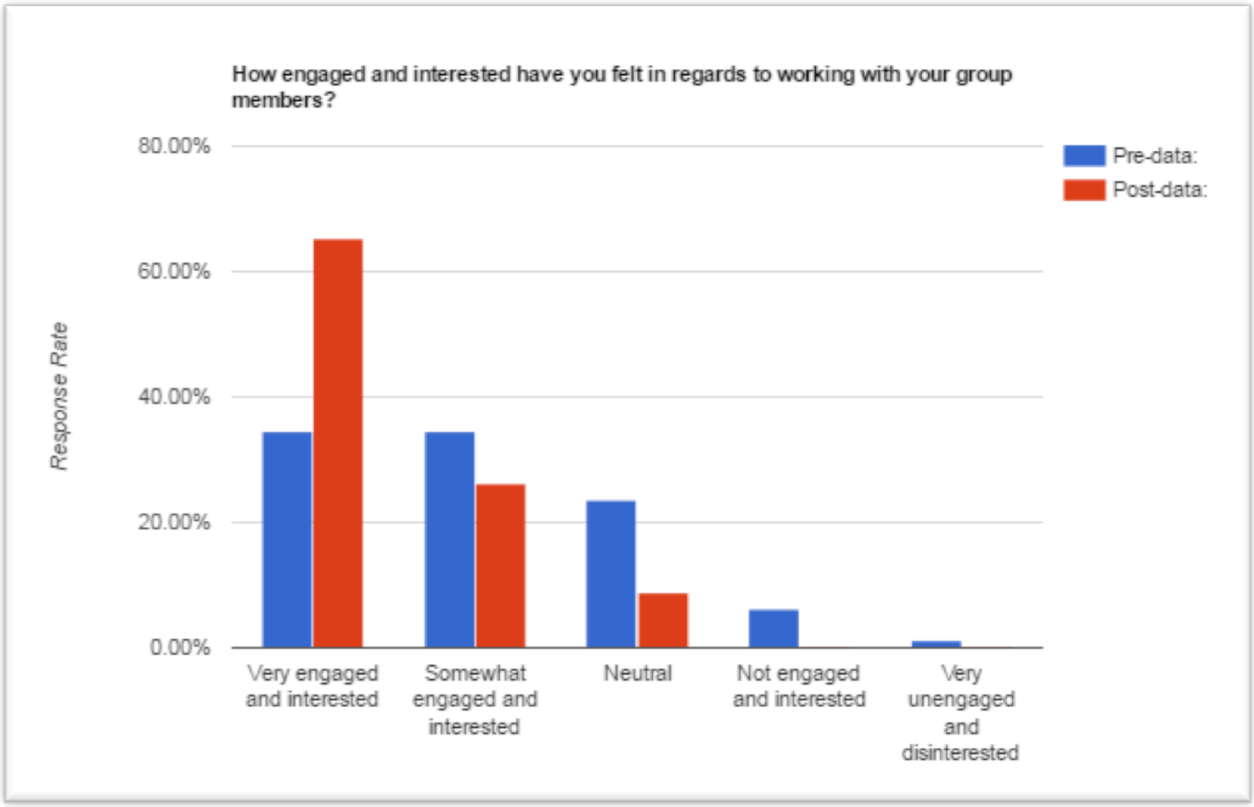
Action Research Question #2. To evaluate the second research question regarding student motivation and interest with science, students took a short reflective survey both before and after the unit. Questions asked them to self-assess their own interest in science, and results to the questions asked are summarized in Figures 5 and 6 below. Although no students reported feeling "very unengaged and disinterested in chemistry content" after implementation of this unit, fewer students indicated a high level of interest and engagement with content. However, a higher percentage of students reported feeling very engaged with their group members during this unit as compared to traditional unit.

Figure 5. Student responses to "How engaged and interested have you felt in regards to learning chemistry content?"



This bar graph shows percentage rate of each response category when the survey was taken before implementation of project-based learning and after implementation of the unit.

Figure 6. Student responses to "How engaged and interested have you felt in regards to working with your group members?"



This bar graph shows percentage rate of each response category when the survey was taken before implementation of project-based learning and after implementation of the unit.

This quantitative data was supplemented by informal teacher observations and reflections as well as opportunities for students to provide qualitative feedback in the form of exit slips. Most students were seen to be more engaged and interested as compared to prior units, and many made comments both informally and in their written exit slips to support this observation. One student even went as far as to claim, "This unit was overall the best unit we had all year" in an exit slip. In examining my own observations and students' written feedback, a few common themes emerged.

Teaching others helped develop understanding of content. My students loved working with the elementary students at the end of the unit, and many said that being asked to present as a summative assessment ensured that they better understood the chemistry content. For example, when asked to write me a letter about how the unit was going towards the end, one student shared, "I think Unit 6 went pretty good. The kids helped a lot to understand all

the gas laws and I think our project was good because it helped the younger students understand the gas laws. It also helped us to explain it to them."

Students who had struggled before flourished. Social students who struggled to focus during note taking sessions blossomed when given opportunities to interact with group members on a daily basis as a primary teaching technique and were excited to come to class. Students whose low math skills had prevented their success in previous units valued the opportunity to create visual models and think about content conceptually rather than mathematically. I was surprised to see students who were quiet speak up and contribute to group discussions, raising their social status in the eyes of their peers as they phrased an observation or question in a particularly compelling way. It was inspiring to listen in on conversations and hear students I would normally expect to fail a written multiple choice test using accurate vocabulary to teach elementary students about the gas laws. As one student described, "I liked working with groups because we were able to put in all of our ideas and combine them. I liked doing a project for our grade because it was a different way to show our knowledge of the chapter."

Many students were confused initially. Not all feedback was positive. Several written comments mentioned the frustration experienced during this unit, especially at the start when the format felt so new. From a teacher's perspective, I saw students being challenged and could tell based on the number of questions I received each day that certain groups were struggling. However, as emphasized over and over, authentic science involves its fair share of frustration, but scientists who persevere through the confusion often have the greatest gains in understanding. Despite initial frustration, many students seemed to agree with this sentiment by the end of the unit, as represented in the following comment: "Unit 6 went well, at first I was confused about how pressure, temperature, and volume worked, but now I know how [. . .] At some points this unit was rough." Similarly, another student wrote, "The new teaching strategy was a little frustrating but by the end I think I understood it."

Traditionally successful students were frustrated. I encountered the most vocal frustration and resistance from students who had received the highest grades in previous chapters. These were students who knew "how to play the game" and had conquered traditional education and grading systems. When asked to collaborate with others rather than rely on themselves and to think critically rather than absorbing content knowledge to later regurgitate, these students asked many questions in search of "the right answer." One particular after-class conversation with two students stood out in my mind: "I don't understand why you won't tell us what the answer is," one said in reference to the tanker

phenomenon early in the unit. That same student later wrote in an exit slip, “I hate PBL and hope we never do it again [. . .] I liked your old style of teaching better, sorry.”

The role of the teacher changed. Stemming from the frustration students experienced, I heard comments from students directly and even from colleagues who claimed that I had “stopped teaching.” Because I spent relatively little time standing at the front of the classroom lecturing as I had in prior units, students felt as if they were not being taught. One high-achieving student characterized this frustration in her exit slip feedback: “Unit 6 was okay. I did understand it, but the way we learned for this unit made it confusing. In my opinion, it was a little annoying having to do everything on our own. I would have comprehended this unit better if you would have taught it.”

Because I was not at the front of the classroom talking for most of the lessons, students perceived that I had “stopped teaching” them. What they did not realize was that they were thinking and learning for themselves in these moments, and that the teacher was still teaching, but in the role of learning facilitator rather than direct instructor.

Discussion

From these results, it can be seen that implementation of inquiry and project-based learning in the chemistry curriculum helped most students gain a better conceptual understanding of content as they were challenged to address prior misconceptions, represent their thinking in multiple ways, collaborate in order to construct an understanding of matter at the particulate level, and ultimately apply their learning by teaching others. In line with the literature review, this type of authentic learning can help address the flaws of the traditional education system represented in the works of Kolodner et al. (2003) and Krajcik and Blumenfeld (2006).

The increase in test scores as documented in this action research also aligns to the findings of similar studies by Mahendru and Mahindru (2001), Yadav, Lundeberg, Subedi, and Bunding (2011), and (Nguyen & Siegel, 2015). Just as Kazempour and Amirshokoohi (2013) reported that inclusion of inquiry-based learning led to a deeper conceptual understanding, my students’ data likewise served as evidence of their understanding of the learning objectives.

Although new techniques were implemented in this unit, it is important to note that group work and collaboration were skills that had been emphasized and practiced all year long.

The importance of communication and collaboration was not a new concept, and many structures and norms had been in place since the start of the school year to support successful student interactions, as recommended by Kolodner et al. (2003). In retrospect, I would argue that the time spent establishing and practicing these norms was critical to my students' success in this particular unit: rather than spending time learning how to work with others, students were able to focus on struggling with content together and thus were ultimately more successful.

Despite the fact that not all students preferred this style of teaching, many were seen to be more engaged and motivated to learn during class time, especially in populations of students for whom chemistry had been a challenge previously. Although minority students were not a particular focus of this research, seeing students who had struggled previously be so successful supports the conclusions of Buck, Cook, Quigley, and Prince (2014) regarding the positive impacts of an adapted science curriculum on the educational inequalities seen in minority students.

Undoubtedly, it would be unrealistic to presume that inquiry and project-based learning could (or should) be included in all units and lessons. However, expansion of this curriculum would no doubt help to alleviate the concerns and frustrations of students who were unused to such teaching methods. Implications for the future include the importance of establishing a culture of learning, collaboration, and critical thinking across the whole school year and within multiple classrooms to support all students' learning.

Despite its successes, limitations of this action research project are duly noted. Although effort was made to collect objective data, many of the observations were subjectively noted, resulting in conclusions grounded in qualitative data. The particular teaching context of my school also undoubtedly plays a significant role in the results of this study, and further research examining this type of learning in additional, more diverse classrooms may be warranted.

Conclusion

This action research project renewed my passion for teaching by challenging me to focus on maximizing student learning and engagement through authentic lessons grounded in real life. Although time consuming, I see the work put into the creation of these lessons as an investment in my teaching career, as I will continue to use and adapt them for years to come. Challenges and frustrations expressed by students were likely reflected in my own experiences, as this unit likewise pushed me to think critically and reflectively about

chemistry content and best teaching practices. Although there were moments of doubt, overall the positive results that I saw in the majority of my students made all of the hard work and most of the frustration worth it in the end.

Because so many students engaged so deeply with this content, I hope to rearrange my curriculum next year in order to implement this unit in the fall semester. By enacting these lessons with students who have a rudimentary understanding of matter and little to no understanding of chemical reactions, I hope to build a particulate-level understanding of matter as foundation that will lead more students to be more successful in future units. Moreover, the skills applied in this unit will serve as practice for the units to follow; skills such as collaboration, questioning, and modeling can be utilized to construct understanding of more complex topics across the rest of the school year.

I also hope to adapt other units in a similar way, slowing building a repertoire of authentic, phenomena –based lessons that require students to develop their own understanding, represent their thinking in multiple ways, and communicate ideas for others. These are all science practices emphasized in the new Michigan Science Standards and utilized daily by scientists in the lab and field all over the world. By deepening my curriculum in this way, I hope to see less frustration from students as they become comfortable with being uncomfortable and as more structures are developed to support them as they grow as unique individuals, learners, and scientists.

About the Author

Michelle Vanhala is a science teacher at Tecumseh High School in Tecumseh, MI. Originally from Big Rapids, MI, she double majored in Integrated Science and English for Secondary Education at Central Michigan University, completing a capstone in transformative educational practices and receiving the 2014 Honors Program Senior Academic Honors Award. In 2014, she was named a Knowles Teaching Fellow through the Knowles Teacher Initiative, a national foundation focused on providing professional development and funding for the support of young math and science teachers. She recently completed a Masters of Science in Science Education through the University of Michigan - Dearborn with a focus on project-based and inquiry learning. Michelle is an avid reader and traveler and can be followed on Twitter through her handle @MsVanhala. Email: mvanhala@tps.k12.mi.us

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References

Albanese, M. A. & Mitchell, S. (1993). Problem-based learning: A review of literature on its outcomes and implementation issues. *Academic Medicine, 68*(1), 52 – 81.

Allen, D. E., Duch, B. J., & Groh, S. E. (1996). The power of problem-based learning in teaching introductory science courses. *New Directions for Teaching and Learning, 68*, 43-52.

Buck, G., Cook, K. L., Quigley, C. F., Prince, P., & Lucas, Y. (2014). Seeking to improve African Americans girls' attitudes toward science. *The Elementary School Journal, 112*(3), 431 – 453.

Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review, 16*(3), 235 – 266.

Kazempour, M. & Amirshokoohi, A. (2013). Exploring elementary pre-service teachers' experiences and learning outcomes in a revised inquiry-based science lesson: An Action Research. *Journal of Education and Learning, 2*(2), 114 – 154.

Klahr, D., & Nigam, M. (2004). The equivalence of learning paths in early science instruction: Effects of direct instruction and discovery learning. *Physiological Science, 15*(10), 661 – 667.

Kolodner, J. L, Camp, P. J., Crismond, D., Fasse, B., Gray, J., & Holbrook, J. (2003). Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting learning by design into practice. *Journal of the Learning Sciences, 12(4),* 495-547.

Krajcik, J. S. & Blumenfeld, P. C. (2006). Chapter 19. *Project-based learning* (317 – 333). New York: Cambridge.

Nguyen, P. D. & Siegel, M. A. (2015). Community action projects: Applying biotechnology in the real world. *The American Biology Teacher, 77*(4), 241-247.

Mahendru, P. & Mahindru, D. V. (2011). Problem-based learning: Influence on students' learning in an electronics and communication engineering course. *Global Journal of Researchers in Engineering Electronics Engineering, 11* (8).

Schank, P. & Kozma, R. (2002). Learning chemistry through the use of a representation-based knowledge building environment. *Journal of Computers in Mathematics and Science Teaching, 21*(3), 253-279.

Schmidt, H. G. (1983). Problem-based learning: Rationale and description. *Medical Education, 17*, 11-16.

Yadav, A., Subedi, D., Lundeberg, M. A., & Bunting, C. (2011). Problem-based learning: Influence on students' learning in an electrical engineering course. *Journal of Engineering Education, 100*(2), 253-280.

Appendix A: Unit 6 Pre/Post Test

Unit 6 Pre/Post Assessment

Think back to the first few chemistry units and use your experiences to answer the following questions honestly.

1. How engaged and interested have you felt in regards to learning chemistry content? a. Very engaged and interested b. Somewhat engaged and interested c. Neutral d. Not engaged and interested e. Very unengaged and disinterested

2. How engaged and interested have you felt in regards to working with your group members?
a. Very engaged and interested b. Somewhat engaged and interested c. Neutral d. Not engaged and interested
e. Very unengaged and disinterested

3. Which of the following teaching practices makes you feel engaged and interested in chemistry? Bubble in all that apply! a. Ms. Vanhala going through examples b. Working in small groups c. Working with a partner d. Individual practice e. Hands on labs

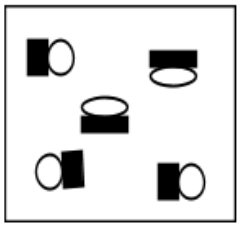
4. How well do you feel you've understood the chemistry content up to this point? a. Very high level of understanding
b. Somewhat high level of understanding c. Medium high level of understanding d. Low level of understanding
e. Very low level of understanding

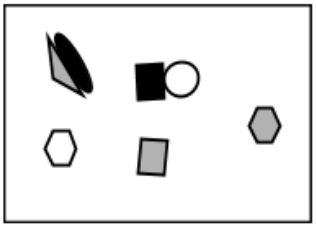
5. Which of the following teaching practices has helped you understand chemistry content up to this point? Bubble in all that apply! a. Ms. Vanhala going through examples b. Working in small groups c. Working with a partner d. Individual practice e. Hands on labs

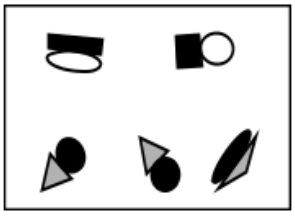
Flip your bubble sheet over - on the back, list out any other teaching practices that help you feel engaged/interested and understand chemistry content!

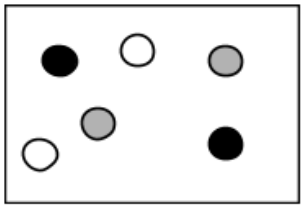
❑ **6.1 I can define element, compound, and mixture by identifying examples of each.**

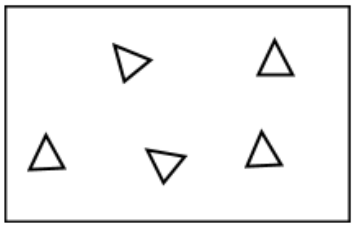
6. Which of the following images below best represents a mixture of compounds and elements?
7. Which of the following images below best represents a pure compound?
8. Which of the following images below best represents a pure element?
9. Which of the following images below best represents a mixture of elements?
10. Which of the following images below best represents a mixture of compounds?

A. 

B. 

C. 

D. 

E. 

❑ **6.2 I can compare inter- and intra-molecular forces by defining each.**

True (a) or False (b)?

11. (T/F) Intramolecular forces act internally to attach elements together in compounds while intermolecular forces work between neighboring particles externally

12. (T/F) Intermolecular forces act internally to attach elements together in compounds while intramolecular forces work between neighboring particles externally

13. (T/F) Both intermolecular forces and intramolecular forces attach elements together in compounds

14. (T/F) Both intramolecular forces and intermolecular forces work between neighboring particles externally

15. (T/F) Neither intramolecular forces nor intermolecular forces act internally to attach elements together in compounds or work between neighboring particles externally

❑ **6.3 I can describe polarity, dipole forces, hydrogen bonds, Van der Waals interactions, and electrostatic forces by identifying examples of each.**

16. Electrostatic forces	a. Attractive or repulsive forces between molecules caused by electrons in one affecting electrons in the other
17. Dipole forces	b. Attractive forces in which a hydrogen atom is weakly bonded to another negative atom
18. Hydrogen bonds	c. Attractive forces resulting from interactions between oppositely charged areas in polar molecules
19. Polarity	d. A molecule in which one side is slightly negative and the other side slightly positive
20. Van der Waals Interactions	e. Attractive or repulsive forces between molecules

❑ **6.4 I can distinguish between temperature and heat by comparing definitions and specific heat of substances.**

21. Temperature
    a. Is a measure of the average kinetic energy of a substance
    b. Has the same definition as the word "heat" in chemistry class
    c. Cannot go higher than 273 Kelvin
    d. Is not related to the movement of particles in a substance
    e. All of the above

22. Which of the following would have the most similar **average kinetic energy** of its particles?
    I. liquid water at 80.0 ºC
    II. solid steel at 0.0 ºC
    III. solid steel at 80 ºC
    IV. liquid methanol at 60.0 ºC

    a. I and II b. I and III c. II and III d. I and IV

23. The particles of the 10.0 kilogram mass of iron at 290 degrees Kelvin will have the same **average kinetic energy** as the particles of a 10.0 kilogram mass of paper at 290 degrees Kelvin.

a. True
b. False

24. Specific heat is
a. The same as "temperature"
b. A amount of energy required to raise a substance's temperature
c. Cannot go higher than 273 Kelvin
d. Is a measure of the average kinetic energy of a substance
e. All of the above

25. True (a) or false (b)? Water has a relatively high specific heat.

❑ **6.5 I can explain what happens to the kinetic energy of a substance as temperature is increased using the kinetic theory of matter.**

26. Which of the following is NOT true about the kinetic theory of matter?

a. The kinetic theory of matter states that in all forms of matter the particles are in constant motion.
b. The kinetic theory of gases assumes that the particles of a gas are small, solid particles.
c. The kinetic theory of gases assumes no energy is lost when the particles collide.
d. The kinetic theory of gases assumes that gas particles have random motion.
e. The kinetic theory of gases assumes that gas particles have a lot of intermolecular forces of attraction.

True (a) or false (b)?

27. (T/F) Kinetic energy and temperature have an inverse relationship.

28. (T/F) As temperature increases, so does the average kinetic energy of a substance.

29. (T/F) A change in temperature occurs during a phase change.

30. (T/F) The energy added to a boiling liquid is lost as water is vaporized, keeping the average kinetic energy of a boiling liquid (at constant pressure) the same.

❑ **6.6 I can distinguish between the four states of matter by describing their kinetic energy and strengths of internal attractions.**

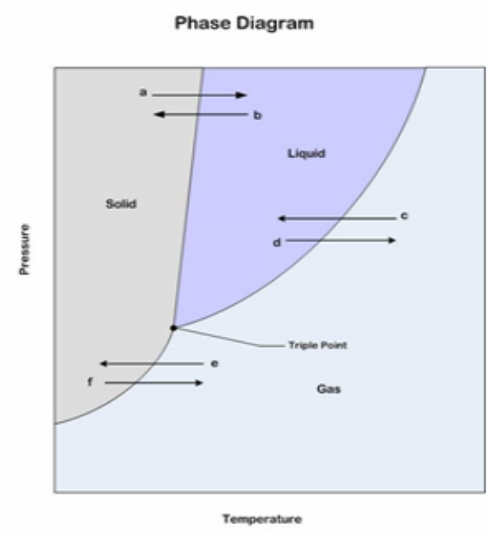
31. Solid
32. Liquid
33. Gas

a. b. c.

34. Which of the following states of matter has the highest kinetic energy?
a. solid b. liquid c. gas d. plasma e. all have the same

35. Which of the following states of matter has the highest intermolecular forces?
a. solid b. liquid c. gas d. plasma e. all have the same

❑ **6.7 I describe phase changes using correct vocabulary and particle diagrams.**



36. In the phase diagram, what best describes what is happening at the triple point?
a. Only the solid state can be found
b. Only the liquid state can be found
c. Two states of matter can be found at the same time
d. All three states of matter can be found at the same time
e. None of the states of matter can be found at this point

37. In the phase diagram, what best describes what is happening at point F?
a. The solid is sublimating into a gas
b. The solid is melting into a gas
c. The gas is sublimating into a solid
d. The gas is condensing into a solid
e. The critical point is occurring

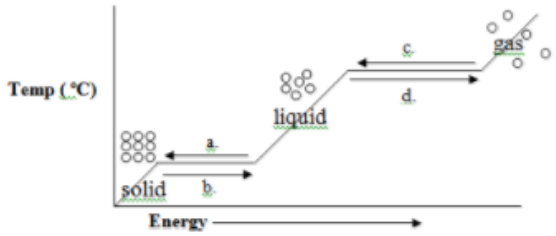
38. In the phase diagram, what best describes what is happening at point D?
a. The liquid is vaporizing into a gas
b. The gas is vaporizing into a liquid
c. The gas is condensing into a liquid
d. The liquid is condensing into a gas
e. The solid is melting into a liquid

39. In the phase diagram, what best describes what is happening at point A?
a. The liquid is melting into a solid
b. The liquid is freezing into a solid
c. The solid is melting into a liquid
d. The solid is freezing into a liquid
e. The liquid is vaporizing into a gas

40. Which of the following is most accurate regarding the phase diagram above?
a. Gases exist at a relatively low temperature and low pressure
b. Solids exist at a relatively low temperature and high pressure
c. Liquids exit at a relatively high temperature and low pressure
d. The triple point occurs at a relatively high temperature and high pressure
e. All of the above are true

❑ **6.8 I can create a phase change diagram to model the energy of a substance as temperature changes over time.**

41. Which of the following is true about the phase change diagram?
   a. At location A the substance is solid only
   b. At location B the substance is both solid and liquid
   c. A location C the substance is a liquid only
   d. A location D the substance is both liquid and solid
   e. All of the above are true



42. Which of the following is NOT true about the phase change diagram?
   a. The temperature is staying the same at A and C
   b. The temperature is increasing at B and D
   c. Heat energy is being removed at A and C
   d. Heat energy is being applied at B and D
   e. A solid is being heated until it is a gas

43. During freezing
   a. temperature increases
   b. temperature decreases
   c. temperature stays the same
   d. temperature varies indirectly

44. During freezing
   a. energy increases
   b. energy decreases
   c. energy stays the same
   d. energy varies indirectly

45. Which of the following is true of water freezing?
   I. the average kinetic energy of the particles remains constant
   II. the average kinetic energy of the particles decreases
   III. the total kinetic energy increases
   IV. the total kinetic energy decreases

   a. I and III b. I and IV c. II and III d. II and IV

❑ **6.9 I can characterize the relationships between pressure, temperature, and volume by using Dalton's Law, Boyle's Law, Charles' Law, Gay-Lussac's Law.**

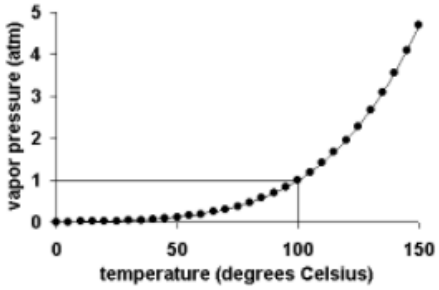
46. Which of the following indicates the relationship between volume and pressure for a mass of a gas at a constant temperature?
   a. volume increases as pressure increases
   b. volume decreases as pressure increases

47. Which of the following indicates the relationship between pressure and temperature for a mass of a gas at a constant volume?
    a. pressure increases as temperature increases
    b. pressure decreases as temperature increases

48. Which of the following indicates the relationship between volume and temperature for a mass of a gas at a constant pressure?
    a. volume increases as temperature increases
    b. volume decreases as temperature increases

49. The following graphs shows the relationship between the temperature and pressure of a fixed mass of gas. The relationship between these two variables is

    a. direct (as one increases the other also increases and vice versa)
    b. inverse (as one increases the other decreases)



50. As the temperature drops, what will happen to the air pressure in your car's tires?
    a. Pressure will increase
    b. Pressure will decrease
    c. Pressure will stay the same
    d. Pressure will increase and then decrease

❑ **6.10 I can calculate pressure, temperature, volume, and moles using the Combined and Ideal Gas Laws.**
R = .08206 L atm mol^{-1} K^{-1}

51. A gas is contained in a 2.0 L rigid vessel (so volume is constant) and the has a temperature of 50.0 K and a pressure of 0.0010 atm. What will the pressure be at a temperature of 200.0 K?
    a. 0.0020 atm b. 0.0040 atm c. 0.00050 atm d. 0.00025 atm

52. A gas is kept at a constant temperature of 0.0 ºC and has a pressure of 700.0 mm Hg and a volume of 55.0 mL. What will its volume be at 965 mm Hg?
    a. 3.63 mL b. 75.8 mL c. 39.9 mL d. 1.22 x 10^4 mL

53. A 2.0 L rigid container contains 0.40 moles of a gas at 20.0 ºC. What is its pressure (in atm)?
    a. 4.8 atm b. 2.4 atm
    c. 0.60 atm d. 0.30 atm

54. How many moles are there in a gas which has a volume of 3.50 L, a temperature of 20.0 ºC, and a pressure of 1.00 atm?
    a. 1620 mol b. 111 mol c. 0.145 mol d. 6.87 mol

55. What is the pressure of 1.2 moles of a gas which has a volume of 1.520 L and a temperature of 40.0 ºC?
    a. 0.0493 atm b. 20.3 atm c. 0.0203 atm d. 1.59 atm

UNDERSTANDING CLASSROOM MOTIVATION AMONG ADOLESCENT HISPANIC MALES

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Albizu University

Abstract This action research study explored adolescent Hispanic male perceptions of classroom motivation in learning. As educators, we struggle to engage young males in the education process, so we decided to ask Hispanic adolescent males what could increase their motivation and engagement in the classroom and learning process. Ten Hispanic male adolescents were interviewed to understand what motivated them in the classroom. They completed a short demographic survey and interview protocol; transcription data was coded and analyzed using the constant comparison method. Findings indicated that a motivated teacher, student decision-making, interesting and relevant topics, the future, and classroom engagement are sources of motivation in the classroom for Hispanic adolescent males. Using these findings, we developed a short questionnaire and survey to integrate in the classroom at the beginning and middle of the school year to best design teaching strategies and activities that would best serve our student population.

Keywords: motivation, Hispanic adolescent boys, student achievement, classroom environment, Hispanic, action research, teacher action research

Introduction

Fostering creative and engaging learning environments can be a challenge for educators with unmotivated students. While the literature informs us of how to develop motivating learning environments for students (Daniels & Pirayoff, 2015), we were interested in learning how adolescent Hispanic males described their own motivation to learn in the classroom. Hispanic male achievement has been identified as a critical topic of research and inquiry due to low educational attainment rates, low achievement scores in reading and writing, their overrepresentation in special education tracks, and referrals to juvenile detention agencies (Saenz & Ponjuan, 2009; Schott, 2015). Prior research asserts that a student's level of motivation is not only dependent upon intrapersonal factors, such as

innate characteristics, but also upon the learning environments in which they develop and build academic competencies (Guay, 2016).

Culture and context also provide a sense of belonging for students and help to increase their motivation for learning; these environments can be developed with careful attention to student attributes, needs, interests, classroom climate, as well as cultural context. Therefore teachers should be pedagogically aware to inspire students in the learning process. This action research study was developed to identify teacher behaviors and classroom teaching strategies that motivate adolescent Hispanic males to increase academic performance and contribute suggestions to accomplish this. Noting that many of our young Hispanic males were struggling with their schoolwork and seemed less motivated than their Hispanic female counterparts, we wanted to understand what learning activities and teacher behaviors might increase male classroom engagement in the learning process. Furthermore, data suggests a decrease in Hispanic male academic performance in the last decade. Hispanic males below age 18 are the largest segment of the U.S. Hispanic population, thus supporting the importance of this research (Clark, Ponjuan, Orrock, Wilson, & Flores, 2013; Schott, 2015).

Literature Review

As educators, we have experienced the direct link between the support and care that family has on youth and their educational attainment (Arbelo-Marrero, 2016; Poza, Brooks, & Valdez, 2014; Woolley, 2009); yet research also demonstrates that support and relationships in the classroom, and school environment also impact student learning and motivation for all students, including minority boys (Guay, 2016; Orthner et al., 2010; Super, 2014). Healthy teacher student relationships are beneficial to educational performance and increase student motivation to learn (Martin & Dowson, 2009; Wubbels et al., 2016). Motivation drawn from positive teacher student relationships sustains a desire to learn over time which positively affects achievement (Henry & Thorsen, 2018). Unfortunately, data points toward a downward spiral in educational attainment among African-American and Latino males (Schott, 2015), and high school completion among Hispanic students are lower than other ethnic groups (Carpi, Darcy, Falconer, Boyd, & Lents, 2013; Lesaux & Rangel, 2013).

For educators it is imperative to understand what inspires adolescents to achieve to better support their school success, especially among underperforming populations. Late elementary and middle school are transitional times in the life of the adolescent; changes in their bodies, expectations from parents and teachers increase, and they struggle as they leave childhood behind them. During this transition, the motivation for learning has the potential to decline (Dent & Koenka, 2016). For boys, the development of self-regulation and the physical constraints of remaining seated throughout the day and listening to lectures can be challenging and they may struggle to develop these behaviors (Long, Monoi, Harper, Knoblauch, & Murphy, 2007; Steinberg, 2005). Gurian (2011) asserts that using

storyboards, graphics, granting autonomy is assignment selection, and same gender project groups have been found helpful in stimulating learning motivation among boys. As educators it is imperative to understand what inspires adolescents to achieve in order to support their success. Through years of interacting and teaching children of all ages, we believe that motivation, whether intrinsic or extrinsic, is the foundation for all learning. It was with this in mind that we developed this action research project.

Methodology

This action research plan included identifying an area of focus, data collection, data analysis and interpretation, and action planning (Mills, 2014). Since we sought to understand the perceptions of Hispanic adolescent boys' motivation in the classroom, one-on-one interview protocol seemed most appropriate for our purposes. The overarching research question was: What motivates adolescent boys to learn in the classroom?

The intent of the study was for the students to inform us of the types of behaviors and activities they believed help to motivate them in the learning process, specifically in the classroom context. The interview questions addressed the students' ideas about their classroom environment, teachers, and also prompted for a reflection of their own motivation in learning.

There were ten male participants between the ages of 11 and 14 recruited from two public schools in southeastern Florida. Parental consent forms were developed to advise parents about the study, how it would be conducted, and what the results would be used for in order to seek their permission to allow their sons to participate in this project. Once parental and participant assent was secured, an individual meeting was conducted with each participant, a brief yet thorough explanation of the intent for this study was provided to them, and any questions they may have had were answered.

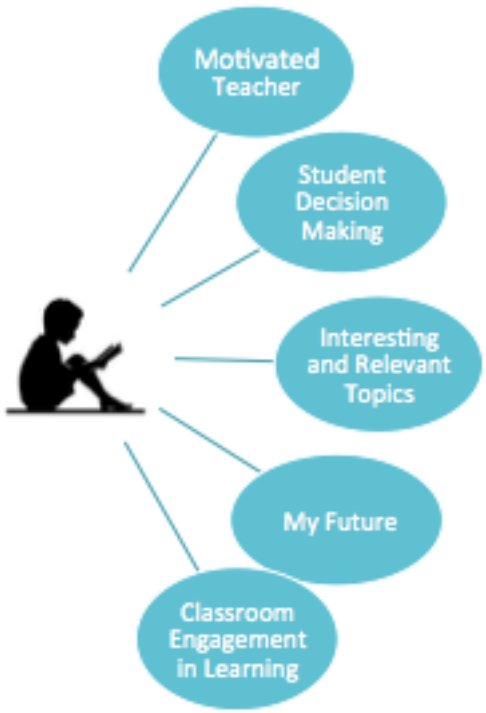
Seven interview questions were developed specifically prompting responses on different areas of motivation such as the classroom climate, the teacher, methods of motivation and self-reflection. All questions were open-ended allowing the student to express himself as needed (see Table 1). The final question simply asked if there were any other comments they would like to share. The reason behind this type of question was to give the student the opportunity to share anything they felt was appropriate without the pressure of focusing on a particular question.

Table 1: Interview Questions: What motivates you to learn in the classroom?

1. What motivates you to learn new things? **2.** How have your teachers motivated and inspired you to learn? **3.** What part of learning new ideas and things do you enjoy most? **4.** What do you think a motivated classroom might be like? **5.** What is it about a classroom environment that sparks your interest in learning? **6.** Do you think you are a motivated student? Why or why not? **7.** Do you have any other comments you would like to share?

Once an interview took place, data was transcribed within 24 to 48 hours of recording, and initial coding then took place. Specifically, line-by-line initial coding was used as it is more suitable for interview transcripts; highlighters marked salient words and ideas across data transcriptions (Figure 2). Annotations were made in the margins during the second round of coding which was descriptive; notes were formulated on separate index cards identifying major themes that emerged from the coding and constant comparison data analysis process (Creswell & Poth, 2018; Saldana, 2015). Comparing descriptions, words, and ideas across transcripts allowed us to determine the major themes across the data.

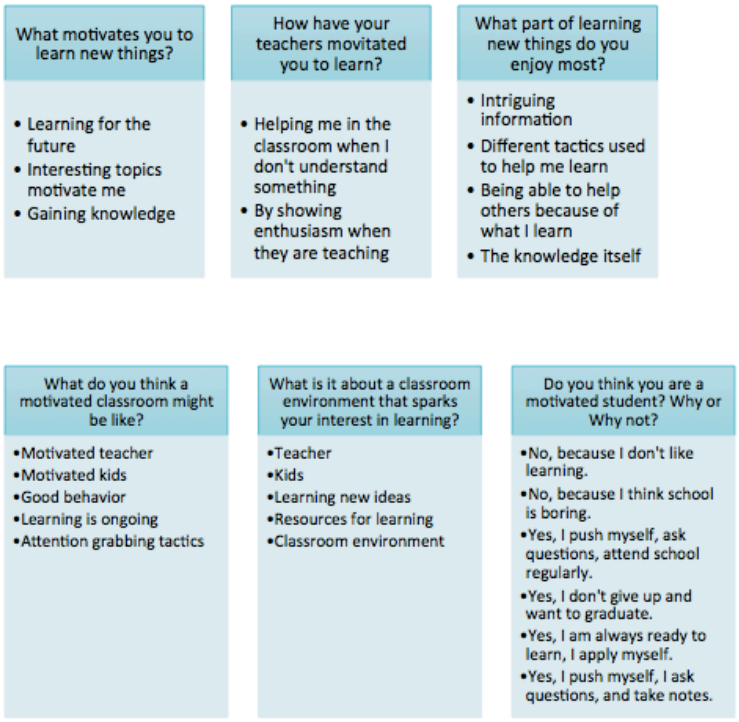
Figure 1: Five Themes: What Motivates Adolescent Hispanic Boys to Learn in the Classroom



Results

Figure 1 shows the thematic units that emerged from the analysis of the data on what motivates Hispanic adolescent males to learn in the classroom. Upon careful interpretation and transcription of the data collected in the student interviews, certain topics became bold and salient, these were: a motivated teacher, student decision-making, interesting and relevant topics, the future, and classroom engagement. Figure 2 shows main ideas that emerged from the student responses. A motivated teacher: It was clear that each participant valued the importance of a caring teacher; one who is interested in student academic success, took time to help students overcome challenging academic content, and demonstrated enthusiasm for learning. A motivated teacher was a crucial element in the learning process. Participants expressed that an enthusiastic teacher set the mood for learning and possesses the ability to grab students' attention and interest for school. The majority of the participants preferred to learn in a calm, organized, and interactive environment where the teacher is readily available and interested in answering their questions and guiding them along. Student decision making: many of the adolescent boys asserted that being able to choose among different projects, assignments, and assessments would be helpful. Allowing students to choose between assignments is motivating and engaging. This included allowing them to decide whether they would like to participate in a group project or complete an alternative assignment on their own. Democratic classroom environments that considered the boys' ideas meaningful and that provided some self-determination in the context of assignments and assessments were, they asserted, a motivating factor in the classroom.

Figure 2. Main Ideas that Emerged for Each Question



Interesting and relevant topics: a common answer that emerged from the question that asked what part of learning new things each enjoyed was that they simply enjoy learning new and interesting things. Participants expressed that learning new ideas, topics, and information presented to them in a manner that they can relate to, created a more engaging classroom environment. The important point here is that knowledge presented in a relevant manner to these young males facilitates the learning process for them. The future: participants also mentioned a desire for learning new academic content and ideas is anchored on a vision of future success; for example, to be college and career ready. Through the interview process, they also conveyed that completing their education was necessary for future employment options. Classroom engagement in learning: most of the participants mentioned that differentiated instructional strategies (e.g. classroom experiments, hands on activities and projects, and simply learning concepts in multiple perspectives) sparked their motivation. Visual displays of useful information such as posters they themselves collaborated to create and the use of technology were stated as resources that sparked their interest in learning.

Surprisingly, all but one participant indicated that they believed they were motivated students. They attributed that teacher enthusiasm, their own readiness and willingness to learn, desire for knowledge, and drive for future success as motivating factors. One participant stated that his motivation to learn was parental influence. He did not want to disappoint his parents, and therefore was compelled to thoroughly complete his

assignments. The last interview question was optional, as it only asked if there were any other comments they would like to share. In response to the final question, three out of the ten participants volunteered some extra information. One attributed the lack of motivation to only caring about being popular in school and not being interested in coursework. Another participant contributed that motivation was different for everyone. The other participant offered a suggestion, "Don't keep it inside and don't be afraid to ask questions about whatever you need." See Appendix C for an interview transcription.

Discussion and Implications

Findings indicate that educators should possess the characteristics of flexibility, compassion, and dedication. Teachers should be inclusive and student centered in their planning, permitting students to provide input in the curricular development and assessment process. This has the potential to help students foster a sense of ownership in learning, which may potentially increase their motivation. This action research study seeks to remind educators that we are accountable for our students' progress, success, and motivation in the classroom; every participant of this study indicated so. Teacher-student relationships are imperative for mutual success. The importance and adaptive value of motivation is directly related to the teacher's own motivation in the classroom (Daniels, 2011). Overall, participants stated that they possessed a desire for learning new things, enjoyed learning with differentiated strategies, longed for the teacher's guidance and support, were aware of the impact of education on future success, and perceived themselves, for the most part, as being motivated students. This study has offered valuable insights into students' attitudes about motivation.

The compilation of data gathered from literature that addressed similar content supports most of these findings (Guay, 2016; Orthner et al., 2010; Super, 2014). One of the most important findings that demonstrated links to existing research was expressed in the Daniels and Pirayoff (2015) study, which states "truly effective teachers combine knowledge about content, pedagogy, and motivation to create learning environments that both allow and encourage students to thrive" (p. 20). Daniels and Pirayoff (2015) encourage teachers to establish rapport and relationships with students that foster motivation. For example, teachers can connect with students at lunchtime, open their classrooms to watch content videos, hold question and answer sessions, or help with homework (Daniels, 2011; Daniels & Pirayoff, 2015).

An action research study should serve a purpose other than data collection. It requires teachers to gain useful insight and reflect upon their own practices to make improvements

for the benefit of the students. This research has led us to develop the following strategies to implement in the classroom:

- Distribute a brief student focused questionnaire providing students with opportunity to answer questions specific to their preferred learning styles, modes of communication, seating, resources, options for assignments, and feedback (Appendix A).
- Have students complete an online survey to collect specific information to better acquaint teachers with their students. (Appendix B).
- Use the information gathered from these questionnaires to foster teacher and student relationships in the classroom in order to increase student motivation and engagement.

Both the online survey and questionnaire are tools we now use for grouping students and creating an engaging classroom climate, which accommodates for individual preferences and learning styles. It is up to the teacher's discretion whether to provide a printed copy of the survey and questionnaire or make them available for online completion.

The benefit of these tools is that they may be re-administered halfway through the school year or the teacher may develop a planned schedule to administer and re-administer to note changes and adjust activities. Opinions change and preferences change; if the student knows the teacher is interested in their learning activities, that alone may be a pivotal point in their learning process. Keeping records of the student's responses and sharing them with parents in a parent-teacher conference can also be quite beneficial. For example, engaging parents in the conversation about what motivates their child, shedding light on a child's interests, and collaborating with parents to discuss learning styles; each supports the student. In addition, the teacher can create a survey for the parents to gain a sense of what the learning environment is at home. This helps to link a child's two most important worlds to best support their achievement. We will begin the next school year with the questionnaire and the survey in order to integrate student ideas and preferences in our teaching practices.

Limitations

Limitations of this study include geographic location and small sample size, which limit the generalizability of the findings. We recommend that future studies include a larger sampling across urban schools and include a parent survey inquiring to the child's behavior and interests outside of school. It would also be helpful to investigate teacher experiences with Hispanic adolescent males from a pedagogical perspective to understand factors of success for this population.

Conclusion

We set out to understand what motivates Hispanic male adolescent learning in the classroom and in the process discovered that they have goals, interests, and aspirations that should be cultivated in the teaching and learning process. Hispanic boys respect and engage with motivated teachers who understand how to include them in curricular decisions that impact their daily learning activities. They desire to be engaged in assignments they enjoy completing without compromising rigor. Boys enjoy interesting and relevant topics that capture their interest and that stimulate creative thinking; learning activities that allow them to demonstrate their strengths and help to develop their academic weaknesses. Adolescent boys are thinking about their futures, they want to make plans and be supported in their endeavors. Engaging Hispanic boys in learning means developing a shared environment where they have a voice in the teaching and learning process.

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References

Arbelo-Marrero, F. (2016). Barriers to school success for Latino students. *Journal of Education and Learning, 5*(2), 180 – 186. Retrieved from https://eric.ed.gov/?q=Barriers+to+School+Success+for+Latino+Students+Journal+of+Education+and+Learning+Marrero%2c+Floralba+Arbelo+2016&id=EJ1097395

Carpi, A., Darcy, R., Falconer, H., Boyd, H., & Lents, N. (2013). Development and implementation of targeted STEM retention strategies at Hispanic-serving institution. *Journal of Hispanic Higher Education, 12*(3), 280-299.

Clark, M. A., Ponjuan, L., Orrock, J., Wilson, T. and Flores, G. (2013). Support and Barriers for Latino Male Students' Educational Pursuits: Perceptions of Counselors and Administrators. *Journal of Counseling & Development, 91,* 458–466. doi:10.1002/j.1556-6676.2013.00118.x

Creswell, J. W., & Poth, C. N. (2018). Qualitative inquiry: Choosing among the five approaches (4th ed.). Thousand Oaks, CA: Sage Publications.

Daniels, E. (2011). Creating motivating learning environments: Teachers matter. *Middle School Journal, 43*(2), 32-37.

Daniels, E. & Pirayoff, R. (2015). Relationships matter: Fostering motivation through interactions. *Voices from the Middle, 23*(1), 19-22.

Dent, A.L. & Koenka, A.C. (2016). The relationship between self-regulated learning and academic achievement across childhood and adolescence: A meta-analysis. *Educational Psychology Review, 28*(3), 425 -474. doi:10.1007/s10648-015-9320-8

Guay, F. (2016). The virtue of culture in understanding motivation at school: Commentary on the special issue on culture and motivation. *British Journal of Educational Psychology, 86,* 154-160. doi: 10.1111/bjep.12105

Gurian, M. (2011). *Boys and girls learn differently! : A guide for teachers and parents* (Rev. 10th anniversary ed., 2nd ed.). San Francisco, CA: Jossey-Bass.

Henry, A., & Thorsen, C. (2018). Teacher–Student Relationships and L2 Motivation. *Modern Language Journal, 102*(1), 218-241.

Lesaux, N., & Rangel, J. (2013). How can schools best educate Hispanic students? *Education Next*, *13*(2), 50.

Long, J. F., Monoi, S., Harper, B., Knoblauch, D., & Murphy, K. P. (2007). Academic motivation and achievement among urban adolescents. *Urban Education, 42*(3), 196 – 222.

Martin, A. J., & Dowson, M. (2009). Interpersonal relationships, motivation, engagement, and achievement: Yields for theory, current issues, and educational practice. *Review of Educational Research, 79*, 327–365.

Mills, E. M. (2014). *Action Researcher: A Guide for the Teacher Researcher* (5th ed). Upper Saddle River, NJ: Pearson Education, Inc.

Orthner, D. K., Akos, P., Rose, R., Jones-Sanpei, H., Mercado, M. & Woolley, M. E., (2010). CareerStart: A middle school student engagement and academic achievement program. *Children & Schools, 32*, 223 – 234.

Poza, L., Brooks, M. D., & Valdés, G. (2014). Entre familia: Immigrant parents' strategies for involvement in children's schooling. *School Community Journal*, *24*(1), 119-148. Retrieved from http://connection.ebscohost.com/c/articles/96513400/entre-familia-immigrant-parents-strategies-involvement childrens-schooling.

Saenz, V. B. & Ponjuan, L. (2009). The vanishing Latino male in higher education. *Journal of Hispanic Higher Education, 8*(1), 54 – 89.

Saldana, J. (2015). *The Coding Manual for Qualitative Researchers (3rd ed.).* London: SAGE Publications.

Schott Foundation for Public Education. (2015). *Black Lives Matter: The Schott 50 state report on public education and black males*. Retrieved from http://www.schottfoundation.org/publications-reports/

Steinberg, L. (2005).Cognitive and affective development in adolescence. *Trends in Cognitive Sciences, 9*(2), 69-74.

Super, J. (2014). Middle School parenting: Graduation is just around the corner. In N. D. Young, C. N. Michael, & editors, *Betwixt and between: Understanding and meeting the social and emotional development needs of students during the Middle School transition years* (pp. 41-54). Lanham, MD: Rowman & Littlefield Education.

Woolley, M. (2009). Supporting school completion among Latino youth: The role of adult relationships. *The Prevention Researcher*, *16*(3), 9-12. Retrieved from http://eric.ed.gov/?id=EJ858777.

Wubbels, T., Brekelmans, M., Mainhard, T., den Brok, P. J., & van Tartwijk, J. (2016). *Teacher student relationships and student achievement.* In K. R. Wentzel & G. B. Ramani (Eds.), Handbook of social in uences in school contexts: Social-emotional, motivation, and cognitive outcomes (pp. 127–142). New York: Routledge/Taylor & Francis

Appendix A: Classroom Learning Engagement Preferences Questionnaire

- Which of the following describes your preferred style for learning?
    - Visual: You prefer using pictures, images, and videos
    - Auditory: You prefer using sound and music
    - Verbal: You prefer using words, both in speech and in writing
    - Physical: You prefer using your body, hands, and sense of touch
    - Logical: You prefer using reasoning, logic, and systems
    - Social: You prefer to learn in groups or with other people
    - Solitary: You prefer to work alone
- In which area of the room do you feel most comfortable in?
    - Towards the front of the class
    - In the center of the class
    - Towards the back of the class
    - I have no preference
- When I am on task, I prefer to sit….
    - Independently
    - With a partner
- How often would you like to discuss your academic progress with your teacher?
    - Once a week
    - Whenever it is necessary
    - I prefer not to discuss my progress
    - I will let the teacher know
- I would like to receive feedback on my assignments
    - I prefer discussing feedback with my teacher
    - I prefer written feedback from my teacher
    - I don't care for feedback from my teacher
- I like using these methods to complete assignments (choose as many as you wish)

  - Research Paper
  - Group projects
  - Work independently
  - Hands on presentations and demonstrations
  - Digital presentation
  - Applying art in my assignment (drawing a picture of a cell or neuron)
  - I have no preference, any method is fine

- Is there something specific that you would like to accomplish this school year?
- How can I help you accomplish this?

Appendix B: Online Survey – Getting to Know You

- What is your name? What name do you prefer to "go" by?
- What ONE word best describes you?
- How often do you understand the content you are learning at school?
    - Almost never
    - Once in a while
    - Sometimes
    - Frequently
    - Almost all the time
- How motivating are the lessons your teachers teach?
    - Not at all motivating
    - Slightly motivating
    - Somewhat motivating
    - Quite motivating
    - Extremely motivating
- How often do you engage in educational activities outside the home? (Tutoring, Library, Educational Camps)
    - Almost never
    - Once in a while
    - Sometimes
    - Frequently
    - Almost all the time
- How regularly do you read for fun? (not school related)
    - Almost never
    - Once in a while
    - Sometimes
    - Frequently

    - Almost all the time

- How well have the teaching methods of your teachers matched your own learning style?
    - Not well at all
    - Mildly well
    - Fairly well
    - Quite well
    - Extremely well
- How much effort do you put into school-related tasks?
    - Almost no effort
    - A little bit of effort
    - Some effort
    - Quite a bit of effort
    - A tremendous amount of effort
- Do you have any other comments, questions, or concerns?

Appendix C: Excerpt Participant Quotes

Question: What motivates you to learn new things?

Participant 1: *Let me think about it for a second. Well I know that if I learn new things I will do well in life and get to go to college and hopefully get a good job one day and not end up like on the streets and all that stuff so that's what motivates me. Just doing I mean a good and going to a good college eventually.*

Participant 2: *The experiences that it could bring like the outcome at the end that I could learn new things.*

Participant 3: *I like learning stuff. Also it helps me get through life. So it can help me in many ways for the future.*

Participant 4: *It's going to pay off when I am older.*

Participant 5: *I feel like I need to know things for the future if I want to get to a good college or yea a good college. So I feel that I need to learn as much as I can now so I can know for the future.*

Participant 6: *If it seems interesting and it might better me later in life.*

Participant 7: *The knowledge of knowing new things.*

Participant 8: *What motivates me to learn new things is mostly my mom and dad how they're always pushing me to learn new things and I don't want to let them down so I just learn new things for them.*

Participant 9: *It has to be interesting. If it's fun.*

Participant 10: *Well I've always been motivated to keep learning because the more knowledge I have I'll be able to be more successful in life. Because my success I feel will be the result of the things I have learned, I have accomplished.*

DEVELOPING STUDENT TEACHERS' ABILITY TO EVALUATE THEIR PUPILS' LEARNING IN THE CLASSROOM

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Abstract Pre-service teachers are often required to evaluate lessons, as part of their development as reflective practitioners. The purpose of this action research was to improve student teachers' critical thinking and evaluative practice, following external comments that this aspect should be strengthened. Utilizing a qualitative method approach, a textual analysis of the quality of the lesson plan evaluations produced over one academic year revealed that, in-line with the literature (Halpern, 1999), student teachers benefited from structured training, encouragement to use critical thinking skills and clear success criteria to enable them to monitor, assess and discuss their own progress. However, it was necessary to revisit critical evaluation several times over the year to support their development as effective, reflective teachers.

Keywords: initial teacher education, student teacher, critical thinking, evaluation of learning, teacher action research

Introduction

Critical thinking skills are seen as essential to success and employability (Clarke, 2014; Wallace and Wray, 2009; Halpern, 1999) and university based programs often require students to demonstrate criticality in their academic work. However, it is not unusual to hear academics despairing about students' ability to 'think' (Birkenhead, 2009*).*

When external inspection feedback was shared with our university programs that student teachers' critical thinking skills and their evaluation of pupils' learning' should be improved, I was given the task of leading on the improvements. This involved carrying out a series of actions (taken in light of the following background literature) and then evaluating if they had indeed led to improvements in the quality of students' lesson evaluations, before the return of the inspectors at the end of the academic year.

Literature Review

The importance of critically evaluating pupils' learning. Initial teacher education programs often require student teachers to plan, deliver and evaluate lessons. Accurate evaluation of the extent of the learning allows the student teachers to consider the impact of their chosen pedagogies (strategies, techniques, assumptions and beliefs) on pupils' progress and achievement. Hattie (2012) stresses the importance of all teachers critically evaluating the impact of their practice on their pupils' learning. It is through thinking critically and questioning outcomes, considering whether they can be improved and examining the evidence from all sides that student teachers can decide what needs to be done in the classroom. Indeed, Richards (2001) considers that both reflection on practice and written lesson evaluations inform further lesson planning and guide further learning.

To evaluate pupils' learning, student teacher must use a range of assessment evidence skillfully and accurately so that they may gauge the extent of achievement and progress of individuals and groups against learning outcomes, national standards or levels. They can then come to judgments about the extent of the pupils' learning so that they can plan the next series of lessons to ensure further progress. Indeed, coming to judgments based on valid evaluation characterizes an expert critical thinker, as outlined in the comprehensive Delphi report into critical thinking (Facione, 1990).

However, it should be noted that there is a difference between 'simple' lesson evaluation (what went well and what needs to be improved) and a more in-depth evaluation involving critical reflection and metacognitive skills (Tibke and Poyner, 2013). The latter allows the student teacher to explore their choice of pedagogy and underlying teacher beliefs on pupils' outcomes in more depth. This can lead to rejecting actions, based on what Dewey (1933, p. 12) terms '*habit, tradition or institutional expectations*' and such thinking can lead to news ways of working or thinking which lead to further achievement and progress (Toplis, 2015). The skilled student teacher will use a range of skills (Wallace and Wray, 2009; Cottrell, 2005; Bassot, 2013) and sources of information (research, theory and classroom data) in order to take part in this metacognitive thinking process. In so doing, the student teacher may also support their transition from student to reflective practitioner.

To evaluate at this deeper level, student teachers may find it useful to apply the skills developed during their university studies to their practice at school. However, there can be an artificial divide between what takes place at university and school. The development of academic skills may be perceived as the prerogative of the university and practical teaching to be the school's role. Furlong (2015) argues against this and says that teacher education should be both practical and scholarly. According to Furlong (2015), the Organization for Economic Co-operation and Development (OECD) advocates such duality of learning and, furthermore, considers it to exemplify best practice in teacher education. It is, therefore, argued that the development of critical thinking during university studies may not only

support students' critical evaluation skills at school, but also bridge the artificial divide between academia and school, promoting such duality of learning.

Challenges and models for developing critical thinking skills. Although critical thinking skills are seen as essential to students at university, it is recognized that some struggle to demonstrate critical thinking (Halpern 1999; Braun 2004). Indeed, Wallace and Wray (2006) discuss what a shock it can be to students when they start university and realize that there is more than one way to interpret information and that different conclusions can be drawn about what should take place. Clearly, this is also true of the student teacher as they being to realize that they are several ideas and theories about what should take place in the classroom to ensure learning takes place.

Furthermore, there are other challenges to developing such critical skills. Halpern (1999, p. 72) notes that some students may be disinclined to use these skills even when they possess them because of how much effort they evoke. Student teachers may, therefore, not only require support to develop these skills but encouragement to use them. Halpern (1999) also discussed that it is essential that student teacher educators address their students' dispositions and that it is not sufficient just to teach these skills without taking these matters into consideration. Moreover, Halpern notes that students can find it difficult to transfer these skills from one context to another. This is especially pertinent to teacher education as it involves two contexts (university and school).

It would, therefore, seem prudent to support student teachers to transfer these skills from university to school. Halpern advocates the following four-part model (adapted below from Halpern, 1999, p. 73) for development and transfer of these skills:

1. Instruction in the skills.
2. Encouragement to exert the mental effort needed to apply them
3. Structured training as a means of improving the probability that students will recognize when critical thinking skills are needed in a novel context
4. Discussion and monitoring of the thinking process and progress made (metacognition).

This study planned to use Halpern's four-part model to improve the students' critical thinking skills and then to ask the following question:

> Can using Halpern's model to improve students' critical thinking skills at university lead to improvements in student teachers' ability to critically evaluate pupils' learning at school?

Methodology

Context and setting. This study was conducted at a teacher education center in Wales. Wales, together with England, Scotland and Northern Ireland make up the United Kingdom. Since, devolution in 1997, educational matters in Wales have diverged from that of England and most teacher education programs in Wales still have an element of university study (Jones and Lewis, 2016).

Participants. This study was conducted with the entire center's student teachers enrolled onto their final year of initial teacher education undergraduate program or those on the one-year postgraduate programs during 2015 – 2016.

Table 1: Total number of Student Teachers Enrolled onto Initial Teacher Education Programs in 2015 – 2016.

Program	Total Numbers	Male	Female
PGCE primary (3 – 11)	168	64	104
PGCE secondary (11 – 18)	144	56	88
Primary Education BA (3 – 11)	68	16	52

Action research was chosen as the research method for this project as it is undertaken by practitioners and is known to support the development of professional practice (Thomas, 2009; Denscombe, 2014; Cohen, Manion & Morrison, 2010). Furthermore, the faculty promotes action research with pre-service and qualified teachers and, therefore, it seemed fitting to utilize this method to explore ways of making improvements to teaching programs. Halpern's model (1999) was used to guide the actions taken as part of the initial part of this research. Students were guided to address certain criteria in their written evaluations (see Table 2.) The students' written evaluations (and related lesson plans) were monitored using a 'progress RAG-rating system (see table 2). There were two review points (Christmas and Easter) (and to prompt corrective action as required) before a final review was undertaken at the end of the academic year to ascertain the summative progress achieved.

Table 2: Lesson evaluation success criteria with progress RAG-rating system

Evaluation success criteria:	Progress is RED	Progress is AMBER	Progress is GREEN
* Explanation of the learning	The criteria	The criteria	All criteria

achieved against every LO (majority, all, etc.); * Evaluation of at least one skills' based LO * Focus on the learning of *individuals* and *groups* within the class. * Explanation of how the learning of each LO was achieved – attribute or credit the learning to something; * Explanation how the literacy/numeracy/ICT aspect/element was achieved by noting clear evidence * Evaluation of the source of evidence used to assess progress and achievement e.g. peer assessment against SC, mentor feedback etc.; * Evaluation of how well the learners' responded to everyday Welsh/use of Welsh e.g. '*the learners used everyday Welsh naturally/ fluently/ with help/ with some encouragement/ with constant encouragement/with clear pronunciation'*); * Given attention to everyday Welsh in your evaluations at the start, middle and end of the file and when there is significant progress/lack of progress * Evaluation of the learning in light of pedagogy used (consider is this the most effective way to teach the knowledge/skills to this age range/ability?) ***** Evaluations reflect upon the influence and effect of the student	have not been addressed fully by a majority of students.	have been partially addressed by a majority of students (i.e. some criteria have been addressed fully but others have not yet been fully addressed.)	have been fully addressed by a majority of students.

teacher's pedagogy on the learners' learning including in terms of developing their literacy, numeracy ICT/DC and Everyday use of the Welsh language; * Ensured that the teaching target is linked to the Qualified Teaching Standards.			

Results

Actions taken: Instruction in the skills and structured training. At the start of the academic year, my small team and I led a professional development event for university tutors on criticality and evaluative practice. Methods for promoting these skills were discussed. These included the use of co-operative techniques to encourage metacognition (Braun, 2004; Gohkale, 1995), teacher educators modeling evaluation of learning and encouraging reflective practice through the use of Socratic questions (Golding, 2011) and guidance on the use of reflective cycles (Bassot, 2013).

Post-CPD activities to promote criticality and evaluative skills (see Appendix 1) were shared with staff that was asked to incorporate these into their normal teaching routines. Tutors were asked to highlight and draw attention to these skills wherever possible. Furthermore, I delivered a stand-alone session at the start of the year to the students on the importance of critical thinking and critical evaluation, which outlined the commonalities and links between the two (the need to base judgments on evidence, to use data critically and to undertake deeper thinking regarding their underlying beliefs and values). A guidance booklet on how to evaluate learning and exemplar lesson plan evaluations were also shared with student teachers, university tutors and school mentors.

First review point. At Christmas 2015, students were asked to submit a portfolio of lesson plans and evaluations to their university tutors. The portfolio consisted of their best lesson and evaluation work. They were also instructed to include the lesson plan and evaluation of each observed lesson (together with the lesson plan and evaluation leading up to and following the observation.)

The students were asked to RAG-rate their portfolios (against the criteria outlined in Table 2) and then tutors were asked to check these RAG-ratings. Each tutor (28 tutors) was then asked to nominate the best portfolio out of all those they had collated and send to myself for moderation. This created a smaller sample of portfolios (28), which were then RAG-rated against the same criteria (see Table 2) by my team of tutors and myself.

Results of first review point. The evaluations were mostly rated as red by the team, as the criteria (see Table 2; Appendix 1) were not addressed in a majority of cases. Most of the evaluations were also found to be RAG-rated too highly by the tutors and students.

To address this, a workshop was arranged and all the tutors took part in a RAG-rating exercise to gain a shared understanding of how to assess the quality of the evaluations. Tutors then led a similar exercise with the student teachers so that the latter could self-assess and peer assess their own evaluations and set targets for themselves. Finally school mentors were given a similar workshop to ensure a common understanding of expectations.

To further support the students, a small group of tutors and myself examined the best evaluations (i.e. those rated as amber or green) for common themes. We independently arrived at a series of themes; we then met and agreed on the following final list of indicators of quality:

- A clear focus on the pupils' learning (less description of what was done; less focus solely on pupils' or teacher's enjoyment of taking part in activities).
- Quantified phraseology used to report on the extent of learning against each learning objective (based on the inspectors terms (Estyn, 2015) most 90% or more, many 70% or more, majority 60%, minority below 40%, few 20%, very few less than 10% etc.)
- The extent of learning of individuals *and* groups referred to.
- A range of valid assessment data referred to (scrutiny of book work, test results, mentor observations etc.) to come to conclusions about the extent of pupils' progress and achievement against each objective. Illustrative examples of pupils' work included exemplifying the extent of learning or issues with learning.
- The impact of chosen pedagogy and strategies on learning outcomes considered, including fundamental beliefs and teacher behavior.
- Challenging learning targets were set and lesson plans adjusted in light of the pupils' previous achievement and progress.

Then we also examined the evaluations RAG-rated as red. The students who had difficulty with their evaluations had superficial comments, most often related to how much the pupils had enjoyed activities (although important, enjoyment does not always signify that learning took place). These evaluations demonstrated very little evidence of a deep understanding of individuals or groups' learning. They also tended to be shorter and to be poorly written; they looked rushed and were unfinished. They were often 'cut and paste' and many were simply lesson plans with missing evaluations. There was a more prevalent tendency to say that 'All learners' had achieved the learning objectives; the better evaluations were more

nuanced and provided evidence to support their statements. Furthermore, the learning objectives were poorly defined and often there was no clear link between the evaluation and the learning objectives; the next learning targets were also poorly defined or absent.

The above activity allowed us to discuss real examples, to target advice on how to improve and to monitor thinking processes with the students during the next student workshop. This led to the production of a more user-friendly single sheet of success criteria which was devised from the aforementioned list (see Appendix 2) which was shared with the students. It allowed us to give further encouragement to use these skills and the workshop was an opportunity to remind the students of the importance of evaluating in depth as a basis for their next lesson planning and to re-focus their attention on these matters.

Second review point, results and further actions. During Easter 2016, the students' evaluations were again assessed with all tutors taking part in the formative exercise (as before). There were more examples in the amber category (see Table 2 for a description of this category). However, some areas were still weak e.g. their evaluation of the development of their pupils' literacy skills and the reference to research to back up their choice of strategies. This was targeted during the next workshop. To motivate the students, they were reminded that basing their practice on an in-depth evaluation of learning could help them to access the higher teaching grades on teaching practice. This was supported by inviting school mentors to the workshops to give their perspective on the importance of developing these skills to become employable and also schools' expectations regarding newly qualified teachers' evaluative skills and the profession in general.

All student teachers were again required to self-assess and peer-assess evaluations and set targets. However, this time the students were required to explicitly discuss the thinking processes they had used so far, the progress they had made in evaluating their pupils' learning and how they had met their targets, during tutorials with their tutors.

Final review. At the end of the year the evaluations were again reviewed. Progress RAG-rating showed there was an improvement by the end of the year (with a majority being either amber or green; although a minority was still poor and classified as red). This assessment was then externally verified by the inspection team as inspections of initial teacher education programs require '*providers to accurately evaluate their own performance*' (Estyn, 2015, p.8). The assessment of outcomes was found to be in accordance with the external judgment.

In verbal feedback, it was reported that the wide range of activities undertaken over the year were appropriate and had helped raise tutors' and student teachers' awareness of the importance of critical thinking skills. They verified that data collection via the monitoring

and RAG-rating of written evaluations had allowed the faculty to identify areas of weakness and to target these in workshops during the year. Overall, student teachers were considered to have been guided to focus more clearly on evaluating pupils' learning.

Discussion

In light of the background literature (Halpern 1999; Braun 2004; Golding 2011) and this study, student teachers do indeed require training, encouragement and support to be critical. To answer the initial question: '*can using Halpern's model to improve students' critical thinking skills at university lead to improvements in student teachers' ability to critically evaluate pupils' learning at school?*' there is some evidence from this study that improving students' critical thinking skills using Halpern's model (1999) does indeed support them to be more evaluative of pupils' learning in the classroom.

Focusing on critical thinking skills and evaluation of pupils' learning seemed to encourage the student teachers to link up their academic studies with their practical day to day teaching, as advocated by the OECD (2012). Although some student teachers may have been motivated enough to improve their evaluative skills by being made aware of the links with academic critical thinking skills' development, most students required much additional support and further encouragement to transfer these skills into the classroom setting. This seemed to work best when there was a shared understanding of expectations between the tutors, student teacher and school mentors.

Students' progress in critically evaluating pupils' learning across the year was not rapid. It was clear from the work of most students at the first review point (Christmas) that the expected improvements had not been made and that further action would be necessary. At this stage, most students needed further time to make links between the skills they possessed in one context and another. When students go to school they are often overwhelmed with information from all quarters and it can take time for them to process it all. It may be a necessary part of the students' development to periodically remind of them of key aspects, such as criticality and to re-focus on these. The focused workshops held across the year certainly appeared to be instrumental in supporting the students to make further improvements as the evaluations improved over the year following this intervention. The tutorial sessions that required the students to discuss their thinking also seemed to support the students to improve their written evaluations of learning.

The findings also suggest that sharing model examples and discussing user-friendly success criteria, as identified during this study (see Appendix 2), may further support student teachers to understand how to evaluate pupils' learning more effectively. Indeed, sharing these with students earlier in the process may have supported more rapid progress. Similarly, the progress RAG-rating exercises, undertaken by tutors, mentors and student

teachers, supported a shared understanding not only of progress but also of expectations. However, this might also be more effective when undertaken earlier in the process.

At the end of the academic year, the majority of the students were able to competently critical evaluate their pupils' learning and there was some evidence from the best evaluations to support the assertion that focusing on the extent of pupils' learning does allow students to improve their subsequent lesson planning (with their pupils' work showing progress and achievement). However, a minority of student teachers still required further support to demonstrate good evaluative skills. Possibly they would have benefited from further time on these aspects to enable them to make more improvements and/or they may have required more input from their school mentors on this aspect too.

Conclusion

The implications of this study suggest that it is essential that critical skills be embedded into the curriculum so that they can be reinforced regularly over time at university and during school placement. Program leaders should, therefore, audit provision (how the skills will be developed) and map out sessions to ensure enough attention is given to these matters throughout the program, alongside all the other aspects of becoming a qualified teacher.

Furthermore, those who work with the student teachers (both at university and at school) should ensure they have a shared understanding of expectations with regards to evaluating learning. Schools that mentor student teachers should be aware that there is an expectation that student teachers will explore and even challenge accepted pedagogy as part of their development. Although student teachers can be agents to drive forward change, this has to be undertaken in an environment where it is acceptable to be critical of the accepted institutional ways of doing things. This may be a necessary pre-requisite of schools involved in leading mentoring student teachers.

About the Author

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References

Bassot, B. (2013). *The reflective journal*. Basingstoke: Palgrave Macmillan.

Birkenhead, T. R. (2009). *We've bred a generation unable to think*. Retrieved from: https://www.tes.com/news/tes-archive/tes-publication/weve-bred-a-generation-unable-think

Braun, N. M. (2004). Critical thinking in the business curriculum. *Journal of Education for Business, 79*(4), 232-236. Retrieved from: https://search.proquest.com/docview/202821745?accountid=14874

Clarke, S. (2014). *Outstanding Formative Assessment*. London: Hodder Education.

Cohen, L., Manion, L and Morrison. K. (2010). *Research methods in education*. 6th ed. Abingdon: Routledge.

Cottrell, S. (2005). *Critical Thinking Skills*. London: Palgrave.

Denscombe, M. (2014). *Good research guide: for small-scale social research projects.* 6th Edition. Maidenhead: McGraw-Hill Education.

Dewey, J. (1933). *How We Think*. New York: D. C. Heath. Classic and highly influential discussion of thinking.

Estyn. (2015). *Guidance for the inspection of initial teacher training*. Retrieved from: https://www.estyn.gov.wales/sites/default/files/documents/Guidance%20for%20the%20inspection%20of%20ITT%20updated%20for%202015.pdf

Facione, P. (1990). *Delphi report.* Retrieved from: https://www.researchgate.net/profile/Peter_Facione/publication/242279575_Critical_Thinking_A_Statement_of_Expert_Consensus_for_Purposes_of_Educational_Assessment_and_Instruction/links/5849b94508ae82313e7108de/Critical-Thinking-A-Statement-of-Expert-Consensus-for-Purposes-of-Educational-Assessment-and-Instruction.pdf

Furlong, J. 2015. *Teaching tomorrows teachers.* Retrieved from: http://gov.wales/docs/dcells/publications/150309-teaching-tomorrows-teachers-final.pdf

Gokhale, A.A. (1995). *Collaborative learning enhances critical thinking*. Retrieved from: https://scholar.lib.vt.edu/ejournals/JTE/v7n1/gokhale.jte-v7n1.html

Golding, C. (2011). Educating for Critical Thinking: Thought-encouraging questions in a community of inquiry, *Higher Education Research and Development.* 30:3, 357-370. http://dx.doi.org/10.1080/07294360.2010.499144

Halpern, D. (1999). *Teaching for critical thinking.* Retrieved from: http://precisionmi.com/Materials/CollegeMat/criticalthinking-Halpern.pdf

Hattie, J. (2012). *Visible learning for teachers*. Abingdon: Routledge.

Jones and Lewis, J. (2015). Teacher education in Wales. In P. Bamber (Ed.) and J. Moore(Ed.), *Teacher education in challenging times*. Abingdon: Routledge.

OECD. (2012). *Strong Performers and Successful Reformers in Education: Lessons from PISA for the United States*. Retrieved from: http://www.oecd.org/pisa/46623978.pdf

Richards, C. (2010). *Learning to teach in the primary school*. 2nd edition. Abingdon: Routledge.

Tibke, J and Poyner, L. (2013). Why is critical reflection important. In: C. Mercier , C. Philpott and H. Scott. (Eds). *Professional Issues in secondary teaching.* London: Sage.

Toplis, R. (2015). *Learning to teach science in the secondary school*. Abingdon: Routledge.

Thomas, G. (2009). *How to do your research project*. London: Sage.

Wallace, M and Wray, A. (2009). Critical reading and writing for postgraduates. Sage: London.

Appendix A: Activities to support the development of critical thinking skills and evaluation of pupils' learning

Critical Thinking Skills Development Activities

Here are examples of five strategies you should use with your classes.

1. **HELPING STUDENTS TO READ CRITICALLY.** Try to encourage a more critical approach to reading. *For example, choose an article, which is biased/one-sided, and/or one that uses spurious statistics. Encourage the students to think about what they have read and might otherwise accept at face value. Set simple questions which guide and challenge them to do more than accept the reading at face value. Set questions which ask them to note facts to show understanding (e.g. define terms), ask them to note evidence, which support various specific aspects and then ask their opinion about something specific and controversial.*

2. **HELPING STUDENTS TO CONSTRUCT AN ACADEMIC ARGUMENT ROOTED IN THE LITERATURE AND RELATED TO PRACTICE (CRITICAL ANALYSIS).** *For example, set specific reading to be done prior to the session. During the session give students a series of quotes from the reading on a particular theme and ask them to sort them purposely (e.g. if the reading discusses a theory, argument or fact, ask them to classify the quotes according to whether they support or challenge the theory/fact/argument.) Then ask them to construct a balanced argument, rooted in the quotes from the reading and tied to their practice, and present these to the class. Next ask them to work in groups with a limited number of articles to construct their own arguments on a particular theme.*

3. **HELPING STUDENTS TO OFFER CRITICALITY WHEN WRITING.** *For example, before the session give the students a directed reading task e.g. 'Read the following four articles on aspects of effective teaching and make notes on what makes an effective teacher. Bring your notes with you to the next session.' During the session ask the students to write an argument in response to an open question e.g. Think of an effective teacher and critically analyze what makes them so effective. List the characteristics of an effective teacher and by each characteristic note what evidence there is to back up the idea that this characteristic is effective. Also note any evidence (formal or anecdotal) which challenges this. Consider your list carefully and come to an informed conclusion about what makes an effective teacher, which goes beyond your list of evidence. Remember to refer to reading to back up your arguments. Then peer mark these against shared success criteria.*

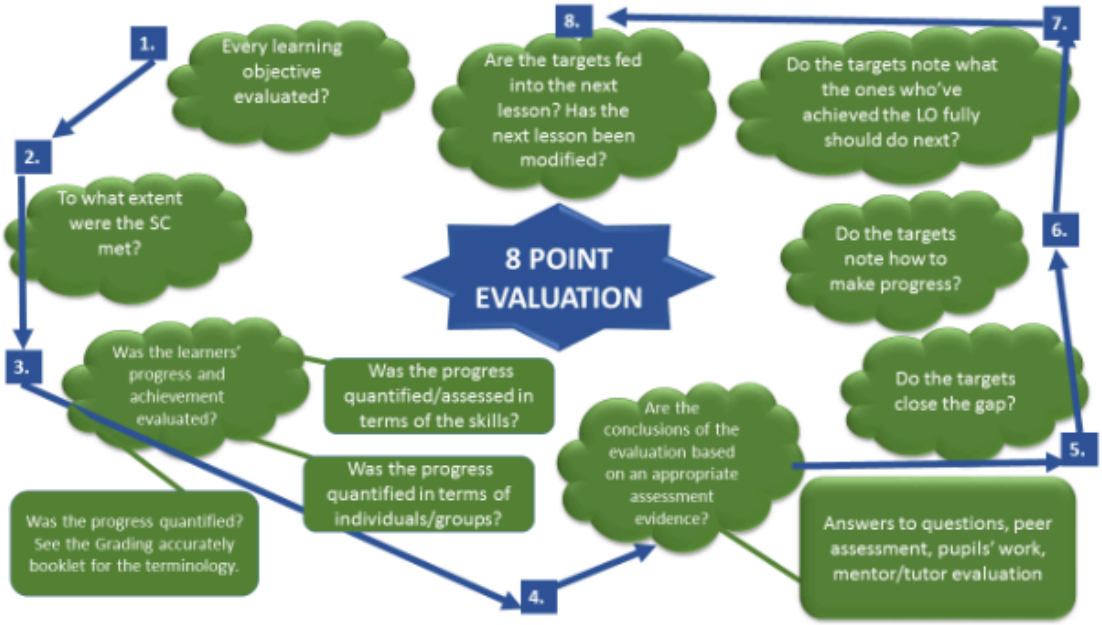
4. **USING CRITICAL EVALUATION AND REFLECTION TO PLAN EFFECTIVE LESSONS.** *Ask students to bring in a series of 6 lesson plans and evaluations to be peer-marked against the success criteria. For example, in pairs ask them to check if the lesson plans show evidence of planning, which takes account of previous evaluations and reflections. Is there evidence that they've developed the learners' critical thinking skills? They should then analyze the evaluations/reflections for evidence of critical evaluation (ask them to check if the evaluations make it clear 'who learnt during the lesson' and 'how they know', 'why something worked and 'how they know'. They should look at the quality of the evidence used to assess learning. They should also look for emotive responses or acceptance of the status quo and try to challenge each other.)*

5. **FEEDBACK THAT ASKS FOR MORE CRITICALITY IN ASSIGNMENTS/EXAMS** – *when writing such feedback, explain how students can offer more criticality. For example,*

    - *Point out where they do it well and why.*
    - *Give them examples of good critical analysis (and put these on the virtual learning platform).*

- *Give them specific examples of the type of writing used when challenging a particular point of view e.g. X argues Y, others have shown more preference towards Z. In conclusion, it is likely that different individual favors different methods in different circumstances.*
- *Use Stella Cottrell's Study Skills Handbook (p232) to help them to understand the difference between descriptive and critically analytical writing.*

Appendix B: Student friendly success criteria to promote a focus on evaluating pupils' learning



THE IMPACT OF SOCIAL STORIES ON COMPLIANCE AND AGGRESSION IN A KINDERGARTEN AGED CHILD

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Abstract A multiple baseline design was used to evaluate the effectiveness of social stories to increase compliant behavior and decrease verbal aggression in a 5-year-old girl. Non-compliant behavior/disruptive behavior has been demonstrated to have immediate and enduring consequences on social behavior, such as loneliness and peer rejection and impede education and social interactions. (Buhs & Ladd, 2001). In this study social stories (Rogers, 2000) were used to target three situations to decrease non-compliant behavior and verbal aggression. The target situations were getting ready for school in the morning, morning recess at school, and dinnertime. The target child was a kindergarten-aged girl with a history of non-compliant and argumentative behaviors. Although a limited number of studies have been conducted using social stories as a behavioral intervention with non-autistic children, results showed an increase in compliant behavior and a decrease in verbal aggression for the getting ready in the morning routine. Based on these findings and past research, social stories can be used as a low-cost, low labor-intensive intervention in modifying disruptive behaviors for all young.

Keywords: teacher action research, social stories, behavior intervention

Introduction

Understanding social rules can be difficult for individuals with developmental disabilities. This may stem from lack of explicit instruction in appropriate behavior and/or response to social situations. Learning by example is often beneficial for individuals with autism or other developmental disabilities. Social stories are an appropriate method to explain social settings, suitable social behaviors, and transitions to someone with a disability. This study implements the use of social stories to improve compliant behavior in a kindergarten- aged girl with developmental difficulties.

Literature Review

Social stories are short, individualized stories that employ positive statements to describe a social situation and teach the correct social response (Gray, 2007). These stories provide children with the support needed to respond appropriately to new and difficult social experiences (Gray, 1995, 2007; Swaggart, Gaghon, Bock, Earles, Quinn, Myles, & Simpson, 1995). Social stories have been used successfully to assist children with Autism Spectrum Disorder (ASD) to develop a better understanding of social situations and cues and respond appropriately to those situations (Rogers, 2000) .

Gray and Garand (1993) established a specific set of guidelines to aid in creating social stories. These guidelines suggest that the social story contain four types of sentences written in first person perspective of the target child. Social stories should include *descriptive* sentences that describe the actions of people in the circumstance, *directive* sentences that identify the appropriate response, *evaluation* sentences that describe the reactions of others when the student makes appropriate choices, and *positive* sentences that provide understanding of common social values (Gray & Garand, 1993; Austin, J., & Agar, G., 2005).

Social stories have been used in various social situations and circumstances with a wide age range of students with autism. The intervention has demonstrated effectiveness in improving behavior at mealtime (Bledsoe, Smith, & Simpson, 2003), increasing on task behavior and hand washing frequency (Hagiwara & Myles, 1999), improving social behavior (Barry & Burlew, 2004), and decreasing behavior challenges (Lorimer, Simpson, Myles, & Ganz, 2002).

The purpose of this study was to determine if social stories might be an effective intervention for teaching social behavior to a kindergarten-aged girl who had difficulty with routine activities both in the home and at school. Although the child has not been diagnosed with ASD, multiple placements in foster care and an interrupted childhood have had an impact on her social, emotional, and mental development. The child has been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD), anxiety, post-traumatic stress disorder (PTSD), and reactive attachment disorder. All of these disorders impact her ability to learn and interact socially at age appropriate levels. A child's development and ability to cope are compromised by repeated moves from home to home due to the adverse consequences of stress and inadequate parenting (Health & Services, 2009).

Methodology

Research Design. Single-subject research design was used to record child behavior within routine activities (Kazdin, 2011). Specifically, a multiple baseline across settings was used to measure verbal aggression and compliance across the child's morning routine, recess, and dinner routine across a 2-week period. Consistent with guidelines set forth by the *Single Case Technical Document* each phase differed in duration and had a "minimum of 5 data

points"; intervention was implemented when baseline levels of behavior documented a "need for change" and were stable (Kratochwill, T. R., Hitchcock, J., Horner, R., Levin, J. R., Odom, S., Rindskopf, D., & Shadish, 2010, p. 19).

Participant. The target child was a 5-year-old girl who exhibited non-compliance and verbal aggression/confrontational behaviors. She had been in and out of foster care since she was 13 months old, and had recently been adopted by her foster family. She was previously diagnosed with attention deficit disorder and reactive attachment disorder and had behavioral problems at school and home. Reactive attachment disorder (RAD) is described as condition that begins before the age of five and is caused by a perpetual disturbance in a child's social relatedness that occurs across social situations (Zeanah C. H., Scheeringa, M., Boris, N. W., Heller, S. S., Smyke, A. T., & Trapani, J., 2004). Social relatedness is a child's biological need to belong, be accepted, and feel positive emotions as part of a group social relatedness (Deci & Ryan, 2010) . RAD is frequently diagnosed in children who may have received grossly negligent care and did not form a healthy emotional attachment with their primary caregivers before age five . Symptoms include an aversion to touch and physical affection, control issues, anger problems, difficulty showing genuine care and affection, and an underdeveloped conscience (Hanson & Spratt, 2000). Teachers and parents reported the child as having fits of rage and an inability to control her emotions. When her parents or teachers physically intervened to stop an aggressive act toward another child, she became physically combative and verbally abusive.

Setting. The study occurred in the target child's home and her kindergarten classroom at school during of the child's morning routine at home, recess at school, and dinner routine at home. The target child's home environment included of her parents and an older sibling. The morning routine involved the target child and her mother and took place in the parent's bathroom; the dinner routine involved the target child's parents and older sibling and took place at the dining room table. The target child's kindergarten classroom consisted of 16 children and one teacher. Data at school were collected during recess, which took place on the playground. The playground consisted of 3 sand tables, several basketball goals, playground equipment to climb on, and a large open field.

Behavior Definitions. The dependent variables were compliant behavior, non-compliant behavior, and aggressive behavior. *Compliant behavior* was defined as initiating response to a teacher or parent directive within 3 seconds. *Non-compliant* behavior was defined as not initiating a response to a teacher or parent directive within 3 seconds. *Verbal aggression* was identified as talking back, being sassy, argumentative, contradictory, saying things the target child intended to be hurtful, (i.e., "You're not my mommy. I don't like you."), as well as defiant statements (i.e., "I'm not going to do it."; "You can't make me"). These aggressive behaviors also included growling, stomping her foot, screaming, and using an aggressive

tone when speaking. The researcher also recorded when there was *no opportunity* to respond because no directive was given.

Childhood is defined as the period from birth to eight years old (Mishra, 2005). It is a time of extraordinary brain growth that lays the foundation for subsequent development. It is a time for social, emotional, cognitive and physical development, discovery, and curiosity (Shanahan & Lonigan, 2010). The interruption of childhood is emotionally and mentally challenging (Phillips & Shonkoff, 2000). An interrupted childhood occurs when affectional bonds are disrupted and normal development is compromised. According to the Committee on Early Childhood, Adoption and Dependent Care for the American Academy of Pediatrics (Miller P. M., Gorski, P. A., Borchers, D. A., Jenista, J. A., Johnson, C. D., Kaufman, N. D., . . . Rezin, J, 2000) consequences of abuse, neglect, and placement into foster care can negatively affect a child's early brain development, ability to attach to care givers, sense of time, and response to stress. An interruption in the continuity of a child's caregiver can be harmful. A child's development and ability to cope are compromised by repeated moves from home to home due to the adverse consequences of stress and inadequate parenting (Health & Services, 2009). Behavior problems occur more frequently in foster children, and foster children perform poorly in activities that lack structure (McKellar, 2007). This study investigates the effectiveness of social stories for changing non-compliant and verbally aggressive behaviors in a child impacted by an interrupted childhood.

Experimental Conditions

Baseline.

- *Morning routine.* The morning routine consisted of activities designed to prepare the child to leave the house each morning (e.g., getting dressed, using the bathroom, washing hands, brushing teeth and brushing her hair). Her mother provided verbal and physical assistance, as needed to move her through this routine. During baseline, the target child was observed refusing to get dressed and required repeated verbal directives to get dressed, put on her shoes, and brush her teeth. She was observed engaging in verbally abusive behavior consisting of yelling and screaming in the absence of getting dressed or refusing help.
- *Dinner routine.* The dinner routine consisted of tasks designed to assist the child in self-feeding (e.g., using utensils skillfully, eating the food on her plate), and appropriate table manners/conversation (e.g., asking for more, saying 'please' and 'no thank you', engaging with family in general conversation). During baseline, the target child was observed refusing to come to the table when asked, shoving her plate across the table stating she didn't like the food, and ignoring requests to eat her dinner. She was also observed to whine and argue about having to sit at the table.
- *Recess.* Recess occurred during school right before lunch, at 10:00am, and lasted for 25 minutes. During recess, children were free to choose among playground equipment and other materials provided outside. The target child was observed

exclusively playing alone. She was observed collecting acorns, sticks, or rocks by herself. She did not allow other kids to join her and was verbally aggressive to the children around her.

Social Story Intervention. A social story for each routine was created in alignment with guidelines established by Gray and Garand (1993) (Table 1). Guidelines for writing social stories suggest the inclusion of short, direct sentences that are descriptive, directive and perspective in consideration of the child's comprehension level (Gray & Garand, 1993). Stories created for the present study described the series of activities the child needed to complete within each routine (e.g., brushing teeth, setting table, lining up), as well as positive consequence for appropriate behavior (e.g., playing with beanie babies, getting more food, playing with friends).

Table 1. Text included in Social Stories for Morning, Dinner, and Recess Activities

Social Story for Getting Ready in the Morning
I just woke up. It is time to get ready for school. I put on my jumper. I put on my socks and shoes. I brush my hair and my teeth. I take my medicine. I do it without talking back or complaining. When I am a good listener I get to play with the beanie babies in Mom's room.
Social Story for Dinner
I help set the table. I come to the table when I am called. I say a prayer before I eat. I use my fork to eat. I say please and thank you when I want more. I have good manners. I don't talk with my mouth full. I take my dishes to the sink.
Social Story for Recess
I line up with my class. I play at the sand table and share the toys. I put the toys away when I am finished. I wait my turn for the tire swing. Then I swing with my friends. I can collect acorns with my friends. I line up before the teacher counts to ten. I listen to the teacher's directions.

Morning routine. The social story included pictures of the target child making socially appropriate choices and being rewarded for her compliant behavior. The social story was read to the target child at night before she went to bed and again in the morning before the getting ready process began. The intervention phase was also videotaped for the first 10 minutes of getting ready in the morning for five days. During the intervention phase the social story encouraged the target child to get dressed without complaining. Each page of the story included a picture of the child completing each step of getting ready in the

morning. The final page was a picture of the child being rewarded with playtime with beanie babies for getting ready and not complaining.

Dinner routine. Another social story was created targeting the appropriate dinner behavior and verbal interactions. This story also included pictures of the target child eating with her silverware, using good manners by saying please and thank you, and coming to the table when called. The story was read 5-10 minutes before the target child was called to the table for dinner.

Recess. A social story was created using pictures of the target child to provide social cues for compliant behavior and encourage playing with others. The social story was read to the target child individually before school started and again with her whole class prior to recess. An additional component was added to the social story intervention for the recess routine. Due to the low level of teacher directives being given during recess (baseline average of 8%) and the fact that the target child was choosing to socially isolate herself, the added component to the social story intervention included teacher directives prompting her to ask someone to join her to play or to join someone else at the rate of once per minute during the 10-minute observation. This gave the target child additional opportunities to comply and encouraged social play.

Data Collection. Data were collected by videotaping the target child during each routine. Interval recording was used to record behavior in 20-second intervals during 10-minutes sessions. Data collection occurred over a period of 2 weeks.

Data Analysis. Single case designs rely on visual analysis of data to determine if a relationship between the independent variable and dependent variable exists (Kratchowill et al., 2010) "A causal relationship is demonstrated if the data across all phases of the study document at least three demonstrations of an effect at a minimum of three different points in time" (p. 17). The independent variable is said to have an *effect* when the pattern in one phase (e.g., intervention) differs from the pattern in the previous phase (e.g., baseline) (Horner, Carr, Halle, McGee, Odom, & Wolery, 2005)

Interobserver Agreement. Observers were trained through written instructions and feedback prior to collecting data. According to Kratochwill, et al, (2010) interobserver agreement was calculated on 20% of the observations across baseline and the social story intervention (n=8)(2010, p. 15). Interobserver reliability was calculated using the formula of the number of agreements divided by the number of agreements plus disagreements and multiplying by 100. The standard agreement should be a minimum of 80% (Kratochwill et al., 2010). Reliability for compliant behavior was 80% (range, 70%-93%).

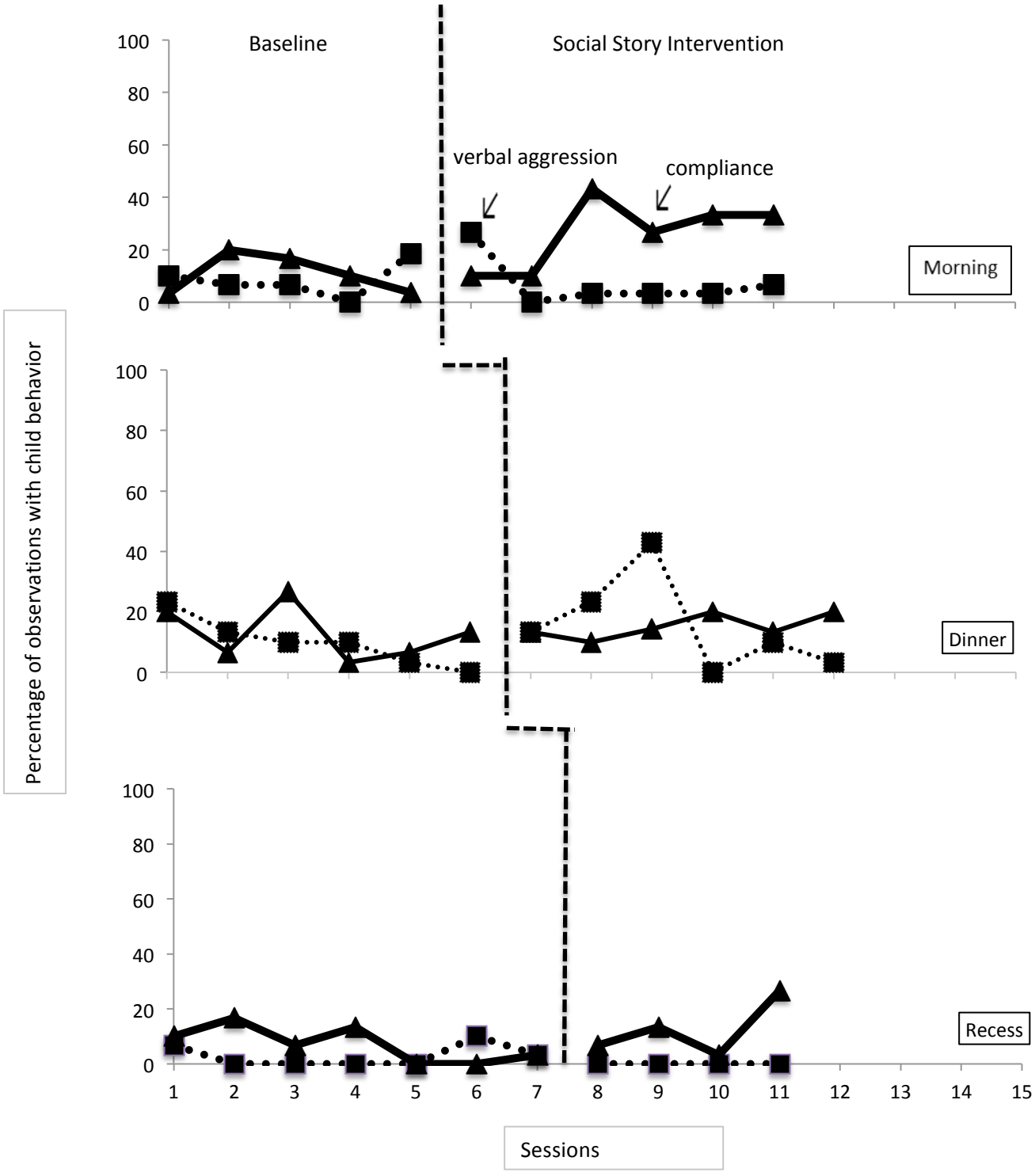
Results

Morning routine. During baseline, the target child was non-compliant on average 34%, compliant on average 11% and displayed verbal aggression on average 10% of the observation sessions (see Figure 1). When the social story intervention was applied, the child was non-compliant on average 14% of the time and compliant behavior increased to an average of 25%, and displayed verbal aggression on average 7% of observation sessions. This represents a 20-percent point decrease in non-compliant behavior, a 14-percentage point increase in compliance, and a 3 percent point decrease in verbal aggression.

Dinner routine. During baseline, the target child was non-compliant on average 20%, compliant on average 13% and displayed verbal aggression on average 10% of the observation sessions (Figure 1). When the social story intervention was applied, the child was non-compliant on average 12% of the time and compliant behavior increased to an average of 27%, and displayed verbal aggression on average 16% of observation sessions. This represents a 2 percent point decrease in non-compliant behavior, a 2 percent point increase in compliance, and a 6 percent point increase in verbal aggression.

Recess. The recess intervention also did not show a desired change in compliant behavior and verbal aggression but an increase in non-compliant behavior (Figure 1). During baseline, the target child was non-compliant on average 1%, compliant on average 7% and displayed verbal aggression on average 3% of the observation sessions. Baseline data also indicated that the target child was only receiving teacher directives 8%, which explains the low measurements. Intervention procedures included a social story that addressed correct social behavior and teacher prompting to encourage playing with others. Teachers were given instructions to prompt the target child each minute to interact with peers, which increased teacher directives to an average of 35%. When the social story intervention was applied, the child was non-compliant on average 23% of the time and compliant behavior increased to an average of 5%, and displayed verbal aggression 0% of observation sessions. This represents a 22-percent point increase in non-compliant behavior, a 2 percent point decrease in compliance, and a 3 percent point decrease in verbal aggression.

Figure 1. *Percentage of observed intervals with verbal aggression and compliance.*



Discussion

Social stories are based on the premise that if a child is presented with expectations of her environment, she is better able to participate (Gray & Garand, 1993). Results of the present study are consistent with previous research, which found that social stories can be effective in assisting children in the development of social participation in some instances, but may not be as effective in others (Tanner, Hand, O'Toole, & Lane, 2015).

There were several factors that may have impacted results from the present study. While the morning intervention showed the most significant results, this may have been due to the child's available resources at this time of day. The target child was better rested and, therefore, may have been more amenable to the social story intervention at this time of day. During the morning routine, parents reported less stress and found getting ready was not as confrontational when the social story intervention was implemented.

In contrast, it is possible that data from the dinner routine were impacted by the lateness of dinnertime, causing the target child to be over tired by this time of the day. The child may have had fewer resources available in terms of attention and patience during the dinner routine. It is possible that moving the dinner routine to an earlier time, in conjunction with the social story intervention, may have an effect on the child's behavior.

During recess, the target child's non-compliant behaviors may have stemmed from the additional teacher directives to join others in playing. This modification was introduced following baseline data, which revealed that the child played in isolation. Although data were not collected on the target child's social play, teachers reported an increase in the child's social interaction with peers when the teachers began providing directives to join the play of other children.

Limitations

One limitation of this study was the relationship between the target child and the researcher, who was the target child's mother. The influence of history and desire for a change in the target child's behavior likely impacted both data collection and interpretation. It deeply influences the researcher's perspective and the way the research was conducted. The researcher was seeking an intervention that would reduce the difficulty and stress of parenting a child suffering from the social, emotional, and mental effects of an interrupted childhood.

The goal of the present study was to increase child compliance while also decreasing both non-compliance and verbal aggression. The results indicated that social stories could be a powerful intervention for behavior change. The positive results of this study were significant because they demonstrated that social stories could be highly effective for typically developing children. Social stories are easy to create, unobtrusive, and personal to the target child's behavior issues. Results from previous studies (Barry & Burlew, 2004; Bledsoe et al., 2003; Lorimer et al., 2002), as well as the present study, suggests that social stories may be effective in some routines, but that additional supports may be needed to effect change in other routines. Data were only collected for a total of a 2-week period; it is not clear what behavioral changes might have occurred if the intervention would have been implemented for an extended period. Further research should be conducted using social stories as a behavioral intervention in school and home routines using more controlled observation and intervention protocol.

Conclusion

Social stories are intended to teach children how to behave in a given social setting by describing the activity in detail, including where and when the activity to occur, what will transpire, who will participate, and why the child should behave in a given way (Gray, 2007). Social stories can be implemented in the classroom to make it possible for children to easily observe, imitate, review, and practice desired and appropriate behavior. This can include daily routines for sharpening pencils, lining up, sitting at group time. Social stories can build student confidence and increase participation when expectations are clear and understood. Social stories can be used to facilitate student learning and increase engagement in multiple classroom activities.

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References

Austin, J., & Agar, G. (2005). Helping young children follow their teachers' directions: The utility of high probability command sequences in pre-k and kindergarten classrooms. Education and Treatment of Children, 28(3), 222-236.

Association, A. P. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*: American Psychiatric Pub.

Barry, L. M., & Burlew, S. B. (2004). Using social stories to teach choice and play skills to children with autism. *Focus on Autism and other developmental disabilities, 19*(1), 45-51.

Buhs, E. S., & Ladd, G. W. (2001). Peer rejection as antecedent of young children's school adjustment: An examination of mediating processes. *Developmental psychology*, *37*(4), 550.

Bledsoe, R., Smith, B., & Simpson, R. L. (2003). Use of a social story intervention to improve mealtime skills of an adolescent with Asperger syndrome. *Autism, 7*(3), 289-295.

Deci, E. L., & Ryan, R. M. (2010). *Self-determination*: Wiley Online Library.

Gray. (2007). *Writing social stories with Carol Gray*: Future Horizons.

Gray, C. (1995). Teaching children with autism to “read” social situations. *Teaching children with autism: Strategies to enhance communication and socialization*, 219-242.

Gray, C. A., & Garand, J. D. (1993). Social stories: Improving responses of students with autism with accurate social information. *Focus on Autistic Behavior*.

Hagiwara, T., & Myles, B. S. (1999). A multimedia social story intervention teaching skills to children with autism. *Focus on Autism and other developmental disabilities, 14*(2), 82-95.

Hanson, R. F., & Spratt, E. G. (2000). Reactive attachment disorder: What we know about the disorder and implications for treatment. *Child Maltreatment, 5*(2), 137-145.

Health, U. D. O., & Services, H. (2009). Understanding the effects of maltreatment on brain development. *Washington: USDHHS*.

Horner, R. H., Carr, E. G., Halle, J., McGee, G., Odom, S., Wolery, M. (2005). The use of single subject research to identify evidence-based practice in special education. Exceptional Children 71(2), 165–179.

Kazdin, A. E. (2011). *Single-case research designs: Methods for clinical and applied settings*. Oxford University Press.

Kratochwill, T. R., Hitchcock, J., Horner, R., Levin, J. R., Odom, S., Rindskopf, D., & Shadish, W. (2010). Single-case designs technical documentation. *What works clearinghouse*.

Lorimer, P. A., Simpson, R. L., Myles, B. S., & Ganz, J. B. (2002). The use of social stories as a preventative behavioral intervention in a home setting with a child with autism. *Journal of Positive Behavior Interventions, 4*(1), 53-60.

McKellar, N. (2007). Foster care for children: Information for teachers. *NASP Communiqué, 36 (4)*.

Miller, P. M., Gorski, P. A., Borchers, D. A., Jenista, J. A., Johnson, C. D., Kaufman, N. D., . . . Rezin, J. (2000). Developmental issues for young children in foster care. *Pediatrics, 106*(5), 1145-1150.

Mishra, R. (2005). *Early childhood care and education*: APH Publishing.

Phillips, D. A., & Shonkoff, J. P. (2000). *From neurons to neighborhoods: The science of early childhood development*: National Academies Press.

Rogers, S. J. (2000). Interventions that facilitate socialization in children with autism. *Journal of autism and developmental disorders, 30*(5), 399-409.

Shanahan, T., & Lonigan, C. J. (2010). The National Early Literacy Panel: A summary of the process and the report. *Educational Researcher, 39*(4), 279-285.

Swaggart, B. L., Gagnon, E., Bock, S. J., Earles, T. L., Quinn, C., Myles, B. S., & Simpson, R. L. (1995). Using social stories to teach social and behavioral skills to children with autism. *Focus on Autistic Behavior, 10*(1), 1-16.

Tanner, K., Hand, B. N., O'Toole, G., & Lane, A. E. (2015). Effectiveness of interventions to improve social participation, play, leisure, and restricted and repetitive behaviors in people with autism spectrum disorder: A systematic review. *American Journal of Occupational Therapy, 69*(5), 6905180010p6905180011-6905180010p6905180012.

Zeanah, C. H., Scheeringa, M., Boris, N. W., Heller, S. S., Smyke, A. T., & Trapani, J. (2004). Reactive attachment disorder in maltreated toddlers. *Child Abuse & Neglect, 28*(8), 877-888.

THE IMPACT OF TEACHER QUESTIONING AND OPEN-ENDED PROBLEMS ON MATHEMATICAL COMMUNICATION

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Abstract This paper reports on an action research project that investigated the ways in which teacher practice impacted students' mathematical communication, particularly in terms of teacher questioning with the use of open-ended problems. Grade level teams in a Title I school were engaged in a professional development model that focused on integrating problem-based lessons that would elicit productive mathematical discussion among students. Results showed that the use of open-ended problems refined teachers' questioning skills and produced more productive student dialogue. Teachers and students also demonstrated more effective communication in general, and teachers specifically were more reflective in their planning and teaching.

Keywords: teacher action research, questioning, open-ended problems, math communication

Introduction

Recent reform efforts are transforming how mathematics is taught in elementary schools. Traditional models for teaching mathematics are being replaced with constructivist, community-based teaching classrooms, increased student expectations around conceptual understanding, and more rigorous standardized achievement measures (McConney & Perry, 2011). One such change includes the explicit emphasis on the role of questioning and communication in mathematics and, more specifically, engaging students to represent mathematical ideas in multiple ways (NCTM, 2014) to generate productive discussion. As such, there is a need for task-based mathematics and instructional practices that produce purposeful mathematical discussions among students in whole and small group settings. Through these practices, teachers can more readily support students' conceptual

understandings of complex mathematical ideas and the connections between them (Yackel, Cobb, & Wood, 1991).

The purpose of this inquiry project was to investigate teacher questioning in the context of an open-ended problem-solving environment, and the impact of task-based lessons on student mathematical communication. The project followed the implementation of a problem-solving plan at an elementary school, in which campus mathematics specialists incorporated teacher training covering questioning, the problem-solving process, and the use of open-ended mathematics word problems. Teacher feedback, student artifacts, and personal observations were used to gain insights on the utilization of questioning strategies with pre-selected word problems and their impact on student mathematical communication.

Literature Review

The national and state mathematics standards draw predominantly from sources such as the *Professional Standards for Teaching Mathematics* (1991), *Principles and Standards for School Mathematics* (2000), and *Principles to Actions: Ensuring Mathematics Success for All* (2014). These resources emphasize the importance of mathematical communication in the classroom and the teacher's impact on student responses. For example, the teacher is seen as one who navigates dialogue through the use of questioning strategies that probe deep student thinking. Students have authority and autonomy to question, justify, and engage in productive arguments as well as provide evidence of thinking through various forms of communication such as oral, written, and symbolic text (NCTM, 1991, 2000, 2014). Thus, mathematical communication is not defined as a one-way discourse from teacher to student. Instead, the standards unearth the importance of the interrelationship between student and teacher to use a complex mathematical language that support the connection, analyzation, and expression of accurate mathematical ideas. Thus, the standards encompass a shift towards different research-based criteria for the roles of teacher and student.

Mathematical standards identify the teacher's role as one of orchestrator, facilitator, monitor, and provoker of student explanations, justifications, and arguments. This differs from a traditional model, which customarily begins with teacher modeling of problems and algorithms. Typically, the teacher then guides students through a series of application questions that require students to reproduce steps instead of generating solutions (Cazden, 1988; Barnes, 1976). This initiation-response-feedback model (I-R-F), is still a practiced method, but is no longer sufficient in meeting the current mathematics standards related to communication (Kyriacou & Issitt, 2007). Teachers "must refine their listening skills, questioning, and paraphrasing techniques, both to direct the flow of mathematical learning and to provide models for student dialogue" (NCTM, 2000, p. 197). Moreover, teachers must provide students with opportunities to share their thinking and learn from the thinking of others. For example, students need opportunities to share mathematical ideas in various

ways, such as speaking, writing, listening and drawing (Gojak, 2011). Therefore, using strategies that provide opportunities for students to engage in mathematical thinking and communication are a necessity in the elementary classroom.

Studies have shown that purposeful, high-level, problem-based questions help teachers extend students' mathematical language (Di Teodoro et al., 2011; McConney & Perry, 2011; Strom, 2001; Webb, 2009; Webb, 2014). These studies collectively imply that using open questioning, where more than one correct response is possible, as well as asking questions that connect student ideas and probe for further explanation (e.g. "why did you…?" "how could you both…?" and "what if…?"), have been found to increase mathematical communication. In this regard, new areas of curriculum development and training support teachers' questioning strategies by providing research based tools and techniques that support students' metacognitive and communicative skills (Walsh & Sattes, 2011). This includes using open-ended questions, connecting student ideas, and probing student thinking.

Additionally, using open-ended mathematics problems is effective in the promotion of mathematical communication. Often heuristic in nature, open-ended problems provide students the choice to select various strategies, arrive at multiple answers, and perform multi-step operations in different combinations (Clarke, Sullivan, & Spandel, 1992). These diverse options allow students to express their mathematical thinking in numerous forms and engage in valuable dialogue with their teachers and peers. Students who solve open-ended problems are prone to actively participate, express their ideas more frequently, and discuss their solutions with other students. More so, utilizing open-ended problems provides an approach to evaluate higher-order-thinking skills and improve teaching and learning (Becker & Shimada, 1997). Using a combination of effective questions with thoughtfully constructed, multifaceted mathematics word problems may provide an effective way for teachers to increase mathematical communication in their classrooms.

Thus, this action research inquiry project aimed to explore the following questions:

1. How does the use of questioning strategies with open-ended word problems impact students' mathematical communication at an elementary school campus?

2. What classroom instructional practices on this campus need to be modified, based on the study's findings, to improve mathematical communication among students?

Methodology

School Description and Sample. This project was conducted at a Title I elementary school in a large, urban district in the Southern U.S. At the time of the study, the school housed a total of 542 students with the following demographic breakdown: 81% Hispanic, 7% White, 6% Black, 4% Asian, and 2% other. Of the population, 85% of students qualified for free and reduced lunch and 75% were considered to be of low socio-economic status. The school had four kindergarten, four first-grade, three second-grade, four third-grade, four fourth-grade, and three fifth-grade teachers. Of the 22 teachers, 10 were new staff members at the campus. All 22 teachers and their students participated in the problem-solving program that was implemented through this project. Typical case sampling was used to select one first-grade, one second-grade, two third-grade, and two fourth-grade teachers and their students as participants of the project for data collection purposes (Creswell, 2012). We will provide an overview of the program, followed by an overview of the data collection and analysis process.

Campus Goals and Training. In collaboration with administration and teachers, the two campus mathematics specialists implemented a series of initiatives to improve mathematical instruction. One particular area of focus was classroom mathematical communication. This included, but was not limited to the following goals:

- Use effective questioning strategies that support the use of the Texas Essential Knowledge and Skills (TEKS) Process Standards
- Support students' use of the district's problem-solving model
- Provide students and teachers with mathematically-rich word problems
- Support student mathematical communication, defined as the use of discussions, drawings, text, and manipulatives to demonstrate development in mathematical knowledge

The staff development program, *Problem-Solving with a Purpose*, was assembled and presented to teachers at the beginning of the school year to address these objectives and provide teachers with training in three areas: the district's problem-solving model, questioning strategies embedded with the state's process standards, and the use of open-ended word problems. An important objective of the training was to emphasize the need for teachers to support students in becoming problem-solvers that communicate, connect, prove, and reason mathematical ideas (Gojak, 2011). Specifically, through the use of quality questions and open-ended problems, teachers were trained to guide students through the problem-solving process and engage learners in these various forms of mathematical communication. Resources created by the school district as well as other supplemental materials were used to develop the training.

First, information about the districts' problem solving model, Facts-Action-Solve-Think (FAST), was presented to the entire staff. Although the school had used this model for several years, foundational training was necessary due to a high number of new teachers at the campus as well as end-of-year feedback from senior staff. The components of *Facts* (gathering necessary facts), *Action* (selecting an appropriate strategy), *Solve (*finding a solution), and *Think* (explain your thinking in words), were modeled and explained. Secondly, concepts of teacher questioning were presented using Walsh and Sattes' (2011) *Thinking Through Quality Questioning: Deepening Student Engagement* and *Quality Questioning: Research-Based Practices to Engage Every Learner*.

The concepts of quality questioning were then connected to the TEKS Process Standards. The Process Standards emphasize that students should "use multiple representations, including symbols, diagrams, graphs, and language to display, explain, and justify mathematical ideas in various ways" (TEA, 2012). Thus, students need to be engaged in multiple forms of mathematical communication and using questions that align to the TEKS Process Standards may prove beneficial to reach this objective. Teachers analyzed the TEKS Process Standards and participated in grade-level discussions to share ways of incorporating standard-based questioning throughout the various sections of the school's problem-solving model. For example, one process standard states that students should "analyze mathematical relationships to connect and communicate mathematical ideas" (TEA, 2012). Thus, questions such as "can you relate this problem to another problem you have solved" and "can you think of a mathematical equation to match the story?" were considered and discussed for application in the classroom. Furthermore, grade-level word problems and student samples were presented while teachers practiced selecting and creating questions that promoted mathematical thinking and dialogue throughout the FAST process. Examples in the *Solve* stage of the FAST problem solving process included questions such as "how can we draw a model that represents this problem?" and "can you convince your partner that your solution makes sense?" This teacher training activity led to a compiled collection of questions that aligned to the first grade-level open-ended problem that teachers would use in their classrooms.

Lastly, characteristics and examples of open-ended problems were highlighted and discussed. This section of the training focused on the importance of selecting and using mathematically rich word problems that provide teachers with opportunities to ask meaningful questions and engage students in various forms of mathematical communication throughout the problem-solving process. This included ways to engage students in purposeful discussions that provide students with opportunities to reason, connect, explain and justify thinking (NCTM, 2014). Additionally, the school's mathematics supplemental resources, often underutilized, were showcased. The teachers then generated open-ended problems, based on the conceptual support that these materials can provide, to use in their classrooms. The training concluded with an overview of the school's

problem-solving plan, termed *Problems of the Month,* which incorporated the concepts discussed in the training.

Problems-of-the-Month Campus Plan. The *Problems of the Month* initiative included a sequence of open-ended problems in grades K-5 for teachers to use bi-monthly in their classrooms along with a district rubric to assess mathematical understanding. A total of 18 problems were selected from the resources, Exemplars' (1999) *Exemplars Differentiated Problem Solving* and Pearson's (2012) *Ready Freddy: Daily Problem Solving* (see Appendix D). The first problem for each grade level along with the initial questions was completed during the training. The teachers were challenged to present the *Problems of the Month*, engage students in the problem-solving process, and use standard-based questioning to promote multiple forms of mathematical communication.

Teachers implemented the *Problems of the Month* in their classrooms were encouraged to use the strategies provided in the training. Teachers modeled the process for the first two months producing teacher samples that were turned in to the mathematics specialists. Subsequently, teachers had the choice to complete the problems in a variety of ways including in whole, partner, and small groups. As students worked through each problem, teachers would select one student work sample from the problem solving session to display on the school's mathematics bulletin board. The result was a monthly board showcasing a collection of completed problems solved in a variety of ways from kindergarten to 5^{th} grade that demonstrated student mathematical representations in a variety of ways. Throughout the year, teachers reflected on their questioning skills and observed their students' mathematical progress. Teachers informally discussed their experiences in monthly meetings facilitated by the campus mathematics specialists.

*Data Collection***.** Three types of data were collected during the seven-month project. The first artifact was a collection of student work samples. The artifacts were taken from the mathematics bulletin board where teachers displayed their selected student pieces. The second artifact was a set of five teacher surveys ranging from first through fourth grades. The surveys were given at the end of the school year, and focused on teacher beliefs about questioning strategies as well as their perceptions of their students' mathematical communication during *Problems of the Month*. Half of the survey questions were in open-ended format. The remaining questions included a 5-point Likert scale; these were sorted by question and quantified (see Table 1). The last artifact was an assembly of field notes based on observations during the monthly reflective meetings with teachers.

Data Analysis. Data, which included student work, teacher surveys, and field notes, were analyzed using thematic analysis. After examining each artifact, we selected our units of analysis for each component of the data. The student work samples were grouped by teacher and placed in chronological order. We searched for patterns that emerged in the

data; including both positive and negative evidence of students' mathematical representation in written, modeled, and other text form. More specifically, we categorized the ways that students were representing their thinking, and the strategies that they were using in the problem solving sessions. We did not use a predetermined set of criteria for this analysis; rather, the strategies and representations emerged from the work itself. We looked for sophistication in representation over time, abstractions, and strategy development, especially as these related to communication of mathematical ideas. For example, we found that open-ended problems encouraged more and diverse methods of communication over time, and elicited multiple representations. Teacher surveys were transcribed and re-organized by question to code within a focused topic. We paraphrased the responses separately and then met to confirm our results. Thus, the findings were double-coded for consistency. Themes were emergent, but we also utilized constant comparison throughout the data analysis process. Field notes were analyzed similarly and provided triangulation for emergent themes.

Results

A major theme that appeared consistently in the analysis was aligned to the notion of *opportunity*. Our observations, teacher surveys, and student work samples demonstrated that *Problems of the Month* provided teachers not only more time, but instructional ventures to explore in-depth the open-ended problems, ask meaningful questions, and engage students in various forms of mathematical discourse. These learning opportunities impacted both teachers and students' abilities to communicate mathematics in a multitude of ways. In this section, the findings are presented by thematic topic with support from work samples and the results of the end-of-study teacher survey shown below (Table 1).

Table 1. Teacher Beliefs about Questioning and Student Communication

Question	Strongly Agree	Agree	Disagree	Strongly Disagree	Did Not Use/Uncertain
1. The POM supported mathematical class discussions	0	5	0	0	0
2. The POM provided opportunities to probe student thinking	2	3	0	0	0
3. The POM provided opportunities to connect student mathematical ideas	1	4	0	0	0
4. The POM provided opportunities to ask open-ended questions	2	3	0	0	0

7. The POM increased mathematical communication in my classroom	1	4	0	0	0
The POM improved mathematical communication in my classroom	1	4	0	0	0

Teacher Questioning. A key finding that emerged from the data showed that using open-ended problems with standards-based questioning refined teachers' questioning skills. Teachers had to think critically about their selection of questions since the nature of the problems encompassed multiple solution routes. The majority of teachers who were surveyed felt that the *Problems of the Month* positioned them to ask better questions. One particular teacher stated, "many of the problems were multi-step, and that challenged me to scaffold their learning and understanding at every step at which they had difficulty." Another teacher revealed that she felt her questioning skills improved throughout the year because she was "able to ask many open-ended questions to discuss the different ways to work out the problems." Furthermore, our field note observations revealed that since the mathematics problems were not easily solvable, teachers had to think, plan, and be selective of the questions they asked; these experiences helped to improve their own inquiry skills.

Secondly, the data revealed that using open-ended problems allowed teachers to ask diverse and specific types of standard-based questions to support mathematical communication. Out of the five teachers surveyed, two strongly agreed and three agreed that *Problems of the Month* provided opportunities to ask questions for specific purposes. One teacher mentioned, "I was able to ask many open-ended questions and evaluation questions. Since there were different ways to solve the problems, it was easy to ask quality questions." This teacher made a distinction about question types, noting differences among the intention of the question, in this case, to evaluate student knowledge. This idea is further supported by another teachers' reflection. "I think the problems of the month improved my questioning skills because it allowed me opportunities to ask more probing questions, which allows me to observe how my students can and can't support their thinking." This teacher also categorized a type of question, probing, for a specific purpose, to look at the strengths and challenges of students' ability to support their math ideas. However, not all teachers felt that the problems of the month sharpened their questioning skills. For example, a teacher participant noted that the problems of the month did not greatly impact her questioning skills, but it did allow for more opportunities to have enriching math conversations with students. In all, identifying and using question types purposefully helped teachers analyze and evaluate student thinking throughout the problem-solving process.

Student Communication. Teachers who used a combination of quality questioning with open-ended problems created a learning space to engage students in various forms of mathematical communication. The findings showed that the multiple choice of strategies and solutions were critical factors in student discussion, symbolic model creation, and written mathematical communication.

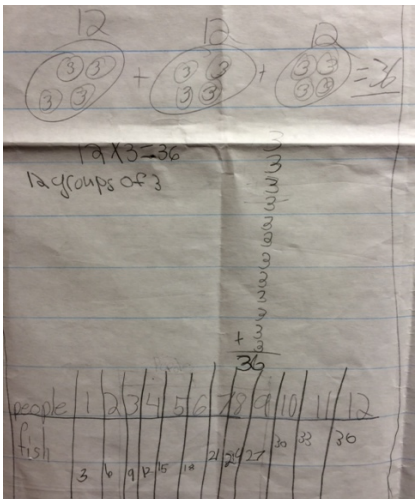
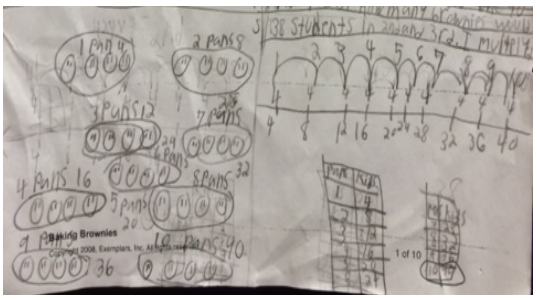
Mathematical Discussions. One form of communication that was positively impacted was student dialogue with teachers and peers. The data showed that during *Problems of the Month*, students used mathematics language to discuss different solutions, strategies, and generate new ideas. The teacher participants noted that they used the multiple solution paths of the open-ended problems to engage students in rich discussion. The survey demonstrated that 4 out of 5 teachers agreed that the word problems provided opportunities for students to connect mathematics ideas. Most teachers had similar responses, acknowledging that the choices the mathematics problems offered were a contributing factor to student discussion. One teacher's observation reinforces this notion:

> "The problems of the month enabled my students to have discussions about why they did certain operations. They would engage more actively when they were trying to support their answers. I think the discussions led them to see how others approached the same types of problems. They realized that there was more than one way to solving a problem. It was very enlightening observing their discussions."

Along with the teacher survey results, the field notes from informal discussions revealed that overall, teachers felt that the *Problems of the Month* allowed for multiple opportunities for mathematical discussions before, during, and after solving the open-ended problems. A teacher comments that the problems lend themselves to "discussing different problem-solving and planning strategies," while another teacher adds that since there were many ways to solve the problems, it "helped generate new ideas and approaches to solving." More so, teachers felt that students had a time and space to participate in discussions and share their thinking with others.

Multiple Representations. Students' increased production of mathematical models and symbols to communicate mathematical thinking was also seen in the data as the year went on. Teachers who asked questions that encouraged multiple forms of symbolic representation (e.g. "can you show me a different way?", "who can draw a different model?") impacted student responses in an assorted of ways. Two examples are seen in Figure 1 (enlarged figures can be found in Appendix A).

Figure 1. Samples of 3rd grade work.

3rd Grade, Group Activity	3rd Grade, Individual Activity
	

This idea was also visible in the teacher survey, were every teacher felt that the *Problems of the Month* provided a unique opportunity to engage and expose students in creating multiple mathematics models. A teacher emphasizes this notion by claiming the following:

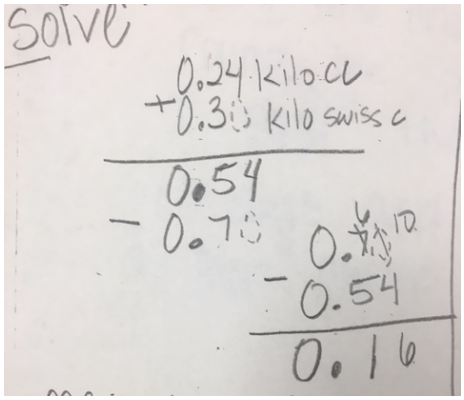
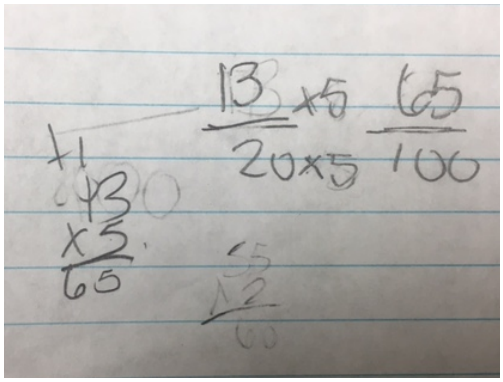
> "The POM was an excellent tool for problem solving with pictures and drawings. Before students drew the picture--the problem was very abstract. I noticed that for my students who drew pictures, it was much easier for them to solve the POM's. This is an excellent strategy that I reinforce daily."

Furthermore, the student examples discussed above are representative of student work where the teacher not only spent time guiding students through the process of developing multiple mathematics models, but also setting expectations for students to show more than one representation of their solutions. On the other hand, the data showed that teachers who did not model the creation of multiple representation nor set the expectation to produce them had less intricate student samples in regards to multiple forms of mathematical representations, as shown below.

In Figure 1, the teacher asked her third grade students to share ideas and create various ways to represent solutions to the problem. The students worked in groups, compared strategies and selected different ways to show their mathematics thinking. Through teacher scaffolding and use of questions that connected student ideas, the learners were able to discuss and create models, tables, and number sentences that represented their solutions. The second example displays an individual student's work with similar results. This third

grade student used a table, model, and number line to communicate his method and solution.

Figure 2. Teacher and Student Solve Samples

5th grade Teacher, September 2013	5th grade student, March 2014
	

This selection shows a fifth grade teachers' modeled *Problem of the Month* at the beginning of the year compared to an end of year student sample from the same class. In particular, the *Solve* section of the teacher-modeled problem shows only an algorithmic solution, with little to no detail of textual representation of the problem or solution strategy. The student sample is strikingly similar in regards to using only the operation to arrive at the solution with minimal emphasis on communicating mathematical ideas using multiple models and strategies.

Mathematical Writing. Student mathematics communication in the form of writing was also positively impacted through the use of the Problems of the Month and teacher questioning. Teachers who probed student thinking and encouraged students to write their procedures and justification increased the quantity and quality of their students written explanations. When asked how the *Problems of the Month* impacted student writing, teachers responded positively. One teacher made the following statements.

> "The problems of the month positively impacted my students writing skills because they had to utilize math vocabulary to support their answers and their way of thinking. They had to be very specific on their steps and thus made them think more carefully about the steps they took in solving problems."

Another teacher added, “writing in detail about their problem solving not only helped their writing skills, but helped students remember and think about steps they took to solve problems.” Accordingly, students not just solved problems, but reflected and explained their thinking in written form. The findings revealed that teachers who used open-ended problems and probed thinking through questioning increased the quality of their students written explanations regarding the problem solving process. An example is seen through a fourth grade student’s work over time (Appendix C).

Here, a fourth grader’s samples are sequenced chronologically. The artifact shows that both the student’s quantity and quality of their written explanations increased throughout time. This student not only wrote more as time progressed, but provided more detail in the method taken to solve problems, the operations and strategies that were chosen, and demonstrated more elaborate explanations regarding their mathematical justifications. This student’s teacher further added that students in her class had the time during *Problems of the Month* to explain their thinking regarding mathematical concepts, which helped with their overall academic writing.

The results of the study were multifaceted with implications for mathematics classrooms, districts, teachers, and administrators. Overall, in the context of problem solving, student communication about mathematics occurred at a higher level. Moreover, teacher communications, such as questioning techniques, ability to engage students in meaningful discussion and connect student strategies, were improved in frequency of specific question types. More so, the results demonstrated the mediation of certain teacher moves related to choices around student grouping and questioning techniques.

Discussion

Overall the findings showed that classroom teachers who used the *Problems of the Month* with diverse questioning to engage students in discussion, model-making, and written form, had positive feelings towards the use of open-ended problems. Consequently, their students showed increased improvement in all three forms of mathematical communication. This has implications for classroom teachers in that it supports the notion that teaching mathematics through open-ended problem solving sessions, as opposed to traditional lecture and worksheet driven instruction, increases not only student mathematical understanding but also teacher practice. Further, when teaching mathematics through problem solving, teachers are inherently and continuously assessing students by circulating, listening, and asking questions about thinking.

The implications at the district level are similar – mathematics curricula should be written with a problem solving focus in order to support student understandings and pedagogical development. Teachers should be trained in this type of instruction, and should be able to

elicit mathematical ideas from students. This type of teaching is more equitable because the students are doing the cognitive work, and therefore maintain a greater level of power in the classroom. Rather than the teacher "holding" the knowledge, it is co-constructed through discussion.

Teacher education programs have adopted this type of pedagogy more readily, but should be conscious to place student teachers in classrooms where mathematics is taught through problem solving. Further, more research is needed to understand the development of teachers as problem solvers.

Limitations and Challenges

Though the results of this study overwhelmingly support the practice of teaching mathematics through problem solving at the elementary school level, there were some challenges that arose and should be addressed. Many of these were at the campus level, but do speak to the fact that success in implementation is based on many factors, some of which are out of a teacher's immediate control.

Campus Challenges. Although the use of open-ended problems with standard-based questioning proved to have positive results, classrooms showed different levels of quality in their work. Mathematics specialists' field notes and examination of all student work helped form a better understanding of the varied degrees of mathematical communication. Teacher expectations, student grouping, and years of experience were factors that impacted the quality and quantity of student mathematical communication. One such finding revealed that teachers who did not set high expectations at the beginning of the year through their modeled samples had lower mathematical communication than teachers who set high expectations. Teachers who took time to engage students in discussion, used questioning to connect ideas, and modeled correct forms of detailed representations had superior results. Additionally, the research showed that teachers grouped students in different ways; students worked in pairs, small groups, or individually. This led to varied degrees of mathematical discussion. Students who worked in pairs or small groups engaged in more peer dialogue than students who worked on the activities individually. The grouping of students also led to exposure to varied forms of mathematical communication from other peers.

Furthermore, the findings revealed that first-year teachers had lower student mathematical communication compared to the classrooms of more experienced teachers. Student samples from two first-year teachers exposed their misunderstanding of the district's

problem solving model as well as less detailed work, which in turn, negatively affected their students' mathematical communication.

Another area of concern dealt with the organizational aspects of the *Problems of the Month*, mainly seen with alignment and frequency issues. The teacher survey revealed that although the *Problems of the Month* were seen as beneficial for student mathematical communication, the sequence of the plan did not always align with the district timeline. This caused some issues for teachers, since at times they were solving challenging problems that required skills that were not yet taught. Although it pushed students to solve problems using innovated ways, teachers expressed concern due to the time and challenges it created. Teacher feedback also revealed that completing the *Problems of the Month* bi-weekly caused some setbacks in keeping up with the district timelines and assessments. Since the open-ended problems required ample time, teachers often either shortened or condensed the daily district mathematics lessons.

Campus Changes. The implementation of the problem-solving plan proved to enhance teacher questioning skills and student mathematical communication; however, this inquiry also exposed campus issues that require further action. Thus, modifications to the campus problem-solving plan and staff trainings opportunities were created to respond to the research findings.

First, the selected *Problems of the Month* were re-evaluated and modified to align with the district timeline. This change has helped teachers present relevant mathematics problems to students after they have acquired some background knowledge and skilled practice. Additionally, the database of problems is available to teachers for modifications to the plan, thus the goal is for teachers to consider the selected problems, but also allow for teacher autonomy. Secondly, the *Problems of the Month* changed from a bi-weekly to a monthly activity. Although the research exposed the benefits of standard-based questions and open-ended problems, the *Problems of the Month* are not the only avenue to accomplish this positive impact on mathematical communication. A campus goal for next year is to encourage teachers to use the *Problems of the Month* as opportunities to engage students in deep mathematical understanding and communication, but the expectation is to apply the research-based strategies across the mathematics curriculum. Furthermore, the mathematics specialists have developed a plan to address new teacher misconceptions by modeling effective strategies and providing support for novice teachers throughout the year.

Lastly, a focus for next year's staff development will incorporate training relevant to the research findings. This includes sharing anonymous examples of quality student work and teacher models with all staff to expose and discuss effective strategies to further enhance mathematical questioning and student communication at the campus.

Conclusion

The procedures and findings of the action research project add to the educational literature by exposing valuable considerations for administrators, math specialists, and teachers to develop and support mathematical communication at the elementary school level. First, the need for administrators and math specialists to cultivate campus-wide goals and support staff in the implementation of reform-based mathematical instruction is important. Specifically, the results showed that the math specialists' role of setting initiatives, conducting staff development, and providing mathematical resources were factors that supported teachers in the implementation of effective instructional strategies. Thus, math specialists need to stay current with mathematical practices and collaborate with administrators to dispense mathematical knowledge to classroom teachers.

Secondly, the project disclosed instructional techniques that benefit educators who work with elementary school students. The use of open-ended problems in combination with meaningful questioning proved to increase the quality of teachers' questioning skills and reflective planning. Hence, creating spaces for teachers to discuss and collaborate with other educators is a central component to enhance instruction. Likewise, challenging and encouraging teachers to implement teaching techniques in various combinations improves instruction and learning. Furthermore, practicing this strategy was also found to increase students' mathematical dialogue, written explanations, and symbolic representation. Thus, the results expose the benefits of using this reform-based strategy to help students explain and justify their mathematical reasoning through multiple avenues.

Overall, the project revealed that the integrated use of standard-based questioning with open-ended problems positively impacted the campus' mathematical communication. Teachers enhanced their questioning skills and engaged students in mathematical discussions, model-making, and written explanations. Moreover, the *Problems of the Month* provided teachers the time to ask diverse sets of questions and guide students through complex problem solving. Students were given opportunities to engage with teachers and peers in dialogic interactions that led to the co-construction of strategies and solutions in multiple forms. The research further showed that each classroom varied in degree of mathematical productivity. Factors such as teaching experience, grouping, and classroom expectations impacted the quality and quantity of mathematical communication.

The findings led to develop a plan of action to further support the use of open-ended problems and quality teacher questioning at this campus.

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References

Barnes, D. R. (1976). *From communication to curriculum*. New York, NY: Penguin Education.

Becker, J. P., & Shimada, S. (1997). *The open-ended approach: A new proposal for teaching mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Cazden, C. (1988). *Classroom discourse: The language of teaching and learning*. Portsmouth, NH: Heinemann.

Clarke, D. J., Sullivan, P., & Spandel, U. (1992). *Student response characteristics to open-ended tasks in mathematical and other academic contexts*. The Centre.

Creswell, J.W. (2012). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Di Teodoro, S., Donders, S., Kemp-Davidson, J., Robertson, P., & Schuyler, L. (2011). Asking good questions: Promoting greater understanding of mathematics through purposeful teacher and student questioning. *Canadian Journal of Action Research*, 12(2),18-29.

Exemplars. (1999). *K-8 Differentiated Best of Math Exemplars I, II, and III.* [CD ROM] Underhill, VA.

Ferrini-Mundy, J., & Martin, W. G. (2000). *Principles and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Gojak, Linda. (2011). *What's your math problem? Getting to the heart of teaching problem solving*. Huntington Beach, CA: Shell Education.

Kyriacou, C., & Issitt, J. (2007). Teacher-pupil dialogue in mathematics lessons. *BSRLM Proceedings*, 61-65.

McConney, M., & Perry, M. (2011). A change in questioning tactics: Prompting student autonomy. *Investigations in Mathematics Learning*, 3(3), 26-45.

National Council of Teachers of Mathematics. Commission on Teaching Standards for School Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2000). Principles and standards for school mathematics (Vol. 1). Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (2014). *Principles to actions: Ensuring mathematical success for for all*. Reston, VA: National Council of Teacher of Mathematics.

Pearson Learning Solutions (2012). *Ready Freddy: Daily Problem Solving.* Boston, MA: Pearson.

Strom, D., Kemeny, V., Lehrer, R., & Forman, E. (2001). Visualizing the emergent structure of children's mathematical argument. *Cognitive Science*, 25(5), 733-773. doi: 10.1207/s15516709cog2505_6

Texas Education Agency (2012). *Chapter 111. Texas essential knowledge and skills for mathematics. Subchapter A. Elementary school.* Retrieved October 30, 2017. from http://ritter.tea.state.tx.us/rules/tac/chapter111/ch111a.html

Walsh, J. A., & Sattes, B. D. (2011). *Thinking through quality questioning: Deepening student engagement*. Thousand Oaks, CA: Corwin Press.

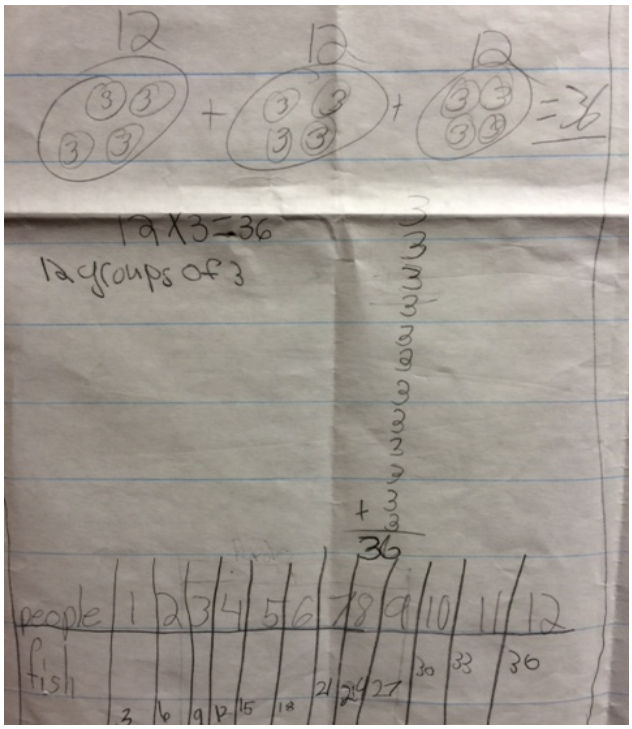
Webb, N. M., Franke, M. L., Wong, J., Fernandez, C. H., Shin, N., & Turrou, A. C. (2014). Engaging with others' mathematical ideas: Interrelationships among student participation, teachers' instructional practices, and learning. *International Journal of Educational Research*, *63*, 79-93.

Webb, Noreen M. Franke Megan L. De TondraChan Angela G. Freund DeannaShein PatMelkonian Doris K. (2009). 'Explain to your partner': Teachers' instructional practices and students' dialogue in small groups. *Cambridge Journal of Education*, 39(1), 49-70. doi: 10.1080/03057640802701986

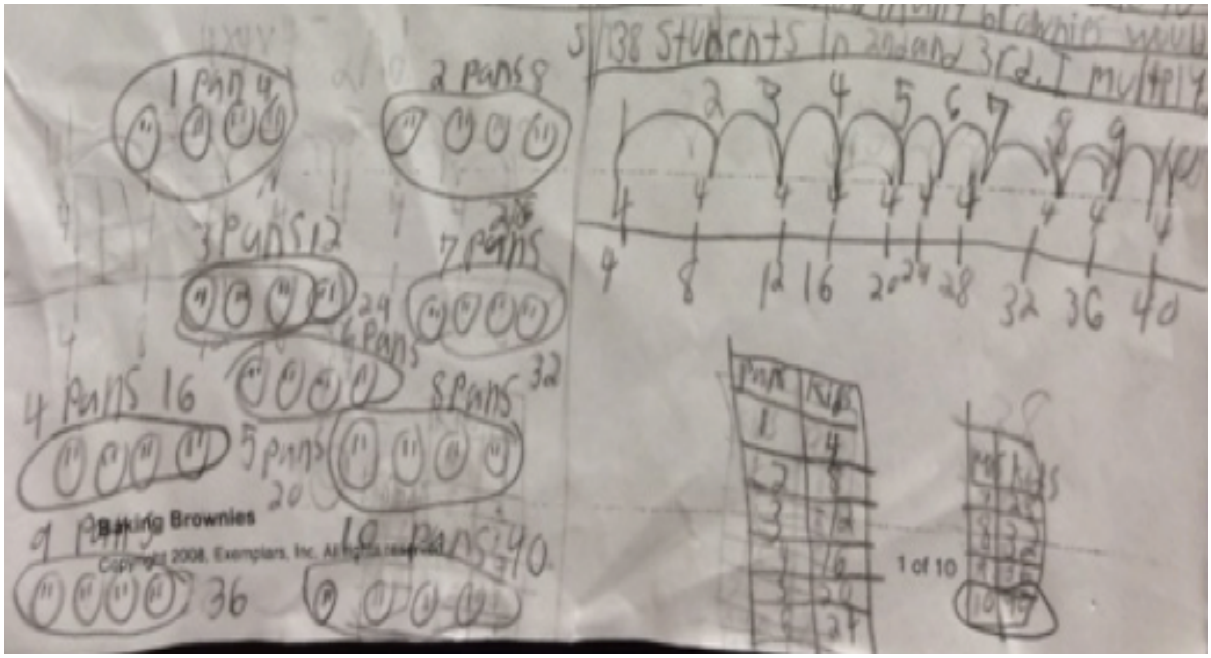
Yackel, E., Cobb, P., & Wood, T. (1991). Small-group interactions as a source of learning opportunities in second-grade mathematics. *Journal for research in mathematics education*, 390-408.

Appendix A: Examples of Third Grade Work as Seen in Figure 1

Group Activity

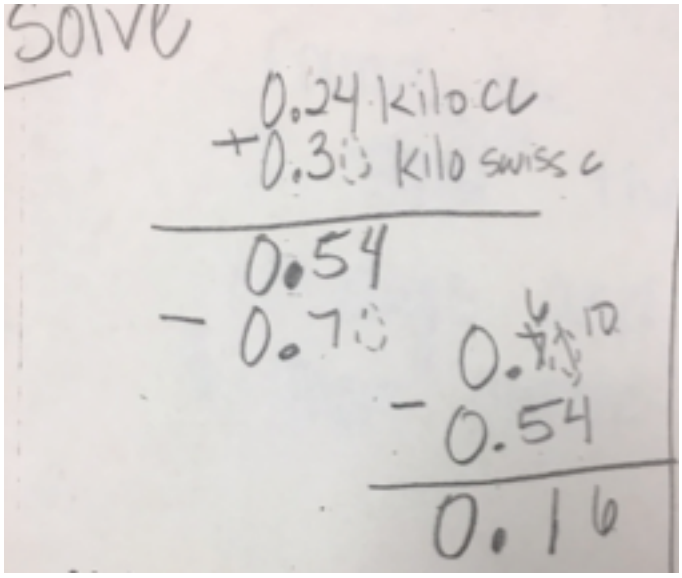


Individual Activity

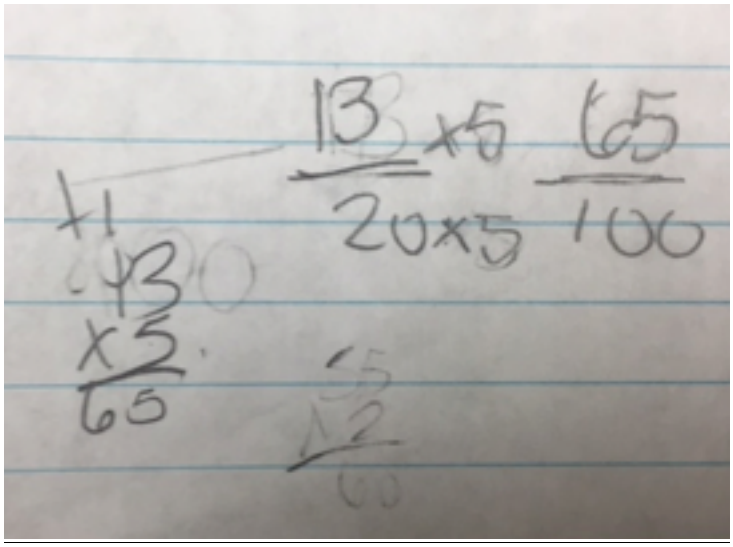


Appendix B: Teacher and Student *Solve* Samples as Seen in Figure 2

5th Grade Teacher - September 2013

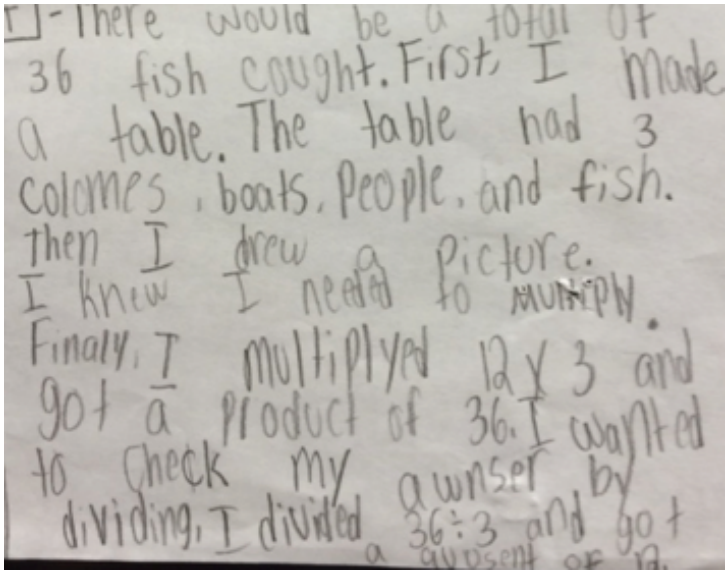


5th Grade Student - March 2014

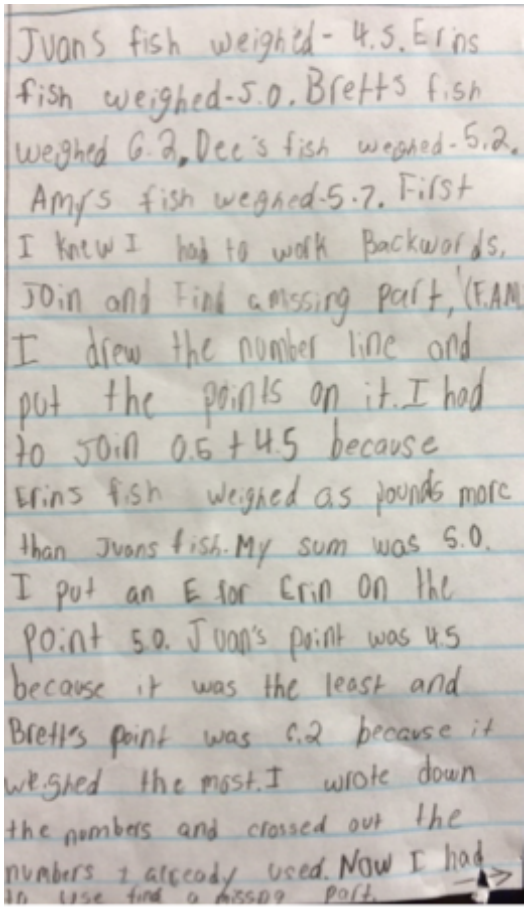


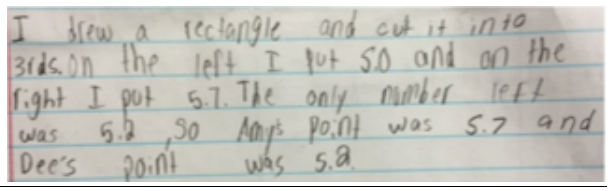
Appendix C: Samples of a 4th Grader's Work Over Time

October 2013



January 2014





Appendix D: Samples of *Problem of the Month*

(Adapted from *Exemplars*, 1999 and Pearson Learning Solutions, 2012)

K-2nd Grade Problems

1. Class Pets
FAST Freddy's class has 7 goldfish. Help FAST Freddy put them into 3 bowls.

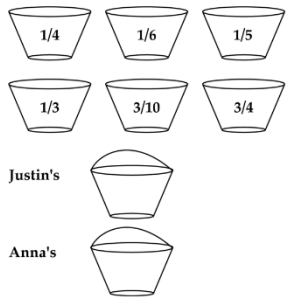
- Each bowl must have at least 1 goldfish
- No bowl may have more than 3 goldfish

How many fish would you put into each bowl?

2. Coins
You and your friend are on your way to the store to buy some milk. When you get there your friend realizes that she is 40 cents shorts of what she needs and asks if she can borrow some money from you. You have pennies, nickels, dimes and quarters. What are different ways you can combine these coins to loan your friend 40 cents?

3rd-5th Grade Problems

1. Lugging Water
Justin and Anna were camping with their family. They joined their dad at the camp water pump where he had partially filled 6 containers. The containers had no handles. As he filled each one, he labeled the fractional amount to which each container was filled. The amounts are shown below.



Justin and Anna each had a container that was the same size as the ones their dad filled, but theirs had handles. Their task was to pour the water from the 6 containers into their 2 containers so they could easily carry the water back to camp. Which containers should Justin and Anna pour into each of their containers so together they can transport the water in one trip? Show your math thinking.

2. Fish Dilemma
There are 3 boats. There are 4 people fishing on each boat. Each person may catch up to 3 fish. How many fish could be caught?

Be sure to explain your reasoning using words, numbers, diagrams and/or charts.

STUDENT AND TEACHER PERCEPTIONS OF STABILITY BALLS AS ALTERNATIVE SEATING IN A FIRST GRADE CLASSROOM

Nicole Schoolcraft

Abilene Christian University

Abstract In recent years, many teachers have chosen to replace desk chairs with stability balls in their classrooms in order to improve student attentiveness. The purpose of this study was to gain a deeper understanding of what first grade students and their classroom teacher thought about using stability balls instead of desk chairs. The author collected data through student and teacher interviews, observations, and a student survey. After analyzing the data by using the constant comparative method, the author found three major themes. The first was that some students believed moving while being seated was helpful, while others found movement distracting. Second, the author found that student attentiveness was related to movement and productivity. Third, students valued their ability to choose their seating. This study may provide useful information to other educators who are deciding if they would like to try alternative or flexible seating in their classroom.

Keywords: teacher action research, alternative seating, flexible seating, movement, student choice

Introduction

"Sit still. Why are you getting up? Stop bouncing your leg. Don't lean back in your chair. Sit up straight. Quit kicking the desk. Put both feet on the floor." I imagine that most educators are familiar with these phrases. Some would probably admit to using one or more of these phrases daily. Teachers have diligently searched for ways to increase student engagement and decrease discipline problems in the classroom in order to maximize learning. While teaching styles, lessons, and activities impact student attentiveness, so does classroom environment. The students' interaction with the classroom environment can either promote or prohibit on-task behavior (Bronfenbrenner, 1979). Part of the classroom environment includes student seating. In the past, seating has typically included plastic or wooden desk chairs. However in recent years, teachers have begun using stability balls instead of desk

chairs with hopes that they will increase student attentiveness while students work at their desks.

The purpose of this study was to gain a better understanding of student and teacher perceptions of stability balls as alternative seating. I also wanted to understand the students' and classroom teacher's perceptions of student attentiveness when students had the option to sit on stability ball rather than a desk chair. My research questions included the following:

- What are the students' and the teachers' perceptions of the use of stability balls as alternative seating in a first grade classroom?
    - Sub question: What are the students' and the teacher's perceptions of their/student attentiveness regarding the use of stability balls?

During this study, I was a graduate student completing a yearlong clinical teaching placement in a first grade classroom at Riverside Elementary (all names have been replaced with pseudonyms). Riverside was a Title I school that served approximately 500 students in grades K-5.

My cooperating teacher applied for and received a grant to replace the desk chairs in her classroom with stability balls in September. We introduced and began using the stability balls in November—about two months prior to the start of my research. Every student had the option to choose between using a regular desk chair and sitting on a stability ball when they worked at their desks each day. We established clear expectations for the use of the stability balls through minilessons and explicit modeling. Some of these expectations included the following: not bouncing too high, sitting with both feet on the floor, not drawing or marking on the ball. We did not start using all 21 stability balls at the same time. We started by passing a few stability balls from student to student during the day, and slowly added more after all students had about two weeks to practice using them. If a student did not follow these expectations, he or she would lose the privilege of sitting on the stability ball for the remainder of the day, but would be allowed to use the ball the next day.

Literature Review

One reason teachers use stability balls in the classroom is because they allow students to move while seated at their desks (Wyatt, 2009). The increased movement is thought to increase student alertness, which may facilitate increased student learning (Mead, Scibora, Gardner, & Dunn, 2016). Burgoyne and Ketcham (2015) stated the following:

> Researchers hypothesize that by bombarding the vestibular and proprioceptive systems with increased input, sensory processing can be improved to help students achieve an appropriate response to classroom demands by focusing on relevant stimuli. When the sensory system has an overload of information, it is better able to

> select relevant input out of the extraneous information in order to produce appropriate responses to a given situation. (p. 47)

The vestibular system is located in the inner ear and controls balance and movement (Jensen, 2005), while the proprioceptive system is responsible for a person's awareness of their body and coordination of limbs (Burgoyne & Ketchum, 2015). These systems work closely together to provide sensory information to the brain about balance, movement and body position (Burgoyne & Ketchum, 2015). Children begin to fidget because their bodies are seeking sensory input and movement (Hanscom, 2014). Similarly Jenson (2005) stated, "Physical movement such as standing, stretching, walking, or marching can increase brain amine levels, which can help improve attentional focus" (p. 51).

Fedewa & Erwin (2011) found that the stability balls were effective in increasing on-task behavior and decreasing levels of hyperactivity because students were able to bounce while working. Both educational research and brain research affirms that movement is linked to learning and attentiveness. This is because the cerebellum processes both learning and movement (Jenson, 2005). There are many ways to get students moving during the day, but sometimes seatwork is necessary. Having stability balls as alternative seating allows for more movement even when students are working at their desks (Burgoyne & Ketchum, 2015).

Many researchers have investigated the effects of stability balls on behavior for students with special needs and students with behavioral concerns. Studies have focused on students with Attention Deficit Hyperactivity Disorder (ADHD) concerns (Fedewa and Erwin, 2011), Autism Spectrum Disorder (Schilling & Schwartz, 2004), inattention, hyperactivity, oppositional defiant behaviors, anxious/depressive symptomatology (Gaston, Moore, & Butler, 2016), and dyslexia (Goodmon et al., 2014). These researchers concluded that the use of stability balls decreased levels of hyperactivity and discipline referrals and increased attention and engagement. While these studies are useful and informative for teachers who teach exceptional students, they lack information about the impact of stability balls as seating for general education students.

A main focus of current research articles about stability balls as classroom seating is their impact on student engagement and on-task behaviors. According to Fedewa, Davis, and Ahn (2015), the use of stability balls was related to a decrease in disruptive behaviors in treatment classrooms, and similar levels of on-task behavior and achievement in control and treatment classrooms. Schilling and Schwartz, (2004) found that the use of stability balls increased engagement and in-seat behavior for students with Autism Spectrum Disorder. According to Fedewa and Erwin (2011), all of their 76 fourth- and fifth-grade participants showed signs of increased attention and improved hyperactivity when seated on a stability ball. Burgoyne and Ketchum (2015) also found that when students were seated on stability

balls 85% of observations indicated on task behavior, as opposed to 50% of observations when students were seated on a desk chair.

When studying the use of stability balls in the classroom, some researchers have investigated possible academic benefits associated with this type of alternative seating. Fedewa et al. (2015) found that stability ball use did not significantly impact student achievement levels on standardized math and literacy tests. Mead et al. (2016) studied how the use of stability balls as seating, compared to other forms of exercise, impacted student achievement on a standardized math test. They found that there was a positive impact on student math scores when they were seated on the stability balls (Mead et al., 2016). Goodmon et al. (2014) noted that stability balls did not have an impact on the reading comprehension of students with dyslexia. These mixed results indicate a need for further research on the academic impacts of stability balls used in place of desk chairs.

Another important factor to consider when looking at stability balls as alternative seating is student and teacher preference. Studies have shown the positive impact of using stability balls instead of desk chairs, but what do students and teachers really think about this form of alternative seating? According to Fedewa and Erwin (2011), Schilling and Schwartz (2004), and Gaston et al. (2016) social validity surveys completed by teachers indicated that they preferred to use the stability balls in their classrooms. Goodmon, Leverett, Royer, Hillard, Tedder, and Rakes (2014) and Gaston et al. (2016) mentioned that the students in their studies preferred to sit on a stability ball. These studies provide a small indication that students and teachers may prefer to use stability balls rather than traditional chairs. There is a lack of research; however, dealing specifically with student and teacher perceptions of stability balls as alternative seating.

Not only are there studies that focus on academic achievement and student behavior, but some of these studies also include discussions of student health. Childhood obesity and the impact of a sedentary lifestyle have become major concerns in the United States. According to Aminian, Hinckson, and Stewart (2015) and Wendel, Benden, Hongwei, and Jeffrey (2016) decreasing the amount of time a student sits still can positively impact their health. Wendel et al. (2016) found that by trading traditional desks for standing desks had a significant impact on student's Body Mass Index. Aminian et al. (2015) studied a classroom that used standing desks as well as stability balls and found that teachers believed the environment resulted in, "increased space, social interactions, happier children, and better, quicker and easier supervision" (p. 643). One study on the physical impact of the use of stability balls as seating yielded neutral results. According to Erwin, Fedewa, Soyeon, and Thornton (2016), stability balls do not necessarily increase physical activity levels, but they do not have a negative impact on classroom learning and environment. These results indicate a need for further research on the relationship between classroom environments and student health.

The results of previous studies indicated that stability balls may be helpful tools to keep student in their seats and focused. My study is important because much of the research that has been done on this topic has focused on the benefits for students with special needs or with hyperactivity concerns. My study provides insight into how the use of stability balls, as alternative seating, could be beneficial in a general education classroom. It is difficult for young students to remain still while at their desks, which can create distractions or behavior problems. When students are given the option to sit on stability balls they may be more engaged and more likely to remain on-task. Other students may prefer to sit in a chair, but giving them the option to choose between a chair and a stability ball may increase attentiveness. According to Wyatt, (2009), the use of stability balls is becoming a trend in elementary classrooms because teachers are seeing increased engagement and on task behaviors. My study contributes to knowledge in the educational community because it focused on the responses and observed behaviors of an entire first grade general education class. This study provides better understanding of student and teacher opinions toward the use of stability balls as alternative seating.

Methodology

The following describes an action research study conducted in the context of a first grade classroom. I studied the perceptions of students and the classroom teacher in relation to general thoughts about the stability balls as well as their thoughts regarding student attentiveness when using the stability balls. Students were comfortable with my role as a teacher and researcher in the classroom because this study was conducted during a portion of my yearlong clinical teaching placement.

Participant Selection. The participants of this study included a single class of first grade students. There were twenty-one possible participants. There were eight girls and 13 boys. The class demographics included the following: 14 white students, five students of mixed race, one African American student, and one Hispanic student. There were three boys and three girls identified as gifted and talented students. When the study began, my cooperating teacher had just completed her Master's in Gifted Education.

Every student who received consent and assented to the study participated in the survey and observations. I used purposive sampling (Patton, 1990) to select students from the class to participate in a short interview. Nine male and female students were chosen for an interview based on my observations of their on-task behaviors at their desks. I interviewed three students who were always on task, three students who were on task most of the time, and three students who were rarely on task. The classroom teacher was also a participant in this study. I conducted an interview with my cooperating teacher to learn more about her perceptions of the stability balls. I sent home an informational letter and a consent form to the parent or guardian of every student in the class. The students who received parental

permission to participate in the study completed an assent form while at school. The cooperating teacher also received an informational letter and consent form. I provided a copy of consent letters for participants to keep.

Data Collection. For this study I collected three types of data: observations, interviews, and a class survey. I observed student behavior when they were working at their desks. I wrote field notes three times a week for two weeks about student behaviors I observed. I recorded observations about the on-task and off-task behaviors I observed while students were working at their desks.

I conducted nine individual semi-structured student interviews that lasted approximately 5-10 minutes each. In these interviews, I asked questions regarding student opinions about using stability balls instead of desk chairs. I wanted to know if they thought the stability balls were helpful tools that helped them stay focused. I also conducted an interview with my cooperating teacher that lasted approximately 25 minutes. During this interview, I asked about why she began using the stability balls and what perceived benefits or drawbacks she had observed since introducing this form of alternative seating. I also wanted to know more about her thoughts regarding the effectiveness of the stability balls in relation to student behavior and attentiveness.

The entire class took a survey about their perceptions of the stability balls; however, I only used data from students' surveys, which assented and received consent to participate in the study. Did they like using the stability balls? Did being able to move help the students feel more focused? All students completed this survey during class. I used survey data in addition to the interview data to gain a more complete picture of how the class felt about the stability balls.

Data Analysis. I analyzed data through the use of the constant comparative method with initial coding followed by the identification of major categories with supporting codes (Hubbard & Power, 2003). First, I manually analyzed about twenty percent of the collected data and created approximately 20 codes. From these level I codes, I then organized my data by creating level II codes based on major themes (Tracy, 2013). I also created a codebook (Found in Appendix B) that listed level I and level II codes, definitions, and examples. I wrote memos based on the level II codes, which allowed me to gain a better understanding of their meanings and connections to the other codes (Tracy, 2013).

Results and Discussion

Based on my data analysis, the major themes I will describe are movement, student attentiveness, and the importance of choice. In the descriptions of my findings I will also

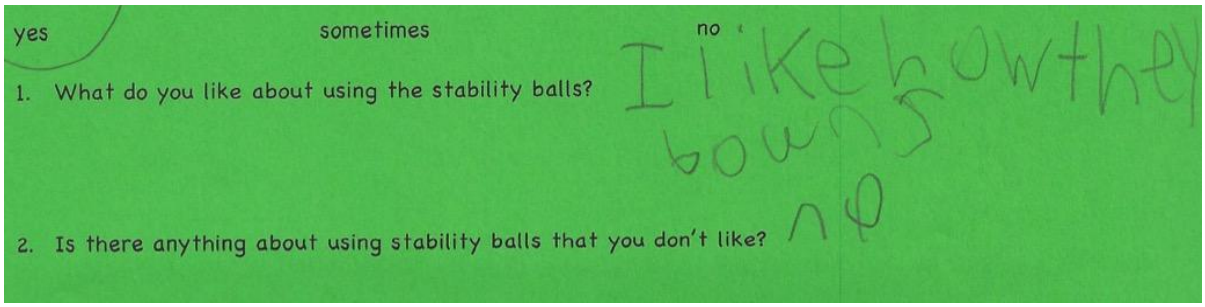
include examples of themes from interviews, observations, and surveys. (A complete list of student responses to the survey questions can be found in Appendix B). I included a photograph in of one of the stability balls we used in our classroom in Figure 1.

Figure 1. Photograph of a student's stability ball.

Movement. As I recorded and reflected on my observations, I knew that bouncing, rolling, sitting, and standing would be recurring descriptions of the movement theme in my study. I took notes on the different movements students made while sitting on the balls during my observations. Some students using the stability ball bounced quickly, some bounced occasionally, some rolled back and forth, and others sat still on the ball. During all of my observations, there were clear signs of movement from the majority of students.

When asked if moving while at their desks helps them learn on the class survey, 7 students answered yes, 8 students answered sometimes, and 4 students answered no. On the survey free response question about what students like about the stability balls, eight students mentioned moving on the ball or bouncing. Some of the responses included the following: "They're bouncy. That you can move. That you can bounce". As shown in Figure 2, Joey wrote that he likes "how they bounce". Seven of the students' surveys were similar to Joey's because they liked how the balls allowed them to bounce, and there was nothing they disliked about the stability balls.

Figure 2. A portion of a student survey.



However, I also found that not every student thinks that movement is helpful. One student I interviewed thought that the balls were good for exercise, but not classroom seating. Aaron said, "They kind of give you a distraction cause you can accidentally bump into stuff." He then talked about how he felt like the stability balls were helpful for exercise, but not really helpful for staying focused. When I asked Aaron if he thought the stability balls helped him do his work in school he said, "Well it's a good form of exercise, but no. I think they help me a little bit...because it's good exercise." In my observations Aaron was often looking around the room or playing with items in his desk instead of working. It is interesting to note that while Aaron finds the stability balls to be distracting, he seldom chooses to sit in his chair. Out of my six observations, Aaron only chose to use his chair on two of the days.

On the student surveys there were three students who wrote that they did not like the stability balls because they are bouncy. Aaron, Jacob, and Harrison all indicated on their surveys, as seen in Figures 3, 4, and 5, that they did not like bouncing or moving on the stability balls. During my observations, these students chose to sit on a chair more often than they had prior to the beginning of my study. Harrison is the only student in the class who consistently chose to sit on his chair more than once per week. While all the students did not seem to agree on whether or not the balls helped them, they agreed that the stability balls were fun. When asked about what he liked about the stability balls Aaron said, "Well they're fun to sit on...cause you can bounce on them."

Figure 3. Portion of student survey. "They're bouncy."

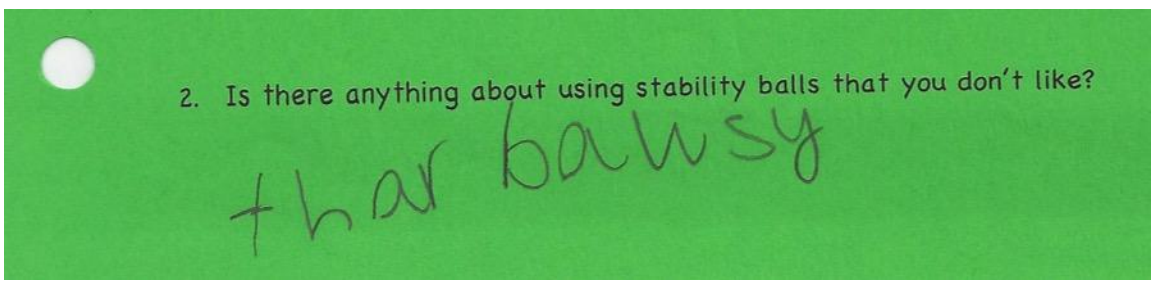


Figure 4. Portion of student survey. "I do not like bouncing."

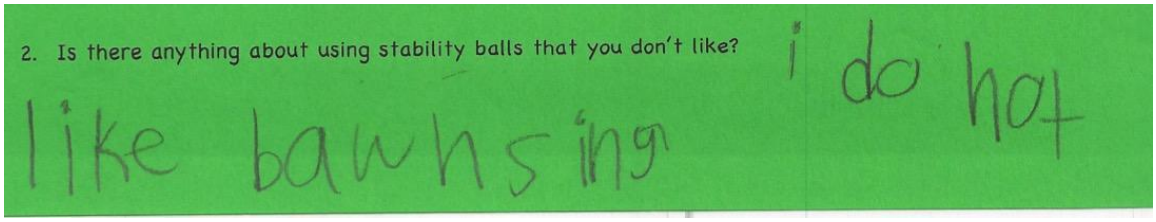
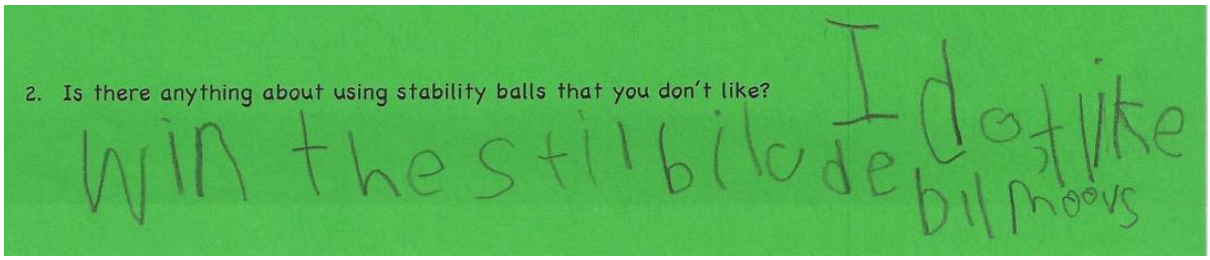


Figure 5. Portion of student survey. "I don't like when the stability ball moves."

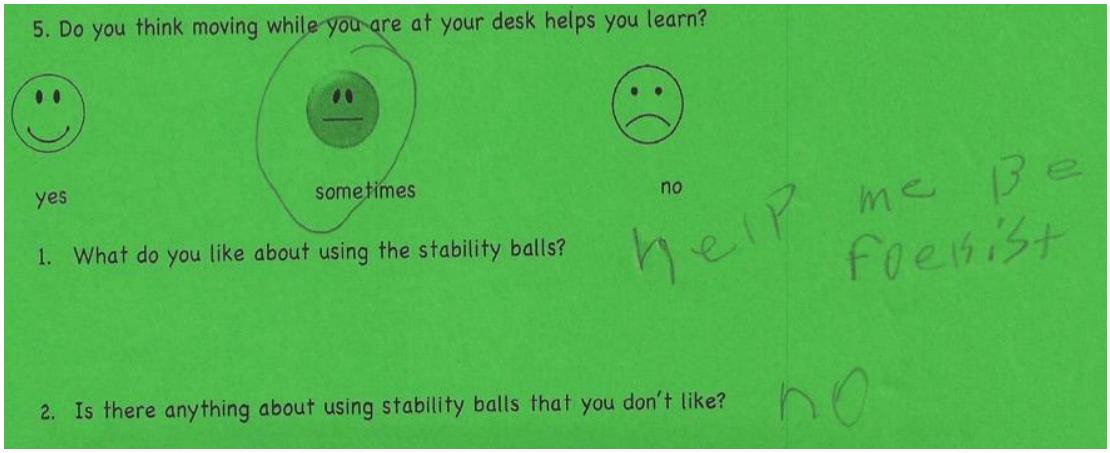


During a few of the student interviews, students mentioned that the stability ball helps their posture. After asking how the ball helps her stay focused when she's bouncing, Brielle said, "It makes my back like straight, and I can work with fresh air." Some students still slouch or lean over on their desks, but the stability balls do help some students have better posture because the balls do not have backs. This was another reason that Aaron did not like using the stability ball. He said, "I honestly don't like them very much cause if you lean back you fall right over and in a chain you can just lean back and you don't fall over." Not having a back on the stability ball forces most students to sit up straight, which may keep them more alert. Peter said, "Well, you can bounce a little bit on them, and they help you stay focused, and you sit up straight, and that makes you focus more than sitting crouched." For Brielle and Peter, posture was related to attentiveness. When they're sitting up straight they are focused and alert, but if they are slouched over, they may not be paying attention.

Movement is something most students and the teacher like about the stability balls. Movement is also seen as something that can impact student attentiveness. According to Madison, "...sometimes they help me concentrate...when my mind gets all confused, sometimes I need to...like sometimes I do verb." While it may be distracting to some students, the movement is very beneficial to other students. Sadie stated, "They (stability balls) help you learn. And this is how I think they help you learn, because you get to bounce and that kinda helps your brain keep thinking..." Movement has been shown in previous research to be helpful when learning (Mead et al., 2016) and in facilitating on task behavior (Burgoyne & Ketchum, 2015), and this data about movement further emphasizes why most students like using the stability balls instead of desk chairs.

Student Attentiveness. One of my research questions was the following: What are the students' and the teacher's perceptions of their/student attentiveness regarding the use of stability balls? I found that my cooperating teacher believes the stability balls do help with student attentiveness. I also found that most students think using the stability balls as seating helps them pay attention in class. According to the class survey, 84% of the class thought that the stability balls helped them focus at least some of the time. As shown in Figure 6, Travis wrote on his survey that he likes the stability balls because, "they help me be focused." According to his survey, he believed that moving at his desk sometimes helps him learn, and he liked that the stability ball helps him stay focused.

Figure 6. A portion of a student survey.



In the student interviews, we discussed whether or not they felt that the stability balls helped them pay attention. Eight out of the 9 students felt that the ball at least sometimes helped them focus. Daniel said, "It just helps me concentrate more cause when I lean up against my desk, it helps me concentrate more." When discussing how the ball helped students pay attention, the students always attributed it to their posture or ability to move. Brielle said, "They help me stay focused when I'm really anxious cause I want to get done really fast, and I like how it keeps me focused". When I asked her how this would be different if she just had a chair she said, "Cause it's (the chair) is hard and you can't like move and it's like stiff."

In her interview, my cooperating teacher reflected on her initial goal to increase student engagement and productivity. She said she was surprised when the balls did not have much of an impact on student engagement. She said, "So I'd say they're [stability balls] more beneficial for productivity than they were engagement even though I would have originally

thought it would've been both." She anticipated that when students were seated on the ball, they would be more engaged in whatever they were working on, but realized that engagement relates more to the subject and activity. Students will not automatically be engaged in the paper or activity just because they are seated on the stability ball. While the stability balls seemed to help some students focus on the task at hand, there was no guarantee that all students would be attentive if they were also using the stability ball. If a student is not interested and invested in his or her work or activity, there is no seating that could compel him or her to stay focused.

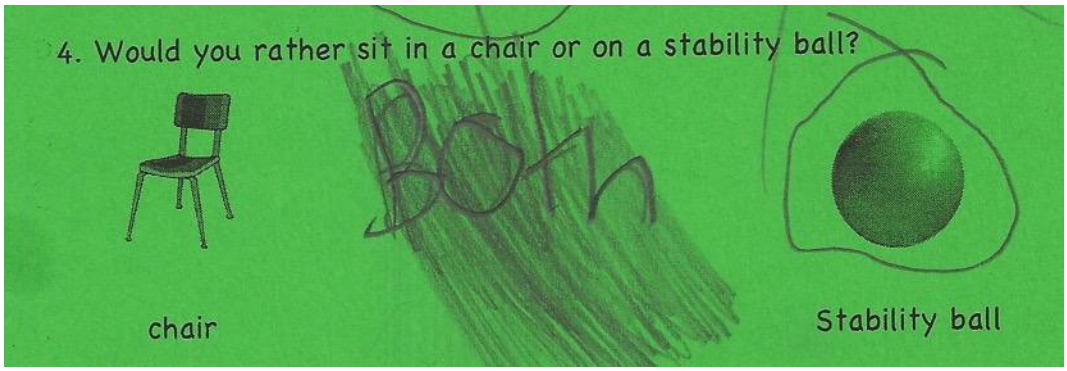
My cooperating teacher and I then discussed how there was a notable increase in productivity of students in writer's workshop. Because of how we structured our schedule and lessons, students did not typically spend very long working at their desks other than during writer's workshop. We tried to give them anywhere from 15-30 minutes of uninterrupted writing time every day. Because of this structure, students spent the most time on their stability ball during writer's workshop. According to my cooperating teacher, "...things like publishing, not everybody would've published and been on time, this time we only had two who weren't done on time. That showed me that our productivity has increased". Whether this increased productivity was related to the stability balls, or natural student growth is not distinguishable, but my cooperating teacher believes that it was both. In order to be productive, students must be attending to their work. Therefore, because more students published their writing on time, student attentiveness has increased.

The Importance of Choice. This was an unexpected code, but I believe it is the most important to my study. I found that above all other things; this was why the stability balls are important. My cooperating teacher said, "I like that they (students) get a choice every morning if they want to sit on the chair or on the ball just adding one more thing that gives them ownership over their own learning throughout the day. I think it's beneficial." This major theme was connected through all aspects of my research. Students *chose* a ball or a chair. Students *chose* how to move on the ball or if they wanted to sit still on the ball. Students *chose* how hard they would work while being seated on the ball.

Every student I interviewed, and I would imagine all of the other students in the class, would agree that choice is very important in the classroom. According to Kimberly, "...sometimes people don't really want to sit on the balls and if they don't have a choice, they have to sit on it. If people want to sit on the ball, but they have a chair they may want to have a choice to switch it". When I asked Brielle what she liked about the stability balls she said, "That sometimes you can switch out your ball for a chair and you can just...I like where you can use a chair and you can have to switch for a chair. I asked her why she liked that they could switch a ball for a chair and she said, "Because if you start feeling like I don't want the ball

today, I can switch it out for a chair. I like that my cooperating teacher didn't get rid of them (the chairs). Even though I don't switch it (the ball) out, it's still a good idea."

Figure 7. A portion of a student's survey.



The survey in Figure 7 shows that Sadie wanted a choice. She wanted to be able to choose between a ball or a chair. I did not think to include a both option on this survey, but I wonder how it would have impacted the data in my study. Four students who took the survey would prefer a chair, one student would prefer both, and 14 students would prefer to use the stability ball. In Sadie's interview I asked if she had to use a stability ball or a chair for the rest of the year, she responded, "If it was the first day of school, I would use both. But if you could only use one, I would rather do the ball because I've only done the chair in the beginning of school..." When I asked Kimberly the same question she said, "Mmm both at a different time...like maybe I would choose a ball for a few days and then the chair for a few days."

These responses about the stability balls and choices are important because they imply that students may need even more choices. During a few of the interviews I asked students about some additional options they might like in the classroom. Some of their responses included the following: cloth seats, cushions, rolling desk chairs, stability balls with printed patterns or different colors, stability balls that have backs, and stability balls that will not roll away. Jenny said, "I like you have the choices of sitting on stability balls or chairs." Students did not seem to really be concerned with what type of seating was offered, as long as there was more than one option.

Implications

Teachers and the education community often discuss the importance of choice in student learning, but the conversation is now beginning to shift also toward student choice in classroom seating. This is opening up a whole new realm of student ownership and meeting

the needs of all students in the classroom. I know that all students need different things when it comes to instruction, and I would also argue that this also applies to seating in the classroom.

In order to learn, students need to be comfortable, focused, and willing to work. When teachers give students the option to choose where they will learn and work best, we empower them and teach them how to make decisions that will meet their own needs. The option of sitting on a stability ball impacted student learning by making the classroom more student-centered. While student engagement seems to depend on subject matter and student interest in individual activities, attentiveness and productivity may be impacted by the use of stability balls in the classroom.

Movement and student attentiveness were very closely related in my study. According to the students, most of them felt that the ball helped them focus because it allowed for movement. Students recognized that having to sit still in a chair sometimes negatively impacted their posture and constricted possible movement. Students like that the stability balls allow them to bounce while they work. While they may not have realized the neurological implications of this movement, they did understand that movement could positively impact their focus and their learning.

My most significant finding was the importance of choice when it comes to classroom seating. Whether or not the students liked the stability ball or the chair better wasn't as significant as how much students and the teacher valued having a choice. Teachers want to empower students, give them what they need, and help them learn. One way we can do this is by considering the use of seating other than the standard desk chair.

My cooperating teacher suggested in her interview that teachers try alternative seating. This doesn't have to be a major change or even something that happens all in one day. Teachers can start by introducing one stability ball or another form of seating at a time to their classroom. Once a teacher feels more comfortable, he or she can introduce more options for seating. Other teachers may want to implement flexible seating, which is when there are several seating options and students may choose daily where they would like to be. There are no hard and fast rules to alternative and flexible seating, rather the teacher gets to try different things that might work for his or her students.

When considering alternative or flexible seating options, teachers should consider searching for grant money through various websites or through school districts. There are also websites teachers can use to get donations from the public. Teachers can submit a story about what they would like to buy why they need money. These websites will then allow people to make donations toward your specified need, and when your project is fully funded, they will ship the requested supplies to your school. Do not let the thought of expenses shy you away from considering alternative seating.

While this study on alternative seating was important and very informative, I am left with questions about how students would respond to alternative and flexible seating arrangements. I love that the students had choice between a chair and a stability ball, but what would happen if even more seating options were introduced? Is there a correlation between flexible seating or alternative seating and academic performance? How do multiple seating options impact student attentiveness and productivity?

This research will impact my future practices because I know how important it is for students to have different seating options. I know that some students need seating that will allow movement while they are seated. Other students need to be still, and may prefer cushions, couches, or sitting on the floor. Knowing that students need choices, I will be able to begin searching for different seating options for my classroom.

Conclusion

Using stability balls as alternative seating was a great way to introduce more student choice in the classroom. While most students thought it was fun to bounce while they worked or felt like it helped them focus, this was not the case with all students. Above all, choice was shown to be very important to both students and the classroom teacher. I am excited to see how new trends in classroom seating impact classroom environments and student workspaces.

I realize that flexible seating may not be realistic for every teacher, but I think it should at least be considered. When students can pick if they're standing, or sitting in a chair, on a ball, on the floor, they are more likely to get what they need. If implemented well, I think flexible seating or having many different seating options could improve behavior management and help students stay focused for longer periods of time.

About the Author

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References

Aminian, S., Hinckson, E. A., & Stewart, T. (2015). Modifying the classroom environment to increase standing and reduce sitting. *Building Research & Information, 43*(5), 631.

Bronfenbrenner, U. (1979). *The ecology of human development*. Cambridge, MA: Harvard University Press.

Burgoyne, M. E., & Ketcham, C. J. (2015). Observation of classroom performance using therapy balls as a substitute for chairs in elementary school children. *Journal of Education and Training Studies*, *3*, 42–48.

Erwin, H. E., Fedewa, A., Soyeon, A., & Thornton, M. (2016). Elementary students' physical activity levels and behavior when using stability balls. *American Journal of Occupational Therapy*, *70*(2), 1-7.

Fedewa, A., Davis, M. A. C., & Ahn, S. (2015). Effects of stability balls on children's on-task behavior, academic achievement, and discipline deferrals: A randomized controlled trial. *American Journal of Occupational Therapy*, *69*(2), 1–9.

Fedewa, A. L., & Erwin, H. E. (2011). Stability balls and students with attention and hyperactivity concerns: Implications for on-task and in-seat behavior. *American Journal of Occupational Therapy*, *65*, 393–399.

Gaston, A., Moore, S., & Butler, L. (2016). Sitting on a stability ball improves attention span and reduces anxious/depressive symptomatology among grade 2 students: A prospective case-control field experiment. *International Journal of Educational Research*, *77*, 136–142.

Goodmon, L. B., Leverett, R., Royer, A., Hillard, G., Tedder, T., & Rakes, L. (2014). The effect of therapy balls on the classroom behavior and learning of children with dyslexia. Journal of Research in Education, 24, 124–145.

Hanscom, A. (2014, July 8). Why so many kids can't sit still in school today. *Washington Post*. Retrieved from https://www.washingtonpost.com/news/answer-sheet/wp/2014/07/08/why-so-many-kids-cant-sit-still-in-school-today/

Hubbard, R. S., & Power, B. M. (2003). *The art of classroom inquiry: A handbook for teacher-researchers* (Rev. ed.). Portsmouth, NH: Heinemann.

Jensen, E. (2005). *Teaching with the brain in mind* (2nd ed.). Alexandria, VA: ASCD.

Mead, T., Scibora, L., Gardner, J., & Dunn, S. (2016). The impact of stability balls, activity breaks, and a sedentary classroom on standardized math scores. *Physical Educator*, *73*, 433–449.

Patton, M. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.

Schilling, D. L., & Schwartz, I. S. (2004). Alternative seating for young children with autism spectrum disorder: Effects on classroom behavior. *Journal of Autism & Developmental Disorders*, *34*, 423–432.

Tracy, S. J. (2013). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*. Chichester, West Sussex, UK: Wiley-Blackwell.

Wendel, M. L., Benden, M. E., Hongwei, Z., & Jeffrey, C. (2016). Stand-biased versus seated classrooms and childhood obesity: A randomized experiment in Texas. *American Journal Of Public Health, 106*, 1849-1854.

Wyatt, K. (2009). Stability balls let kids get rid of the wiggles. Retrieved from http://www.sfgate.com/education/article/Stability-balls-let-kids-get-rid-of-the-wiggles-3168996.php

Appendix A: Student Survey

Student Survey

1. Do you like to use the stability balls?


yes


sometimes


no

2. Do the stability balls help you stay focused?


yes


sometimes


no

3. How often do you choose to sit on the stability ball?


always


sometimes


never

4. Would you rather sit in a chair or on a stability ball?


chair


Stability ball

5. Do you think moving while you are at your desk helps you learn?

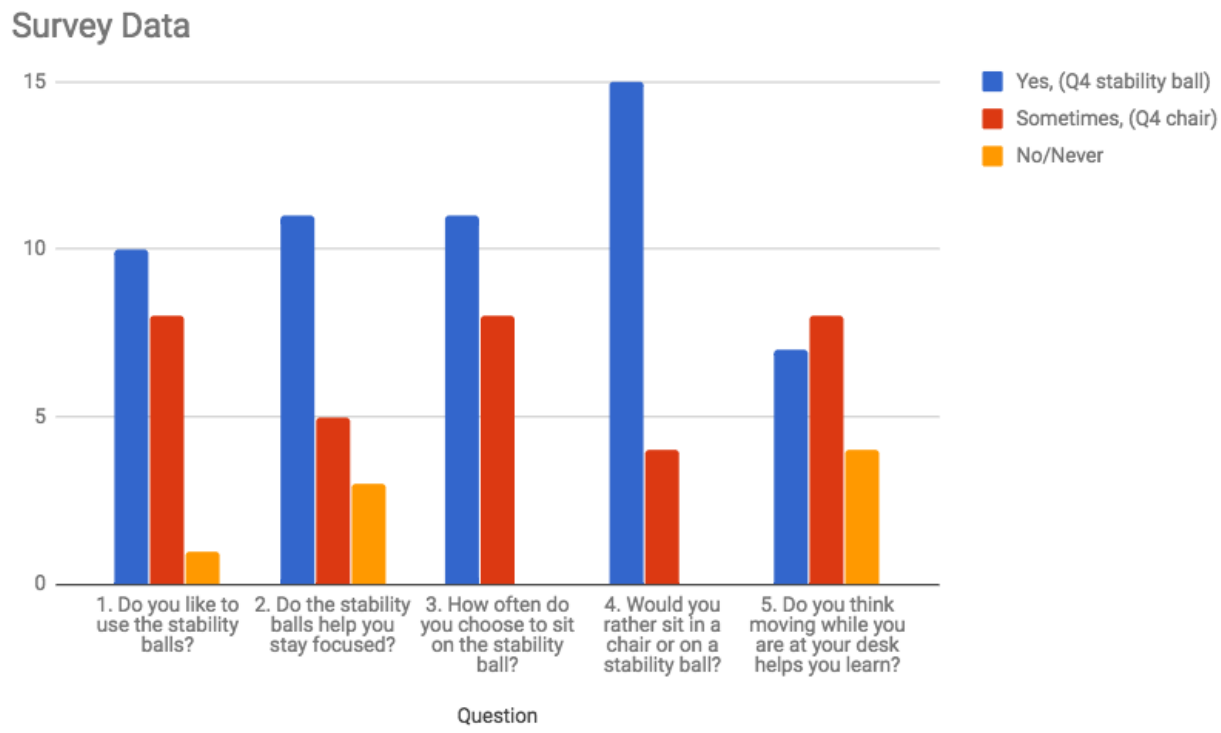
yes

sometimes

no

1. What do you like about using the stability balls?
2. Is there anything about using stability balls that you don't like?

Appendix B: Survey Data and Codebook



Question	Yes	Sometimes	No/Never
1. Do you like to use the stability balls?	10	8	1
2. Do the stability balls help you stay focused?	11	5	3
3. How often do you choose to sit on the stability ball?	11	8	0
4. Would you rather sit in a chair or on a stability ball?	Ball: 15	Chair: 4	
5. Do you think moving while you are at your desk helps you learn?	7	8	4

1. What do you like about using the stability balls? (Each sentence is a different student's response.)

I can move. It helps me learn reading. They're teal and teal is my favorite color and they bounce. Help me be focused. They're comfortable. Bounce. They're bouncy. Helps my tailbone. The balls you can bounce on them. I like how they bounce up. You can bounce. That you can bounce. That you can move. They're fun to bounce on, but some of the balls are not bouncy.

2. Is there anything about using stability balls that you don't like? (Each sentence is a different student's response.)

They're bouncy. Nothing. No. I lose them. Falling down. I don't like when the stability ball moves. I do not like bouncing.

Codebook			
Code Name	***Level***	***Definition***	***Example***
AT-always on task	1	Behaviors that show a student is always on task	"Writing the whole time, worked quietly, worked the whole time"
MT-on task most of the time	1	Behaviors that indicate a student is on task most of the time	"talking to neighbor, looking around the room, wrote most of the time"
RT-rarely on task	1	Behaviors that indicate a student is rarely on task	"getting up often, talking to neighbor, playing with supplies on desk"
Sitting still	1	Any mention of sitting still	"I get tired of bouncing around and I would just like to sit still."
Money and grants	1	Mention of money or grants	"If I hadn't gotten them through a grand then I could've done things like donors choose..."
Order delay	1	Mention of the delayed delivery of the stability balls	"I purchased it and I waited and waited and it said it was going to take like two months to get here."
Ball design	1	Mention of the stability ball design or how the design could be improved	"I like that they have feet on the bottom."
Research	1	Mention of my mentor teacher's research	"There wasn't a lot of research about the use of it with gifted students, but there is a lot of research with students with Attention Deficit Disorder..."
Donors choose	1	Discussion of the donors choose website	"...it's attached to your school it's a legitimate thing, but basically you get on there and you say what you're wanting...and then people can get on there and they can donate money to you..."
Correct ball use	1	Discussion of how to correctly sit on and use the stability ball	"...it's not a toy it is our chair and that it's not a soccer ball or a bowling ball or any kind of ball like that..."
Meeting student needs	1	Mention of how teachers can meet students' needs	"I think that students and how students learn are changing and I think that this is one way that teachers are trying to

			figure out a way to keep up with what students need..."
Distraction	1	Discussion of how the stability ball can be a distraction	"Sometimes they can actually distract you from working."
Exercise	1	Mentions of the stability ball being used for exercise	"I think they help me a little bit...because it's a good form of exercise."
Safety	1	Mention of safety or something not safe in relation to sitting on the ball	"Because if you lean back your stability ball you can fall over and get very injured."
Posture	1	Mention of sitting posture	"And also for good posture, it's helpful for your back."
Fun	1	Mention of the stability ball being fun	"Cause chairs, they're kinda boring, and balls are fun."
On the rug	1	Mentions of wanting to use the ball on the rug	"What I want to change about the stability balls is that we can sit on them on the rug."
Behavior management	1	Discussion of behavior management in relation to the stability balls, including the mention of rules, or consequences	"So they kind of get a warning and so if they're still not sitting on it correctly they need to switch back for their chair."
Movement	2	Anything that mentions movement while seated on the ball	"And this is how I think they help you learn because you get to ounce and that kinda helps your brain keep thinking..."
Choice	2	Anything that indicates student choice related to classroom seating	"I like how you have choices of sitting on stability balls or chairs."
Attentiveness	2	Any mention of student attentiveness, focus, paying attention, or on task behaviors	"They help me stay focused when I'm really anxious cause I want to get done really fast and I like how it keeps me focused."