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Using the growth mindset to improve opportunities for negotiation in argument-based inquiry elementary classrooms

Bridget Tharp
University of Northern Iowa

USING THE GROWTH MINDSET TO IMPROVE OPPORTUNITIES FOR NEGOTIATION

IN ARGUMENT-BASED INQUIRY ELEMENTARY CLASSROOMS

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Bridget Tharp

University of Northern Iowa

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Date Mason Kuhn, Honors Thesis Advisor, Curriculum & Instruction

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Date Jessica Moon, Director, University Honors Program

Abstract

The purpose of this study is to evaluate if teaching students about the growth mindset improves achievement on standardized science assessment in a classroom that uses argument-based inquiry (ABI) instruction. A critical part of ABI is also referred to as negotiation and is considered cognitively demanding for students. The demands of argumentation often make its implementation extremely challenging for teachers because students often do not have strategies to overcome the failure they will encounter during the process. ABI is a research-based instructional practice that has been shown to improve student learning in science. This study will look at specific aspects of ABI and ways to improve student negotiation. Specifically, I was interested if including the growth mindset will help teachers with the rigor of ABI instruction. In order for meaningful negotiation to take place, students must develop their claims, back them with evidence, and critique the claims of others. Deciding that an alternative claim has better evidence than the student's current claim is not always easy to accept, and that is why teaching the growth mindset could greatly impact students' ability to overcome their false beliefs and recognize that failure is a part of learning. To determine if lessons about the growth mindset led to more meaningful ABI experiences, a quantitative analysis of Iowa Assessment Science scores was conducted through a one-way analysis of variance (ANOVA). Students in the study showed statistically significant growth in their science scores from third grade (where they did not learn about the growth mindset) to fourth grade (where they did learn about the growth mindset), which is encouraging data for teachers who use the growth mindset as a part of their ABI instruction.

Introduction

Argument-Based Inquiry (ABI) is a specific type of science instruction that focuses on the construction and critiquing of ideas. Inquiry based science approaches, when tested, have been proven to improve student outcomes on standardized assessments. Even though ABI is considered a successful inquiry based science instructional approach, many districts have not implemented it into their science curriculum. In fact, the majority of schools are still learning science through textbooks and other non-inquiry based approaches. ABI, in the classroom, places high cognitive demands on the students, which could be a challenge for many teachers, because most students have not had to ask student to perform at the level of rigor promoted in ABI. Some students are not used to be challenged, and students may want to give up. A possible solution to this problem is the growth mindset. The growth mindset teaches students that their knowledge is not innate and if they put in the effort they can overcome hardship. If the growth mindset can help students preserve through the cognitive demands of ABI, then more teachers might be willing to change their science instruction to inquiry-based learning.

Literature Review

Over the last few decades, many researchers (e.g., Bricker & Bell 2008; Berland & Reiser 2009; Oral 2012) have supported the notion that ABI is a valuable method of instruction in science, and that it leads to improvement in student learning. ABI is an example of a successful inquiry-based science instructional approach. Though current research has been limited, when tested, inquiry-based science instruction has proven to improve standardized test scores, understanding of content and process, and student achievement as a whole (Marx et al. 2004). Kahle et al. (2000) focused specifically on the improvement of student achievement during inquiry instruction. The results showed that African American students' overall achievement did increase when being taught through an inquiry approach (Kahle et al. 2000). According to past research and others like them (e.g., Taylor et al., 2011), the aspect that changed student outcomes was the teachers' implementation of the inquiry approach. In Taylor et al. (2011), teachers were evaluated by their ability to utilize dialogic feedback, which can be considered the impetus behind quality inquiry instruction.

In 2015, the state of Iowa became the fifteenth state to adopt the Next Generation Science Standards (NGSS) as their state's science standards. According to the National Science Teacher Association, there are currently 18 states, not including the District of Columbia, that have adopted the NGSS and more states are considering including them as their science curriculum (NSTA, n.d.). As school districts across Iowa transition from a curriculum based on the science standards in the Iowa Core to the new Iowa Science Standards aligned with the NGSS a number of issues are likely to occur. The previous Iowa Core Science Standards were written to promote inquiry, but the NGSS go a step further and support a specific type of inquiry: argument-based inquiry (ABI). All K-12 Performance Standards in the NGSS are built on a framework that suggests students should be active in research design and construct claims based on evidence. The eight science and engineering practices (SEP) that all performance standards are built upon, state that students should be able to (NGSS, Lead States, 2013):

1. Ask questions (for science) and define problems (for engineering)

2. Develop and use models

3. Plan and carry out investigations

4. Analyze and interpret data

5. Use mathematics and computational thinking

6. Construct explanations (for science) and design solutions (for engineering)

7. Engage in argument from evidence

8. Obtain, evaluate, and communicate information.

As indicated by the SEPs, the authors of the NGSS want students to be engaged in robust argumentation, also referred to as negotiation, with their peers as they learn the science content. The change from argumentation to negotiation is crucial for teaching science in an elementary school. Schoerning and Hand (2013) emphasized the importance of using the term negotiation:

> The meaning of argument in this context can be confusing to students, especially younger children. The word argument can carry negative connotations. During arguments people are often aggressive or mean, only one person wins and talk often becomes personal instead of remaining centered on concepts and ideas. Negotiation doesn't have these negative connotations. In a negotiation people work together to build and refine ideas and solutions. Nobody wins a negotiation; the ideas and solutions that come out of negotiation benefit everybody involved. (p. 42)

The National Science Education Standards (which were the foundation of the Next Generation Science Standards) stress the need for students to be active learners, use inquiry, and to communicate their reasoning and understanding with their peers (Hand, Norton-Meir, Staker, Bintz, 2009). If teachers are not competent in pedagogy that engages students in these practices, it is likely they will struggle to meet the expectations of the new Iowa Science Standards. These standards, however, help provide students with valuable experiences that are the foundation for the scientific practices that takes places early on in scientists' research: "Scientists are involved in posing questions, making claims, providing evidence, debating with each other, comparing their answers with others in the field, and attempting to look for patterns across their results" (Norton-Meir, Hand, Hockenberry, & Wise, 2008, p. 2).

The practice of science is fundamentally social and researchers support the idea that students should be involved in the same social practices as scientists (Ford, 2012). Traditional instruction in science usually consists of using the scientific method and laboratory reports (Duschl et al., 2007; Flup, 2002; Osborne et al., 2003). When teachers have students engage solely in activities based on the traditional laboratory report, they are being deprived of critical learning experiences. Scientists use the standard sequence of hypothesis, procedures, observations, results, and discussion when they are getting ready to publish their findings, but they rarely use this lock-step approach when they are learning about the phenomena. When reflecting back on the NGSS, it is clear that inquiry and argumentation is an essential component of science education. As Berland and Reisner (2009) put it, "If the goal of science education is to foster student participation in scientific practices then our understanding of explanation must expand to include the process of constructing these explanations…in scientific communities, explanations are developed through argumentation" (p. 27).

As mentioned earlier, one way to accomplish the goals of the NGSS is through ABI. Two critical components of ABI are when students are asked to both construct their knowledge and critique the claims of others. Students construct knowledge by posing questions, experimenting, generating claims, testing, critiquing the claims made by others, challenging norms, and reaching agreements. Each of these activities require a student to be vulnerable to the unknown part of the process. A teacher who implements ABI with fidelity would allow students to struggle with ideas and debate each other without telling them who is right or wrong. This approach will lead to times when students fail at their experiments. These failures can be used as learning opportunities if the teacher allows the students to reflect and grow from the experience. The process of argumentation has been a central focus for science education because of its potential to stimulate understanding of content and to hopefully help students want to learn for their own benefit, or as Bricker and Bell (2008) surmised: “Argumentation as a learning process, is an outcome associated with the appropriation of scientific discourse, and as a window onto the epistemic work of science” (p. 473).

In the majority of schools, both K-12 and in higher education, science is being taught through textbooks, "cookbook" labs, and rote memorization (Hand, Wallace, & Yang, 2004). In this traditional mode of instruction, students lack a sense of autonomy and are not given opportunities to engage in interactive dialog. This method of instruction is likely affecting students' perception of science and the Nature of Science (NOS). The effect of cookbook labs and rote memorization can also be recognized through the national science assessments scores. In fact, the National Assessment of Educational Progress (NAEP) shows that from 2009 – 2011 there were not any statistically significant gains in science scores (Martin, Mullis, & Foy, 2012). The Trends in International Math and Science Study (TIMSS) also shows that achievement scores on national science assessments are not increasing. In the report, it revealed that there was no measurable difference between U.S. fourth grade science scores in 1995, 2007, and 2011 (Martin et al., 2012, p. 539-544). This data proves that traditional instruction (cookbook labs, rote memorization, etc.) is not successful in increasing student achievement on national science assessments.

Recent studies have shown that inquiry-based approaches are likely to improve student achievement. The results from two meta-analyses of inquiry approaches showed that inquiry-based approaches, increase student performance (Hattie, 2009). Argument-based inquiry is cognitively demanding for the students. When the students are engaged in the practices of actual scientists, they are likely to increase their scientific literacy (Kuhn, 2015). Even though research has shown that teachers who use ABI have students who outperform their counterparts who use traditional instruction there is still much to learn about quality implementation of ABI. The next section will describe one way that an individual might improve ABI instruction.

Growth Mindset

The ABI approach has many positive benefits for students; however, this approach does come with its challenges. When students experience a failure or an exceedingly difficult problem, some students may feel tempted to give up. The growth mindset could improve ABI by teaching students that with hard work and dedication a person's knowledge can grow—through the acknowledgment that they have the capability to overcome adversity.

Asking students to engage in argumentation adds another level of rigor to science instruction. Students need to be able to persevere through the demanding tasks and accept that sometimes they might fail and recognize that failure is an essential part of learning. Dweck (2006) defined the growth mindset as "the belief that abilities can be cultivated" (p. 50). The growth mindset is truly about believing that if a person puts in the effort, they can learn anything and become smart or talented (Dweck 2006). Students who have a growth mindset tend to possess some of the following characteristics: "seek out opportunities to learn, extend beyond assignment requirements, pursue learning opportunities both in and out of class, embrace and persist in the face of challenge, and utilize both feedback and study strategies to improve" (Esparza, Shumow, & Schmidt, 2014, p.10). The growth mindset pushes students to obtain the most out of every learning experience and persevere through challenges. Dweck (2006) classified those who have an opposing view about intelligence as having a fixed mindset.

The fixed mindset is the belief that a person's intelligence has a limit. In this mindset, success is determined by a person's innate abilities and not their effort. In fact, effort is useless in the fixed mindset because smart people should not have to try hard and people who do not have intelligence should not waste their time because they are not smart enough to achieve the same standard as those who have intelligence (Dweck, 2006). These students feel they must prove they are smart or talented to be recognized as successful (Dweck, 2006). Since students with a fixed mindset believe their knowledge is static, they are more likely to adopt "maladaptive and counterproductive educational patterns" (Esparza, Shumow, & Schmidt, 2014, p. 10). The significant difference between a fixed and a growth mindset lies in the way that they respond to individual experiences (Dweck & Leggett, 1988). When students with a fixed mindset fail they create a sense of self-doubt where they believe that success is unattainable (Dweck, 2006). Anytime a student fails at a task it signifies that they will never be able to succeed, no matter how much effort they put in. Students with the growth mindset, however, look at the failed task as a setback, but also a learning opportunity. Having a growth mindset does not mean that failing will not affect the individual's emotions—it can still be incredibly distressing. However, individuals with a growth mindset do not let failure define them. They face the problem, come up with a solution, and learn from the experience (Dweck, 2006).

Dweck (2006) argues that everyone begins life with a growth mindset. All people start out as individuals who seek new experiences and love learning. Consider a toddler; they are always watching, listening, and learning about every experience around them. When they attempt to walk for the first time and fall, they do not just give up and crawl the rest of their life (Dweck, 2006). In fact, Dweck (2006) makes a powerful statement about the power of a mindset in regards to learning: "people are all born with a love of learning, but the fixed mindset can undo it" (p. 53). A fixed mindset can greatly impact a person's motivation to learn, and it can also affect a person's thinking. Vandewalle (2012) mentions that there are several studies that indicate that a person with a fixed mindset is less likely to consider alternative points of view. Heslin, Latham, and Vandewalle (2005) researched performance through multiple studies of appraisal accuracy. In their first study, nuclear power plant managers evaluated videos of a worker engaging in a negotiation task. They did not know that the worker was an actor. First, the managers watched two videos of a worker underperforming. Then they were instructed to give the worker an evaluation. Then the managers watched two videos of the same worker, but this time the worker was exceeding expectations. Heslin, Latham, and Vandewalle (2005) used a variety of scales (Behavior Observation Scale (BOS), Implicit Person Theory (IPT), and Likert-type) to see "whether a manager's IPT affects his or her appraisal of a positive change in an employee's initially poor performance" (p.844). The results of the managers' evaluations showed that some of the managers were able to recognize the change in performance more than others. This study directly relates to Dweck's growth mindset. It is likely that the managers that who did not have a growth mindset did not see a change in performance because they think of knowledge as innate. They might have had the perception that even if that worker is dedicated they will not be able to get better. The managers who recognized the change in performance likely had a growth mindset because they did not categorize them as "failures." This shows the power of an individual's mindset.

Teachers can also play a major part in a student's mindset. When researching the effect of teacher behaviors Schmidt, Shumow, & Kacker-Cam (2015) concluded: "when teachers behaviors were observed to be supportive of a growth mindset, students adopted stronger mindset beliefs and were more likely to maintain these beliefs over time" (p. 31). On the other hand, if a student holds a fixed mindset and experiences failure they are more likely to permanently think of themselves as failures.

The growth mindset has the potential to make an overarching impact on student performance, by increasing their sense of self-worth and overcoming failure. It has been concluded that the theories of intelligence do have a positive impact on academic achievement (Blackwell, Trzesniewski, & Dweck, 2007). These theories are important because it shows how students view their intelligence, which certainly impacts the concept of mindset. The growth mindset has been studied thoroughly in correlation with socioeconomic strata. Claro, Paunesku, and Dweck (2016) concluded, “a growth mindset (the belief that intelligence is not fixed and can be developed) is a comparable strong predictor of achievement and it has a positive relationship with achievement across all of the socioeconomic strata” (p. 8664). Throughout this section the benefits of the growth mindset have been presented. In the following section the case for including the growth mindset as a part of ABI instruction will be made.

Benefits of the Growth Mindset in ABI Instruction.

ABI is a well-researched topic that has been proven to be effective in science education. ABI encourages students to take risks and learn from failure. When students take risks, the consequence is that many times they will fail. ABI teachers encourage students to engage in inquiry prior to learning the scientific concepts. For example, before teaching anything about gravity, a teacher might ask their students to explain, in their own words, why a paper ball and a rubber ball hit the floor at the same time when dropped from an identical location. The teacher would not teach the science behind the activity until students had a chance to create their own reasoning and explore the thinking of others. Since the students do not learn about the scientific concepts until after the demonstration, it ensures that a significant percentage of students will have to alter their original ideas. If students have a fixed mindset, they might be unwilling to try again because of their perceived notion that they are now a failure. This unwillingness to further engage in inquiry will restrict their learning and understanding of the scientific concepts. The students with the growth mindset may be more likely to take the leap and engage in inquiry and trial and error. If the growth mindset encourages students to engage in inquiry, then the growth mindset may be a significant asset to ABI. This research will work as a pathway for educators to delve deeper into the possible correlation between ABI and the growth mindset, therefore, by enhancing quality science instruction the field of education.

Methodology

This study focused on the influence of the growth mindset on ABI instruction, and how this affects student achievement. The significance of the growth mindset was measured using the students' Iowa Assessment Science scores using a one-way analysis of variance (ANOVA). Using this analysis, the significance of the growth mindset would be quantifiable.

The null hypothesis of this study was that if the growth mindset was included as a part of instruction in an argument-based inquiry (ABI) classroom, then there would be no improvement on student performance on the science portion of the Iowa Assessments. The alternative hypothesis of this study was that if the growth mindset was included as a part of argument-based inquiry (ABI), then student performance would improve on the science portion of the Iowa Assessments.

The participants in this study include third and fourth graders from four schools in a mid-sized school district in the Midwest of the United States. The district has a total of 2,183 students, 21.21% of which are eligible for Free and Reduced Lunch. The district has a low number of minority students with 92.8% of its students being white and 0.5% being considered to have a Limited English Proficiency (LEP). These teachers were chosen based on their prior training in Science Writing Heuristic (SWH), which is an approach to teaching science that was developed out of ABI research. The teachers' district uses the NGSS standards as a guide for their science curriculum.

This study worked with human participants; therefore, it was necessary to submit an application to the Institutional Review Board (IRB). The application was completed and approved in November of 2016. After the IRB was completed, the teachers participated in a short professional development about the growth mindset. In addition to attending an hour lesson that demonstrated the importance of the growth mindset and teaching strategies that have the potential to promote it with their students, each teacher received a copy of Carol Dweck's book *Mindset.*

After a few weeks, my advisor and I traveled to the classrooms of the teachers who agreed to participate in the study. We introduced the concept of the growth mindset through a short lesson and a discussion of the book *Ada Byron Lovelace and the Thinking Machine.* During the read aloud questions were posed about the growth mindset, and during the discussion students participated in a brainstorming activity that prompted them to think about why Ada Byron did not give up. Subsequently, each classroom teacher was presented with the book *On a Beam of Light: A Story of Albert Einstein.* At another time during the school year, the teacher read the book to the students to further discuss the growth mindset. In addition to our professional development and mini-lesson the school district introduces the growth mindset to the students in fourth grade through multiple session from the counselor; therefore, the students received information about the growth mindset from both their guidance lessons and their science instruction. Growth mindset lessons were only taught in fourth grade as a part of the guidance curriculum in the district.

At the end of the school year, a list of students' National Science Scores (NSS) scores on the Iowa Assessments was collected. No student names or identifiers were collected: only a list of the NSS scores. The district's curriculum director provided the students' NSS from third grade and fourth grade to analyze if statistically significant growth was obtained (note: All of the third grade teachers in the district have received the same SWH training as the fourth grade teachers and only scores of students who took the Iowa Assessments in the district in third and fourth grade were used in the analysis). Then a variety of t-tests and a one-way analysis of variance (ANOVA) were used to determine if there was a statistically significant change in the students' science scores to determine if the null hypothesis could be rejected.

Results

This study evaluated if including the growth mindset as a part of argument-based inquiry (ABI) improved student performance on the science portion of the Iowa Assessments. By examining the district's NSS scores and proficiency levels from the 2016-2017 Iowa Assessments it became evident that the growth mindset could have improved the students' scores. The first analysis looked at the data from a proficiency standpoint. We used this data to see if there was a visible change in proficiency for the district in comparison to the state and the AEA. The following analysis revealed the students' NSS raw scores and allowed us to compare these scores to the state and AEA. In the third analysis, a variety of t-tests were used to see if the change in NSS scores for each school was statistically significant. However, these results only accounted for each school individually. In the t-test, the significant change could be attributed to two or three of the four schools. To give us a better view of the schools as a whole, we performed a one-way analysis of variance (ANOVA) to see if the change was significant for all of the schools.

Figure I

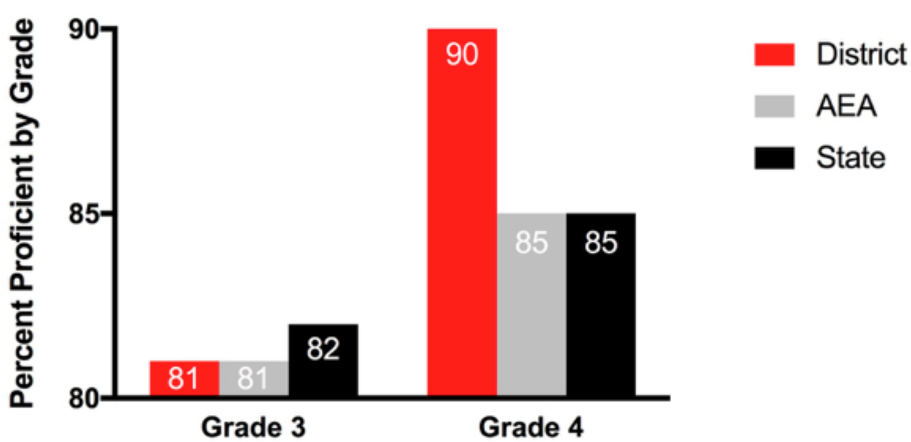
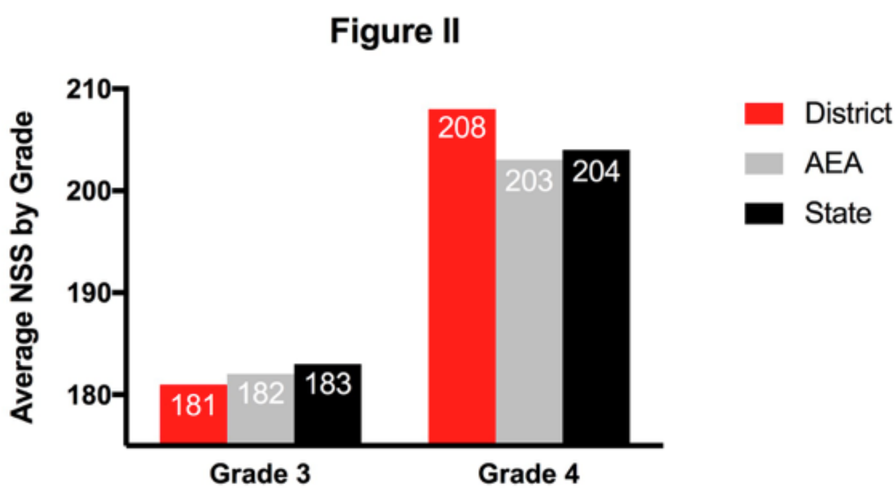
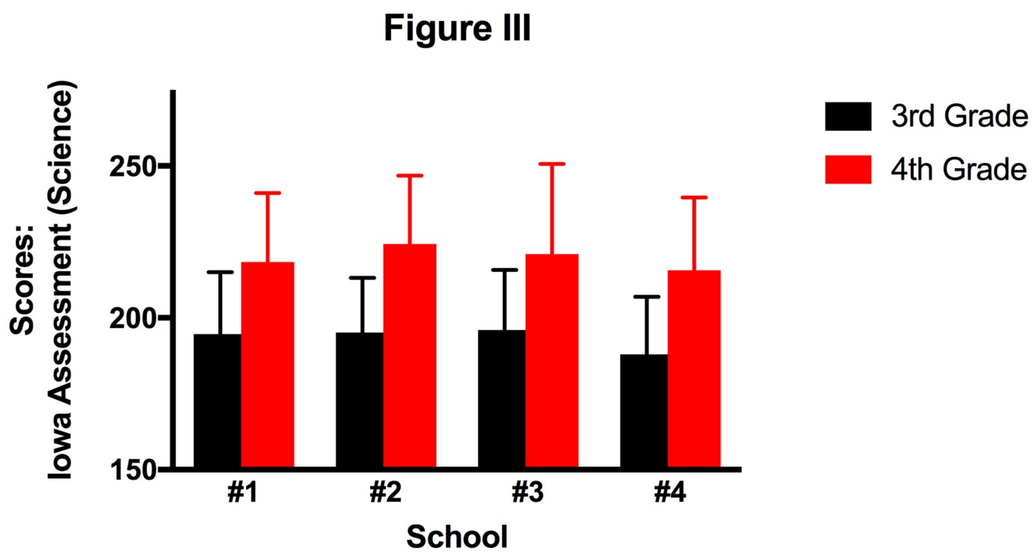


Figure 1 shows the percent of proficiency for the district, AEA, and the state of Iowa for the Iowa Assessments for Science. From third to fourth grade the district's proficiency levels increased 11.1%. The proficiency levels for the state of Iowa increased by 4.9% and the proficiency levels for the AEA increased by 3.7%. Figure 1 shows that the students in the district improved at a much higher rate on the science section of the Iowa Assessments than students in the same AEA and the state. This data demonstrated the need for further investigation on the correlation between the district's third and fourth grade scores.



When taking a closer look at the district's scores, it was evident that there was a substantial increase in NSS from third to fourth grade. Students scored significantly higher in fourth grade (SD= 24.3) as opposed to third grade (SD= 19.2). In fact, the district received a much larger increase than both the state and the AEA. The increase from third to fourth grade for the district increased by 14.9%, which was statistically significant at the .0001. This data, in addition to Figure 1 demonstrated the need to look closer into the data from each school within the district.



A paired-samples t-test was used to determine whether there was a statistically significant mean difference between the students' third and fourth grade scores. No outliers were detected. Students scored higher in fourth grade (SD= 22.8, 22.5, 29.7, 24.0) as opposed to third grade (SD= 20.4, 18.1, 19.8, 18.9). To further determine if these results were significant a one-way ANOVA was performed.

Figure 4

Analysis of Variance (One-Way)

Summary						
Groups	*Sample size*	*Sum*	*Mean*	*Variance*		
3rd Grade Scores	176	33,827.	192.19886	370.24023		
4th Grade Scores	176	38,596.	219.29545	591.23792		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*p-value*	*F crit*
Between Groups	64,611.82102	1	64,611.82102	134.40102	0.	3.86816
Within Groups	168,258.67614	350	480.73907			
Total	232,870.49716	351				

A one-way ANOVA was conducted to determine if the students' fourth grade scores increased in comparison to the students' third grade scores. For the final analysis, an ANOVA was selected because our study included four different teachers in four different schools. All of the teachers received the same amount of instruction, but fundamentally, the level of implementation will differ from teacher to teacher. In the previous analysis, we aggregated all of the student scores in one t-test, but since each teacher is different, we wanted to see if there was any difference between groups. Multiple t-tests were considered for the final analysis, but, every time a t-test is conducted there is a chance that a Type I error will be made. Type I errors can lead researchers to claim that an effect or relationship exists when in fact it does not, also known as a "false positive" (Cohen, 1988). An ANOVA controls for these errors and researchers can be more confident that any statistically significant result is not just the result of multiple tests.(Cohen, 1988).

An ANOVA was performed to help account for teacher differences, in their implementation of the growth mindset. Students' National Science Scores (NSS) increased from third grade (M=192.2) to fourth grade (M=219.3). The differences between these grades were statistically significant, $p < 0.\ 01$.The group means were statistically significantly different ($p < .05$). Since the students' scores were statistically significant between groups, it is likely that the growth mindset had some impact on their scores, and therefore, we can reject the null hypothesis and accept the alternative hypothesis.

Discussion and Limitations

Discussion

This study looked at the influence of the growth mindset on ABI instruction and student achievement on standardized science instruction. At the end of school year, the students took the

Iowa Assessment Science test. The results, as shown above, from the students' third and fourth grade Iowa Assessment Science scores indicate that there was a statistically significant increase. These data support the alternative hypothesis and reject the null hypothesis.

The growth mindset helps students by reinforcing the idea that if they work hard, they can achieve their goals (Dweck, 2006). ABI instruction, specifically the negotiation aspect, can be incredibly challenging for students because they will likely suffer setbacks during the process. In fact, in the ABI approach, students are engaging in the same process as real-life scientists. This approach asks students to pose questions, create claims, find evidence, engage in argumentation, discuss their results with others, and analyze their results (Norton-Meir, Hand, Hockenberry, & Wise, 2008). Real scientists consistently experience failure because they are testing out new ideas and building upon their results when they do not come to fruition. The increase in the students' scores, therefore, could be attributed to the growth mindset and their ability to overcome setbacks.

Students rarely hear the message that failure can be used as a tool for learning. Instead, they are consistently told that failure is detrimental and should be avoided at all costs (Dweck, 2006). Students engaged in ABI may become discouraged if their claims do not match the evidence, and if they have a fixed mindset, they may give up. However, if a growth mindset has been taught, the students will revisit their data and possibly re-run their experiment to figure out why their ideas do not match the evidence. If students adopt the growth mindset, it could help them become less discouraged. The students' persistence through each investigation could have increased their comprehension of the content, which would have directly impacted their test scores.

As a preservice teacher, I have been able to share the growth mindset with a variety of different students. I will never forget the first lesson I taught with a group of colleagues about the growth mindset. In this lesson, students had to work together to cross a pathway. The pathway was made of 12 boxes (4 x 3). The students were split in half to make two separate teams. Students had to figure out the correct path, but only the person behind them could talk. If one of the teammates made a mistake, they would have to give advice to the next person. The task was not easy, and most students could not visualize the pathway quickly. However, student participation reached its peak during this activity. All eyes were on the pathway and students were giving positive advice and encouragement to each other. After both teams made it across the path, the students were split into groups to discuss the activity. During the discussion, one student said, "This activity was very challenging and we failed a few times, but that is ok because we never gave up and we worked together." Another student commented, "Even though we did not get it right away, it was nice having my team cheer me on and help me across." In this activity, the students' participation did not decline when someone stepped on a wrong square; instead, students were determined to overcome their group's setbacks. If students had given up during the activity, they would not have had the same experience. The growth mindset helped students to persevere through the activity even when things they faced adversity. The power of the growth mindset truly came to life in this activity: failure is not permanent.

Limitations

Even though the results showed that there was a statistically significant increase in the students' scores, we cannot say that the only variable that caused the change was the teaching of the growth mindset. In fact, there are many other factors that could attribute to this increase, including teacher beliefs about instruction, education level, etc. The students from third to fourth grade did not have the same teachers, but all of the teachers used the ABI instructional approach. Yet, we cannot assume that it was implemented the same way in each classroom. With a variety of teachers, there always comes a variety of experience. The varying approaches to ABI may have contributed to the increase in the students' scores, without even taking the growth mindset into account.

Another factor to consider is location. This study focused on one district in the Midwest. This district's diversity is certainly different than others: having a total of 2,183 students with only 21.21% eligible for Free and Reduced Lunch. Just because an approach works for one school district does not necessarily mean that it would work for another. In order to examine this factor more closely, this study would have to be replicated using a variety of different school districts. These school districts would have to vary in their population, size, socioeconomic status, and more. Duration also played a prominent role in this study; for example, we cannot assume that these results would be replicated in the same study if it was done with the following group of fourth-graders. In order to strengthen the argument for the teaching of the growth mindset, this study would have to be repeatedly performed over a more significant duration of time. This would definitely be an avenue for further research.

The application process through the Institutional Review Board was certainly a challenge I faced in this study. This was my first quantitavive academic research project; even though the process was demanding, I learned how quality research is conducted. Ultimately, the application process through the IRB made my research stronger.This study did involve human participants, which meant it was necessary to receive IRB approval. The original methodology consisted of only two of the four schools receiving the instruction of the growth mindset. The IRB ruled that this methodology would not be minimizing the potential for harm if the growth mindset proved to be beneficial. When using human participants, the study must not have a negative impact on the participants. In my original methodology, 50% of the district would not have received the growth mindset. If the research showed that the growth mindset benefited students, the 50% who did not receive the instruction would have been "harmed." Since the original methodology for this study was denied, it made it more challenging to design a study that would pinpoint whether the growth mindset was the cause of the increase. Even though the cause of increase may still be uncertain, the growth mindset is still a critical concept for students, teachers, and educators alike to understand and implement in their lives.

Implications for Educators

The Next Generation Science Standards (NGSS) are slowly being adopted across the United States. The NGSS standards put a major emphasis on negotiation. ABI directly aligns to the NGSS standards. When students are engaged in ABI, they are often asked to both construct and critique their own claims as well as those of their peers. This environment creates an opportunity for meaningful negotiation to occur amongst students. The process of negotiation is an important aspect of science education because it is cognitively stimulating. Even after considering its cognitive benefits, there are still numerous educators that are not using ABI as their instructional approach to science education.

Several schools still teach science through basic, less stimulating textbooks, “cookbook” labs, and rote memorization (Hand, Wallace, & Yang, 2004). These approaches do not align with the rigor of the NGSS. In the NGSS, the emphasis is on student involvement in negotiation. One way that students can engage in negotiation is through ABI. As previously mentioned, negotiation and the ABI approach are cognitively demanding for students. Educators will need to be equipped with strategies that will help them transition from traditional science instruction to ABI.

This study tested whether teaching the growth mindset could improve opportunities for negotiation. Based on the results of this study, it is probable that the growth mindset is a strategy that educators could use to help their students with negotiation. The growth mindset can boost negotiation because it uses failure as a learning tool. When students adopt a growth mindset, failure no longer becomes a roadblock, but rather an opportunity to persevere. With the design of negotiation and the NGSS as whole, it is likely that students' claims will not always be correct. In order for the students to build on their content knowledge, it will be necessary for them to overcome their failures and continue to critique and edit their claims. This rigorous process is likely to lead students towards making connections and fostering a deep understanding of scientific phenomena.

As states continue to adopt the NGSS, training will become available for educators to adjust their method of instruction to meet the needs of these standards. In order to account for the rigor of the NGSS, teachers should also consider learning about the growth mindset. The growth mindset will help students get the most out of each learning experience and persevere through challenges of negotiation tasks during science instruction. This study was designed to uncover the importance of ABI and to show whether the growth mindset could have improved the effectiveness of ABI. Learning about ABI is not enough; in order to witness the possible benefits of teaching the growth mindset, educators must incorporate it into their argument-based inquiry science instruction.

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