

Growth Mindset of Gifted Seventh Grade Students in Science

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ABSTRACT

Through secondary analysis of data collected in middle school science classrooms, this study (a) compared gifted and regular students' beliefs about the malleability of intelligence in science; (b) investigated whether teaching gifted and talented middle-school students about malleability of the brain and study skills helped them to develop a growth mindset (Dweck, 2000), and (c) examined whether there were teacher effects in the impact of the intervention. Compared to the general student population, gifted and talented students were more likely to endorse the idea that intelligence is malleable, but there was considerable variability

among gifted students' mindset beliefs. Results of a mixed between-within subjects ANOVA showed a large effect size in the impact of the six week mindset intervention (Brainology) among the gifted and talented students. While strong teacher effects on growth mindset were found among students in the general population who participated in the intervention, similar teacher effects were not found among the gifted and talented students. A growth mindset is particularly important for gifted students because they are at risk for both under-achievement and perfectionism, which may hinder them from reaching their potential.

Gifted students who reach their potential are likely to make contributions to society by solving problems and making advances in their chosen fields. Expertise in STEM fields like medicine, engineering, economics, and psychology is especially needed (Committee on Prospering in the Global Economy of the 21st Century, 2007). Unfortunately, many gifted students do not reach their potential (Adams et al., 2008), which has consequences for them and for society at large.

Under-achievement, perfectionism, and helplessness have been identified as barriers that contribute to academic disengagement and prohibit gifted and talented students from reaching their potential (Carr, Borkowski, & Maxwell, 1991; Fletcher & Speirs Neumeister, 2012; Roedell, 1984). Students with a growth mindset, who believe that intelligence is malleable, are less likely to manifest academic under-achievement or maladaptive perfectionism than their peers who believe intelligence is fixed (Siegle

& McCoach, 2005). Studies have shown that teaching students in the general population about growth mindset can help them overcome these conditions (Dweck, 2000; Shumow & Schmidt, 2013), but little is known about the mindsets of gifted students or about how gifted students respond to education designed to enhance a growth mindset in specific subject areas such as science. This study addresses those gaps in the literature by investigating gifted middle school students' mindsets in science.

Mindset

Dweck (2012) describes a growth mindset as one in which a person believes that his/her intelligence is malleable and can grow. Students with a growth mindset tend to embrace challenges, persist in the face of obstacles, perceive effort and study strategies as a means to learn, utilize feedback to improve, and find inspiration in the success of others.

In general, they have a mastery goal orientation focused on learning. In contrast, a fixed mindset describes the belief that intellectual ability is a fixed trait that one cannot change (Dweck, 2012). Students with a fixed mindset prefer to look smart by succeeding at easy tasks, quit when obstacles arise, perceive effort as a sign of low ability, reject constructive feedback, and are threatened by the success of others. In general, fixed mindset students have a performance goal orientation focused on besting others and preserving an image of smartness and ability.

According to decades of research by Dweck (2000), approximately 40-45% of young adolescents have fixed mindsets, and the same percentage has growth mindset, with about ten to fifteen percent falling in between. Growth mindset beliefs predict higher achievement and greater effort than fixed mindsets for students from early childhood through college (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2006). The present study investigates the mindset of gifted students in science; much of the prior research has focused on students in regular education in mathematics.

Mindset of gifted and talented students

Little is known about the mindset beliefs of gifted students. Teachers sometimes express the misconception that gifted students hold growth mindsets (Shumow & Schmidt, 2014), but Dweck (2012) recently suggested that identified gifted students are at risk of developing fixed mindsets. She speculates that this may be caused by the labeling of gifted students and/or the way they have been praised for their intelligence by parents and teachers (Dweck, 2007). Researchers have found that gifted students tend to have greater intrinsic motivation than their peers in regular education (Clinkenbeard, 2012), but we found no studies comparing mindsets of gifted and regular education students.

We investigated the science mindset of identified gifted and talented middle school students and whether it differed compared to other (regular education) students in their science classes. As subsequently described, mindset may be an important underlying factor in the failure of gifted students to reach their potential.

Mindset and under-achievement in gifted and talented students. Mindset is a likely contributor to underachievement problems that have been observed in some gifted students. One reason for underachievement among gifted and talented students is that the school curriculum is not challenging for them; they often learn more quickly than other students and may already know much of what is being taught in the classroom (Reis et al.,

1993). Gifted students who subscribe to a fixed mindset are likely to rest on their laurels. Further, they may believe that if they have to work hard at learning, this is a signal that they are no longer smart. One study indicated that middle school students who endorsed fixed mindset of learning declined in motivation to learn whereas those with a growth mindset were motivated to learn more (Haimovitz, Wormington, & Orpus, 2011).

Mindset and perfectionism in gifted and talented students. Perfectionism, which describes the inner drive to achieve excellence, operates differently for people with fixed and growth mindsets (Diehl, 2014). Perfectionists with growth mindset endorse the view that errors are part of the process of achieving excellence. However, perfectionism can become maladaptive resulting in crippling anxiety or paralysis. Wang, Fu, and Rice (2012) found that gifted students with maladaptive perfectionism held performance goal orientations, which are indicative of fixed mindsets.

Mindset and helplessness orientation in gifted and talented students. Carr, Borkowski, and Maxwell (1991) believe that motivational beliefs underlie helplessness orientation. Dweck (1975) found that students with a helpless orientation display the fixed mindset tendency of blaming failure on lack of ability and fall into the trap of believing that if they have to work hard, they must not be very smart. Consequently, when they make mistakes, they may try to hide them rather than repair them. Further, students with a fixed mindset try to preserve their self-image by withdrawing from challenge and may lack strategies that allow them to deal with challenge. In contrast, students with a growth mindset persist when faced with failure, consider challenge an opportunity, and work hard with the intention of becoming better and smarter.

Mindset Interventions

Given the negative consequences of holding a fixed mindset, it is important to find methods of encouraging a growth mindset in students. Initially, as detailed in Dweck (2000), researchers demonstrated that they could successfully change students' mindsets. Efforts were then made to implement mindset interventions in schools. Students were taught about how the brain responds to learning and how to use study strategies to learn (Dweck, 2012). The combination of teaching middle school students both about the brain and study skills increased their (a) beliefs about the malleability of intelligence, (b) desire to learn, and (c) their mathematics grades (Blackwell, Trzesniewski, & Dweck, 2007). Shumow and Schmidt (2013) recently implement-

ed a similar mindset intervention in seventh grade science classrooms as part of a larger research project called Incremental Mindset and Utility for Science Learning and Engagement (or IMUScLE). In the IMUScLE Project, participants became more likely to endorse beliefs about the malleability of intelligence after participating in the intervention whereas students in the control group did not. The present study investigates the results of the intervention among the gifted and talented students who participated in the IMUScLE study.

Teacher effects on student mindset

Recently, teacher effects were identified within a mindset intervention with seventh graders (Shumow & Schmidt, 2013). Those teacher effects were related to teachers' support for or undermining of growth mindset beliefs during science instruction. Teacher effects can be expected for several reasons. First, teachers with a growth mindset provide more encouragement and teach more learning strategies to students, which may in turn influence growth mindset in students (Dweck, 2008). Second, it is likely that teachers amplify or dampen the impact of an intervention by how faithfully they implement the intervention (the follow up activities in this case). Finally, teachers vary in the amount of challenge they present to students, the ways that they respond to error, and the opportunities they provide for improvement.

Most studies that focus on teacher effects have been conducted within either regular-education or with under-performing students. Very few studies have looked at the influence of teacher attitudes on gifted students. Seigle and Reis (1998) studied whether gifted students' beliefs about their own ability, effort and work aligned with those of their teachers. In that study, gifted students differed from their teachers, which may suggest that they were relatively impervious to some teacher attitudes. This study investigates whether the teacher effects that were evident in the general population occurred within the population of gifted students.

In summary, this study investigates three questions. First, what do gifted students believe about the malleability of intelligence compared to regular students? Second, do gifted students who participate in a mindset intervention during science class increase in growth mindset compared to a control group? Third, what was the effect of the teacher on the mindset intervention for both gifted and regular students?

METHOD

Data used in this paper were collected as part of the Incremental Mindset and Utility for Science Learning and Engagement (IMUScLE) Project (Schmidt, Shumow, & Durik, 2011), a quasi-experimental study designed to test the impact of targeted treatments on male and female students in science classrooms.

Setting

Data were collected during the 2011-2012 school year. Students from all the seventh grade science classrooms ($n = 16$) in two middle schools within a district serving students from a diverse community located on the fringe of a large metropolitan area participated.

Participants

Altogether, 380 seventh grade students participated in the study (mean age = 12.24). Participation rate across all seventh grade classrooms was very high with several of the classrooms studied having 100% participation. The seventh grade sample was 45% male and 55% female. The sample was 22% White, 42% Latino, 11% African American, 3% Asian, less than 1% Native American, and 22% multi-racial. According to school records, 61% of students in the sample were eligible to receive free or reduced lunch. Forty-four percent of the students in the sample reported that neither of their parents had attained a college degree. Twelve percent said that at least one parent had graduated from college, and 11% indicated that at least one parent had earned an advanced degree. Thirty-three percent of students in the sample did not know their parents' educational attainment.

Eighty of the students had been identified as gifted and talented by their school district by using standardized test scores, teacher evaluated learner characteristics, and grades. Among the gifted student seventh grade participants 44% were male and 56% were female. The gifted sample was 38% White, 30% Latino, 7.1% African American, 1.2% Asian, and 23.8% multi-racial. According to school records, 37.3% of the gifted students in the sample were eligible to receive free or reduced lunch. Gifted students were enrolled in the regular science classes and received occasional and unsystematic pull out enrichment. Among this group of gifted identified students, 21.25% were enrolled in a NCSSSMST school after school enrichment program. Students in seven classrooms received the mindset treatment. Students from the remaining nine classrooms,

served as controls for the mindset treatment.

Procedures

Brainology Intervention. The Brainology intervention consisted of an interactive online software program based on Carol Dweck's mindset research. The goal of the program is to encourage a growth mindset in learners. It teaches: how the brain works; that effort and leaning strategies will improve one's intelligence; and how lifestyle choices along with study skills facilitate learning and growth. Students participated in the interactive program for six weeks. The program was completed either in the school's computer lab or using laptops in the science classroom, depending on available resources for that class. One full class period per week was devoted to the program supplemented by brief homework assignments or additional in-class activities on other days. Each week, the program included an opening activity led by one of the IMUScLE researchers, followed by the computer module section that introduced content knowledge and provided frequent opportunities to both apply the knowledge and reflect on the material in an "e-journal." Following the completion of each module, students were given a follow-up activity (this was completed as homework if they did not finish in class) and participant teachers selected additional supplementary activities from the Brainology teachers' manual to reinforce relevant concepts during the week.

Student Survey

Student mindset. Four items were used to measure students' beliefs about the *malleability of intelligence*. The items asked students to report on a six-point scale (from disagree a lot = 1 to agree a lot = 6) whether they believed it was possible to change one's intelligence in science (2 items) or whether science intelligence is fixed (2 items which were reverse scored to create this variable). A factor analysis provided evidence of the construct validity of this subscale. Cronbach's alpha for these items was: .60 in the initial survey, .74 in the post intervention survey, and .74 in the follow-up survey. Items were drawn from published studies (Aronson et al., 2002; Blackwell et al., 2007), which reported test-retest reliabilities ranging from .77 to .82.

RESULTS

Comparison of Growth Mindset between Gifted and Regular Education Students

Before the intervention, gifted students' beliefs about the malleability of intelligence in science were compared to

the beliefs of students in the general population. Gifted students ($M = 4.5$, $s.d. = 1.1$) were more likely to believe that intelligence in science was malleable ($t = 4.24$, $p < .001$) than were regular education students ($M = 3.96$, $s.d. = .73$). Inspection of the means indicates, however, that there is room for growth in the mindset of both the gifted and the regular education students. Inspection of the standard deviations further indicates that there is considerable variability in the growth mindset of the gifted students.

Impact of the Brainology Program on Growth Mindset of Gifted Students

IMUScLE project data were analyzed to compare change in mindset beliefs about the malleability of intelligence of the 32 gifted and talented seventh grade science students who participated in a six-week computer-based intervention (Brainology) with 48 gifted and talented students who served as controls. A mixed between-within subjects ANOVA was conducted to assess the impact of the Brainology program on the students' growth mindset from preintervention to postintervention. Results can be seen in Figure 1. There was a significant interaction between time and Brainology, Wilk's Lambda = .86, $F(1, 78) = 12.6$, $p < .001$, partial eta squared = .14 indicating a large effect size.

Time Period	Pretest	Posttest
	M (SD)	M (SD)
Control group (n=48)	4.54 (.96)	4.41 (1.0)
Intervention group (n=32)	4.42 (1.3)	5.19 (.90)

Table 1. Growth Mindset of Gifted Students by Time and Intervention Group

Gifted and talented students who participated in the Brainology intervention increased in growth mindset. In further analyses, which are not shown, that change was maintained through the follow-up demonstrating the lasting effect of the intervention.

Change in Belief about Malleability of Intelligence by Teacher

Contrary to the results in the overall population, no teacher effects were found for the gifted students. Change in the gifted students' beliefs about the malleability of intelligence was not moderated by teacher. Rather, the observed change in gifted students' mindset was similar across teachers.

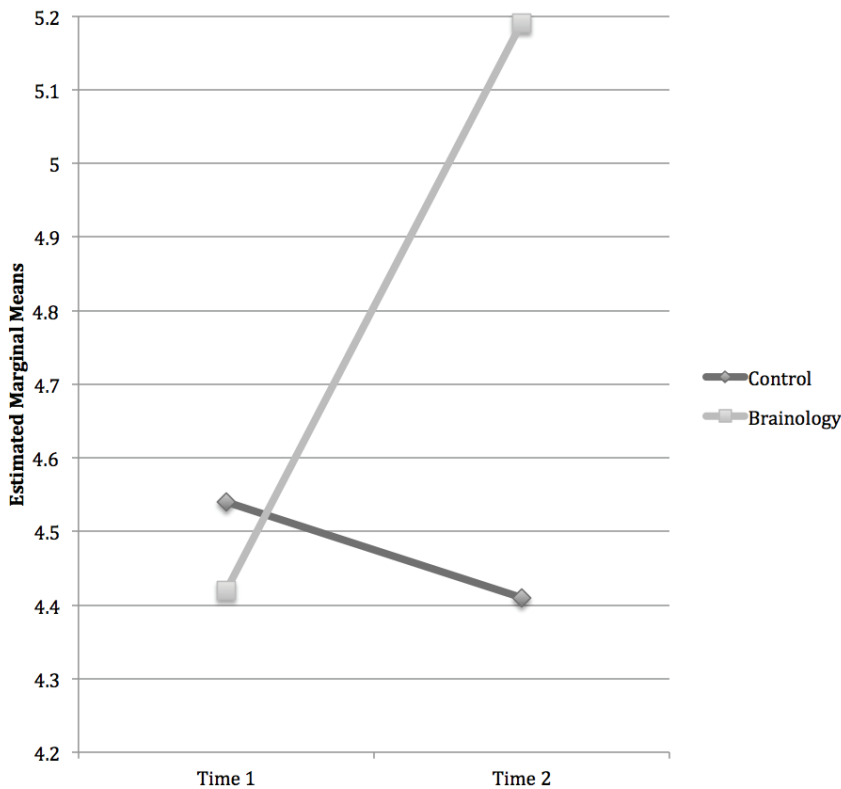


Figure 1. Change in Beliefs about the Malleability of Science Intelligence among Gifted Students as a Result of a Mindset Intervention.

DISCUSSION

Mindset describes an important constellation of beliefs that can explain whether and how gifted students might realize their potential. Students with a growth mindset are more likely to seek out opportunities to learn, extend beyond assigned 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. Students who hold a fixed mindset are likely to be at risk of adopting maladaptive and counterproductive educational patterns. For those reasons, educators of gifted students can benefit from a solid conceptual understanding of mindset and from empirical evidence about how to promote growth mindset among their students (Clinkenbeard, 2012). Little empirical evidence has been available about mindset among gifted students.

The first purpose of this study was to estimate and compare the mindset beliefs of gifted and regular education students. Consistent with the speculations expressed by teachers (Shumow & Schmidt, 2013), gifted seventh-grade students participating in this study were more likely to believe that

their intelligence in science was malleable than were their regular education classmates. Nevertheless, there was considerable variability among the mindsets of gifted students. Fewer gifted students fell into the fixed mindset range than regular students. Yet, for many, there was room for growth.

The second purpose of this study was to examine how gifted students responded to an intervention aimed at increasing growth mindset. This study showed that gifted and talented students changed the way they viewed their own intelligence after they were taught about how the brain works and techniques for learning. Changing student mindset to a stronger growth orientation may prevent and remedy motivation issues and other problems that prohibit gifted and talented students from reaching their potential. Moreover, teaching growth mindset is an affordable intervention that has effects past the initial instruction.

The final purpose of this study was to ascertain whether there were teacher effects in the extent to which the intervention impacted the increase in growth mindset among the gifted student participants. A previous analysis of data collected for the broader study (Shumow & Schmidt, 2013) found that, although students in the general population increased in growth mindset in both teachers' classes, students in one teacher's classes improved more than students in the other teachers' classes in the extent to which their growth mindsets increased. The teachers' discourse during science instruction and their beliefs about motivational strategies were consistent with those changes. The teacher whose students increased more expressed beliefs and used practices that promoted growth mindset more and fixed mindset less than the other teacher. This study indicates that the benefits of the intervention were not moderated by teacher for the gifted students as they were for regular education students. This finding suggests that the gifted students were able to override the teachers' beliefs and practices given exposure to knowledge about neurophysiological changes in the brain associated with learning, mindsets, and methods that students can use to control their learning.

Without intervention, we might have seen a greater influence of teachers' beliefs and practices in the classroom on the gifted students. Based on her extensive experience

studying mindset, Dweck (2012) recently expressed a concern that gifted students are at risk of developing a fixed mindset because of the messages they receive about ability. Although one recent study uncovered no differences in mindset beliefs between high-ability students as a result of being labeled as gifted in the academic setting (Snyder et al., 2013), daily messages about ability and effort might influence mindset among gifted students if those students are not given access to information that counteracts it.

This study did not directly address the underachievement, perfectionism, and helplessness orientation that may undermine gifted students' realization of their potential. Rather, it focused on a likely factor underpinning those maladaptive patterns. Future studies are needed to connect those constructs with mindset. The findings of this study also suggest that it would be beneficial to test other interventions (Yaegar & Dweck, 2012; Yeager, Paunesku,

Walton, & Dweck, 2013) aimed at enhancing growth mindset among gifted students specifically.

In our society, highly capable children and adults are a precious commodity. They must be nurtured and valued. Our nation has spent the last decade focusing on students who were not making adequate yearly progress. Educational resources were invested in students who were not achieving grade-level specific outcomes and very little effort was put toward moving above-level students upward. Therefore many became disengaged from school. Teaching these students about growth mindset and how they can improve their own learning experience is a step toward remedying that neglect.

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