2018

An Online Growth Mindset Intervention in a Sample of Rural Adolescent Girls

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Recommended Citation

Burnette, Jeni L., et al. "An online growth mindset intervention in a sample of rural adolescent girls." *British Journal of Educational Psychology* 88.3 (2018): 428-445.

Abstract

Background: Students living in rural areas of the United States exhibit lower levels of educational attainment than their suburban counterparts. Innovative interventions are needed to close this educational achievement gap.

Aims: We investigated if an online growth mindset intervention could be leveraged to promote academic outcomes.

Sample: We tested the mindset intervention in a sample of 222 10th grade adolescent girls (*M* age=15.2; 38% White, 25% Black, 29% Hispanic) from four rural, low-income high schools in the Southeastern United States.

Methods: We conducted a randomized controlled trial to test the efficacy the growth mindset intervention, relative to a sexual health program. We used random sampling and allocation procedures to assign girls to either the mindset intervention (*n*=115) or an attention-matched control program (*n*=107). We assessed participants at pretest, immediate posttest, and four-month follow-up.

Results: Relative to the control condition, students assigned to the mindset intervention reported stronger growth mindsets at immediate posttest and four-month follow-up. Although the intervention did not have a total effect on academic attitudes or grades, it indirectly increased motivation to learn, learning efficacy and grades via the shifts in growth mindsets.

Conclusions: Results indicate that this intervention is a promising method to encourage growth mindsets in rural adolescent girls.

Keywords = growth mindsets; academic interventions; efficacy; belonging; learning motivation

Abstract Word Count = 203; Word Count = 5,221

Growth mindset interventions, which focus on cultivating students' belief that their general intellectual ability can improve, can foster academic achievement (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007). In the current work, we developed and tested if a growth mindset intervention could be leveraged to enhance academic outcomes in a sample of students in a low-income, rural area of the Southeastern U.S. These students face high inequality in educational outcomes compared to youth from more affluent areas (Byun, Irvin, & Meece, 2015). There are several contributors to these attainment gaps, including environmental factors (Khattri, Riley, & Kane, 1997), parental expectations (Smith, Beaulieu, & Seraphine, 1995), and broader cultural influences (Chenoweth & Galliher, 2004). These barriers likely undermine motivation to learn (Eccles, 2005). Additionally, students are deterred from continuing their education beyond high school when they doubt their ability to handle learning challenges and question their sense of belonging in school. We suggest a growth mindset intervention can offset the belief that to be successful one must have an innate ability, thereby sparking motivation, efficacy, and sense of belonging.

Mindset Theory

We anchored our intervention in mindset theory, which differentiates between growth beliefs and fixed beliefs about human attributes (Dweck, 2008). Students with a growth mindset believe that intelligence is changeable and that they have the capacity to improve. These students also view setbacks as opportunities to develop their skills and use feedback as information to progress towards their goals. In contrast, students with a fixed mindset believe their intelligence is a static trait that cannot be enhanced. When facing challenges, these students get discouraged, question their ability, and disengage.

Considering the robust link between growth mindsets and effective self-regulatory processes and goal achievement (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013; Dweck, 2008), several researchers investigated if growth mindset interventions could bolster academic performance (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007; Paunesku et al., 2015). For example, for students facing negative stereotype-based expectations of underperformance, such as female students in math, a growth mindset intervention improved standardized test scores (Good, Aronson, & Inzlicht, 2003).

However, despite mounting research examining the impact of mindsets on academic performance, we have few clues about their potential to promote more positive learning attitudes. The current research makes important advances to existing mindset theory literature by systematically investigating if the benefits of growth mindsets extend to motivation, learning efficacy and belonging, and by examining these links in a sample of adolescents attending school in a rural, under-resourced area. A culture of anti-intellectualism in high-poverty rural communities may undermine students' desire to learn, weaken their perceived ability to learn, and make students doubt their sense of school belonging. Compared to youth in urban and suburban areas, students in rural areas question the relevance of education because the type of work promoted in their community does not emphasize the importance of intellectual growth (Kannapel & DeYoung, 1999). However, growth mindsets can offset the anti-intellectual climate by highlighting that everyone has the capacity to learn. Growth mindsets can also buffer the effect of poverty on academic achievement outcomes (Claro, Paunesku, & Dweck, 2016).

Building from previous mindset interventions, we developed an online intervention, titled Project Growing Minds, to promote growth mindsets across domains relevant to adolescent girls living in high-poverty, rural contexts. The current work had four goals. First, we examined if we

could reliably shift mindsets and if this effect held at a four-month follow-up. Second, we predicted that growth mindsets would be critical for fostering learning motivation including intrinsic motivation (e.g., enjoyment), value (e.g., utility of learning), and persistence (e.g., intentions to pursue education beyond high school). A fundamental predictor of motivation to learn is evaluations of potential for mastery of the subject (Eccles, 2005), and a growth mindset captures these expectations about learning abilities. Additionally, many correlational and experimental findings support a link between growth mindsets and positive academic outcomes including valuing learning and being motivated to learn (Dweck, 2000). And, at least two interventions (Aronson et al., 2002; Blackwell et al., 2007) have demonstrated the potential for growth mindset interventions to help students enjoy and be more motivated to engage academically.

Third, we hypothesized that growth mindsets would be critical for learning self-efficacy—namely a belief in the capacity to learn even if it is challenging (Bandura, 1997). A recent meta-analysis highlighted the link between growth mindsets and expectations for success in a series of analyses examining mindsets and self-regulatory processes (Burnette et al., 2013). Additionally, growth mindsets correlated positively with self-efficacy in academics (Tabernero & Wood, 1999). Students with a fixed mindset tend to view failures as an indication of a personal deficiency, which erodes their sense of self-efficacy. In contrast, students with a growth mindset tend to view failure as part of the process, which contributes to their self-efficacy, even when the work is hard. This is important because learning self-efficacy is a robust predictor of academic persistence and performance (e.g., Zimmerman, 2000).

Finally, we investigate if our growth mindset intervention could increase a sense of belonging in school. A recent study in the field of computer science found that, relative to a

control, students in a growth mindset intervention reported significantly greater belonging to the field (BLINDED). Within computer science, there is a strong culture of brilliance that may undermine belonging. In the current work, there is potentially a culture of anti-intellectualism that can also undermine belonging, but we expected that cultivating a growth mindset could offset these potential deleterious effects. Empirical lab-based work supports this proposition. For example, when asked to think about joining a tutoring club that advocates either a fixed or a growth mindset of intelligence, people anticipated having a greater sense of belonging in the growth mindset organization (Murphy & Dweck, 2010).

In summary, we examine the efficacy of the Project Growing Minds intervention in a randomized controlled trial. We hypothesized that this program would strengthen growth mindsets of intelligence, would enhance academic attitudes including motivation to learn, learning efficacy, and school belonging, with implications for grades.

Methods

Procedures

We randomly assigned participants to Project Growing Minds (*n*=115) or to an attention-matched control program (*n*=107). A third-party randomly assigned participants to condition using random sampling and allocation procedures in SPSS V22 and created randomization envelopes for each participant. Sealed envelopes included study condition and were labeled with participant identifiers. At the start of each individual session, research assistants opened the sealed envelopes to reveal condition.

At baseline, approximately 2 weeks prior to the intervention, participants completed a battery of questionnaires. Immediately following the intervention and at four-month follow-up, participants again completed the outcome measures. Students in both conditions completed the

online interventions using headphones in a private room with minimal instruction or interaction from the research assistant. Participants were compensated with $10 for returning parental consent forms, regardless of whether consent was granted. Additionally, participants received $10 for the baseline assessment, $30 for the intervention and immediate posttest assessment, and $10 for the four-month follow-up. The University Institutional Review Board approved procedures.

Description of Project Growing Minds

We created a short, scalable intervention lasting approximately 45 minutes, with all information delivered via an online web-based platform (see Table 1 for details; http://www.projectgrowingminds.com). We started with a general introduction and then anchored the remaining modules within various abilities relevant to adolescent girls: intelligence mindsets, person mindsets, and self-regulation mindsets. We chose this diverse structure because it afforded a clear platform for delivering information about mindsets relevant to success in high school—not just academically but socially as well. In addition, we sought to anchor key findings in the mindset literature into a framework relevant to student life without focusing exclusively on learning outcomes in order to minimize demand characteristics.

The modules, presented in one session, had a consistent four-part structure. First, we taught students about research related to growth mindsets. Second, we delivered the standard growth mindset message—"you can change your intelligence" typically incorporated into mindset interventions (e.g., Aronson et al., 2002; Paunesku et al., 2015). Third, we incorporated a role model, an undergraduate student at one of the state's flagship universities, who delivered a tip for success. This tip reiterated the importance of hard work and of adopting effective learning strategies using growth mindset messages. We included this component because the use of

successful role models can strengthen attitude change (Crano & Prislin, 2006). And fourth, at the end of each module students participated in a "saying is believing" exercise used in past interventions to encourages participants to adopt the growth mindset message (e.g., Burnette & Finkel, 2012).

Description of the Control Program

HEART (Health Education and Relationship Training) was an attention-matched web-based intervention developed to focus on cultivating sexual communication skills and safer sexual decision-making among adolescent girls (Widman, Golin, Noar, Massey, & Prinstein, 2016). HEART included five interactive program modules that, like Project Growing Mindsets, took approximately 45 minutes to complete. These modules were taught within a sexual health paradigm that emphasized personal values, positive aspects of sexuality, and the importance of competent interpersonal skills. Additional details about the development, acceptability, and preliminary efficacy of HEART can be found elsewhere (BLINDED).

Measures

Students completed all questionnaires online, answering questions related to sexual attitudes and behavior before answering questions related to implicit theories, learning motivation, efficacy, and belonging. The following measures were answered on a 7-point scale (1=*strongly disagree*, 7=*strongly agree*).

Mindsets. We used a 3-item intelligence mindset questionnaire that focused on three fixed-worded items (e.g., "You can learn new things but you can't really change your intelligence"; Dweck, 2000). We recoded items such that higher numbers represent stronger growth mindsets (baseline α=.86, immediate posttest α=.87, follow-up α=.92).

Learning Motivation. Participants completed five items that tapped motivation to learn, including intrinsic motivation (e.g., "I enjoy learning new things at school"; Benningfeld, 2013), value (e.g., "Learning is important to me"; Walton & Cohen, 2007) and persistence (e.g., "I plan on continuing with my education after high school"). Higher scores represent greater motivation to learn (baseline α=.82, immediate posttest α=.88, follow-up α=.88).

Learning Efficacy. Participants completed three items that tapped the capacity to learn in challenging situations (e.g., "I am sure I can do even the hardest work in my classes"; Fast, et al., 2010). Higher scores represent greater learning efficacy (baseline α=.90, immediate posttest α=.92, follow-up α=.94).

School Belonging. Participants completed seven items that tapped their sense of belonging at school (e.g., "I feel like I belong in school"; Cheryan, Plaut, Davies, & Steele, 2009; Good, Rattan, & Dweck, 2012). Higher scores represent greater belonging (baseline α=.89, immediate posttest α=.92, follow-up α=.95).

Grades. We obtained 183 participants' grades for courses taken during 9th and 10th grade. Mean final grades for each year were calculated by averaging participants' end of quarter grades for each course.

Participants

We recruited female participants from four rural, low-income high schools in the southeastern U.S. to participate. We focused on adolescent girls because we partnered with researchers testing the efficacy of HEART[1], a sex education intervention aimed at helping adolescent girls communicate about safe sex. All 10th grade girls across the four schools (n=371) were eligible to participate. We used active parental consent and student assent. Seventy-eight

[1] These efforts coordinated with a randomized controlled trial (clinical trial registration number NCT02579135) targeting sex communication related to girls.

percent of youth returned a parental consent form, and 79% of those parents granted consent. The final sample included 222 girls (see Figure 1 for flow diagram).

No participants were lost between baseline and immediate follow-up, though 1 participant in the growth mindset condition did not complete all measures because she ran out of time. At the four-month follow-up assessment, 95% of participants (n=211) were retained in the study (92% intervention; 98% control; $\chi^{2=}$4.18, p=.041). Of the 11 girls who did not return for follow-up, 7 were no longer enrolled in the school district (6 intervention, 1 control) and 4 were no longer interested in participating (3 intervention, 1 control). Participants who completed the study did not differ from participants who dropped out on race ($\chi^{2=}$3.94, p=.268), pretest mindsets [t(220)=-0.60, p=.549], pretest learning motivation [t(220)=-0.05, p=.961], or pretest learning efficacy [t(219)=0.55, p=.585]. However, the groups did differ in their pretest reports of belonging [t(219)=2.43, p=.016] such that individuals who dropped out of the study reported less belonging (M=3.38) than did those who remained (M=4.34). Considering the majority of students who did not return at follow-up were no longer enrolled, it is perhaps not that surprising that they felt less connected to school.

Results

Descriptives and pretest differences

Table 2 presents descriptive statistics and correlations between variables. At pretest, students in the intervention did not significantly differ from students in the control condition on any relevant assessments, including race ($\chi^{2=}$1.13, p=.769), previous year's final grade averages [β=0.84, SE=1.08, t(177)=0.78, p=.438; $M_{intervention}$=83.23, $SD_{intervention}$=7.52, $M_{control}$=82.39, $SD_{control}$=7.19], growth mindsets of intelligence [β=0.30, SE=0.19, t(217)=1.64, p=.102; $M_{intervention}$=4.66, $SD_{inteverntion}$=1.37, $M_{control}$=4.35, $SD_{control}$=1.39], learning motivation [β=-0.15,

SE=0.13, *t*(217)=-1.22, *p*=.225; $M_{intervention}$=5.75, $SD_{intervention}$=1.04, $M_{control}$=5.90, $SD_{control}$= 0.84], learning efficacy [β=-0.02, *SE*=0.18, *t*(216)=-0.10, *p*=.925; $M_{intervention}$=5.24, $SD_{intervention}$=1.39, $M_{control}$=5.25, $SD_{control}$=1.24], or school belonging [β=-0.14, *SE*=0.17, *t*(216)=-0.81, *p*=.420; $M_{intervention}$=4.18, $SD_{intervention}$=1.32, $M_{control}$=4.32, $SD_{control}$=1.26]. These findings support the efficacy of randomization.

Effects of the intervention at posttest

We used HLM 7.01 (Raudenbush, Bryk, & Congdon, 2013) to estimate two-level models predicting our outcomes of interest (growth mindsets, learning motivation, learning efficacy, school belonging, and grades) in which we included a randomly varying intercept and controlled for the interdependence of students within each school in the second level of the model. Deviance tests conducted for the reported models indicated no other random effects were necessary for any of the models.

***Mindsets*.** To examine the effects of our intervention on students' growth mindsets at posttest, we estimated a two-level model in which growth mindsets at posttest were regressed on a dummy-coded variable (growth mindset condition=1, control condition=0) in the first level of the model, and the second level of the model controlled for the interdependence of students' data. Supporting our hypothesis, condition significantly predicted growth mindset [β=.76, *SE*=0.19, *t*(214)=3.94, *p*<.001, *r*=.26], with girls in the growth mindset condition reporting stronger growth mindsets (*M*=5.22, *SD*=1.40, 12.02% increase from pretest) than girls in the control (*M*=4.46, *SD*=1.53, 2.53% increase from pretest). Notably, this effect holds when controlling for pretest mindsets [β=0.59, *SE*=.16, *t*(213)=3.67, *p*<.001, *r*=.24].

***Academic attitudes*.** Second, we examined the effects of the intervention on academic attitudes at posttest by estimating three separate two-level models in which the relevant

dependent variable was regressed onto our dummy-coded condition variable in the first level of the model, controlling for the interdependence of students' data in the second level. Analyses revealed no significant total effect of condition on learning motivation [β=-0.13, *SE*=-0.13, *t*(215)=-1.02, *p*=.309, *r*=.07, $M_{intervention}$=5.82 (1.22% increase from pretest), $SD_{intervention}$=1.07, $M_{control}$=5.95 (0.85% increase from pretest), $SD_{control}$=0.86], learning efficacy [β=0.04, *SE*=0.17, *t*(215)=0.21, *p*=.834, *r*=.01, $M_{intervention=}$5.56 (6.11% increase from pretest), $SD_{intervention}$=1.30, $M_{control}$=5.53 (5.33% increase from pretest), $SD_{control}$=1.26], or school belonging [β=-0.18, *SE*=0.17, *t*(217)=-1.02, *p*=.308, *r*=.07, $M_{intervention}$=4.59 (9.81% increase from pretest), $SD_{intervention}$=1.35, $M_{control}$=4.77 (9.43% increase from pretest), $SD_{control}$=1.27]. All effects remain non-significant when controlling for pretest assessments [i.e., motivation: β=-0.02, *SE*=0.09, *t*(214)=-0.27, *p*=.790, *r*=.02; efficacy: β=0.04, *SE*=0.13, *t*(213)=0.31, *p*=.759, *r*=.02; belonging: β=-0.06, *SE*=0.10, *t*(215)=-0.64, *p*=.526, *r*=.04].

Mediation. Despite the lack of total effect, in line with best practices for theory development (Rucker, Preacher, Tormala, & Petty, 2011), we examined if effects are driven by the significant shift in mindsets. For example, previous research within a weight management context suggests that the benefits of the intervention for avoiding weight gain in the wake of severe setbacks was driven by stronger growth mindsets (Burnette & Finkel, 2012). The decision to examine indirect effects aligns with prevailing views suggesting that the focus of mediation analyses should be on assessing the magnitude and significance of indirect effects (Hayes, 2009; Rucker, et al., 2011; Zhao, Lynch, & Chen, 2010). Thus, we next examined whether growth mindsets mediated the association between condition and academic attitude outcomes. We estimated three separate two-level models in which the dependent variable was regressed onto

growth mindsets at posttest, controlling for our dummy-coded condition variable in the first level of the model, and controlling for the interdependence of the data in the second level.

First, we tested the association between growth mindsets at posttest and learning motivation at posttest. Consistent with predictions, growth mindsets significantly predicted posttest learning motivation [β=0.17, *SE*=0.04, *t*(213)=3.92, *p*<.001]. We followed Tofighi and MacKinnon's (2011) recommendation for computing 95% confidence intervals and submitted the two components of the indirect effect, path a and path b, to the RMediation program. The mediated effect was significant, 95% *CI*: [0.05, 0.23]. Once again, this effect remains when controlling for pretest mindsets and pretest motivation, β=0.08, *SE*=0.04, *t*(211)=2.34, *p*=.020, 95% *CI*: [0.01, 0.11]. With growth mindsets in the model, the effect of condition on posttest motivation (i.e., the direct effect) was significant, β=-0.27, *SE*=0.13, *t*(213)=-2.09, *p*=.038.

Second, we tested the association between growth mindsets at posttest and learning efficacy at posttest. Again consistent with our prediction, growth mindsets significantly predicted posttest learning efficacy, β=0.27, *SE*=0.06, *t*(213)=4.74, *p*<.001. Confidence intervals computed using RMediation indicated that the mediated effect was significant, 95% *CI*: [0.09, 0.35]. Once again, this effect remains when controlling for pretest mindsets and pretest efficacy, β=0.13, *SE*=0.05, *t*(210)=2.50, *p*=.013, 95% *CI*: [0.01, 0.16]. The direct effect of condition on posttest efficacy was not significant, β=-0.18, *SE*=0.17, *t*(213)=-1.05, *p*=.294.

Finally, we tested the association between growth mindsets at posttest and school belonging at posttest. Contrary to predictions, growth mindsets at posttest were not associated with school belonging at posttest, β=0.04, *SE*=0.06, *t*(213)=0.61, *p*=.541. The effect was unchanged when controlling for pretest mindsets and pretest belonging, β=0.04, *SE*=0.04, *t*(210)=0.85, *p*=.397.

Effects of the intervention at four-month follow-up

To examine whether the effects of the intervention lasted beyond the immediate posttest, we repeated the previous analyses using students' reports of growth mindsets, learning motivation, learning efficacy, and school belonging four months after the intervention.

Mindsets. Condition significantly predicted growth mindsets at the four-month follow-up, β=0.43, *SE*=0.21, *t*(206)=2.03, *p*=.044, *r*=.14, such that girls in the intervention condition (*M*=4.91, *SD*=1.49, 5.36% increase from pretest) reported stronger growth mindsets than did girls in the control condition (*M*=4.48, *SD*=1.61, 2.99% increase from pretest).

Academic attitudes. Consistent with the pattern of results for posttest learning motivation, learning efficacy, and school belonging, condition did not predict learning motivation at follow-up [β=-0.08, *SE*=0.15, *t*(206)=-0.50, *p*=.618, *r*=.03; $M_{intervention}$=5.61 (2.43% decrease from pretest), $SD_{intervention}$=1.24, $M_{control}$=5.68 (3.73% decrease from pretest), $SD_{control}$=1.05], learning efficacy at follow-up [β=0.04, *SE*=0.20, *t*(206)=0.18, *p*=.855, *r*=.01; $M_{intervention}$=5.36 (2.29% increase from pretest), $SD_{intervention}$=1.52, $M_{control}$=5.33 (1.52% increase from pretest), $SD_{control}$=1.36], or school belonging [β=0.23, *SE*=0.21, *t*(206)=1.10, *p*=.273, *r*=.08; $M_{intervention}$=4.87 (16.51% increase from pretest), $SD_{intervention}$=1.47, $M_{control}$=4.63 (7.18% increase from pretest), $SD_{control}$=1.64].

Mediation. Next, we examined whether growth mindsets at the four-month follow-up mediated the association between condition and learning motivation, learning efficacy, and school belonging. To determine the b-path of our mediation models, we estimated three separate two-level models in which the dependent variable was regressed onto growth mindsets at follow-up, controlling for our dummy-coded condition variable in the first level of the model, and controlling for the interdependence of the data in the second level.

First, growth mindsets at follow-up significantly predicted follow-up learning motivation, controlling for condition, β=0.14, *SE*=0.05, *t*(205)=2.78, *p*=.006. Confidence intervals computed using RMediation indicated that the mediated effect was significant, 95% *CI*: [0.01, 0.14]. With follow-up growth mindsets in the model, the association between condition and follow-up learning motivation (i.e., the direct effect) was not significant, β=-0.14, *SE*=0.15, *t*(205)=-0.88, *p*=.379.

Second, growth mindsets significantly predicted follow-up learning efficacy, controlling for condition, β=0.15, *SE*=0.06, *t*(205)=2.42, *p*=.017. Confidence intervals computed using RMediation indicated that the mediated effect was significant, 95% *CI*: [0.004, 0.15]. The direct effect of condition on follow-up learning efficacy was not significant, β=-0.03, *SE*=0.20, *t*(205)=-0.15, *p*=.884.

Finally, growth mindsets did not significantly predict follow-up school belonging, controlling for condition, β=-0.06, *SE*=0.07, *t*(205)=-0.89, *p*=.377.

Grades

We examined the total effect of the intervention on grades by estimating a two-level model in which the average of participants' course grades was regressed onto our dummy-coded condition variable in the first level of the model, controlling for the interdependence of students' data in the second level. Analyses revealed no significant total effect of condition on participants' final 10^{th} grade average [β=0.64, *SE*=1.35, *t*(179)=0.47, *p*=.637, *r*=.04; $M_{intervention}$=81.36, $SD_{intervention}$=10.27, $M_{control}$=80.72, $SD_{control}$=7.85].

We next examined if growth mindsets mediated the effect of the intervention condition on grades. First, we tested the association between intervention condition and the average of participants' reports of growth mindsets across the semester (i.e., at posttest and the four-month

follow-up). Intervention condition significantly predicted the averaged growth mindsets, β=0.64, *SE*=0.18, *t*(217)=3.61, *p*<.001. Second, growth mindsets significantly predicted final 10th grade average, controlling for condition, β=2.53, *SE*=0.47, *t*(178)=5.36, *p*<.001. Finally, we computed 95% confidence intervals and submitted the two components of the indirect effect to the RMediation program. Confidence intervals indicated that the mediated effect was significant, 95% *CI*: [0.66, 2.79]. The direct effect of condition on grades was not significant, β=-0.60, *SE*=1.28, *t*(178)=-0.47, *p*=.642.

Discussion

The educational attainment gap for youth from impoverished, rural communities–both in terms of proficiency and persistence–requires ongoing, innovative approaches to promoting not only academic performance but also more positive academic attitudes. To address this issue, we evaluated the efficacy of a brief, scalable, web-based intervention that focused on developing growth mindsets. Overall, we found that girls who completed the mindset intervention reported stronger growth mindsets compared to girls in a matched control program and this effect held at the four-month follow-up. Students in the growth mindset, relative to control condition, also indirectly reported greater learning motivation and efficacy as well as higher end of semester grades. Contrary to predictions, we see no effects of growth mindsets on belonging. However, both motivation and efficacy are correlated with this outcome. Although it is promising that we found immediate and follow-up changes in growth mindsets four months after the intervention, it is important to note that for learning attitude outcomes and final grades, we only see an indirect effect via this shift in mindsets.

The lack of total effects of the intervention on academic attitudes and final grades is contrary to much of existing literature. Indeed, larger high-powered studies typically find not

only a change in mindsets but also improved academic outcomes. For example, Paunesku and colleagues (2015), in a sample of nearly 1600 students, found that growth mindset interventions can be leveraged to enhance GPAs–especially for students at risk of dropping out. And, using multiple samples of underrepresented students transitioning to college, Yeager and colleagues (2016a), found that growth mindset interventions, relative to the controls, improved enrollment rates and grades, helping to reduce achievement gaps. However, despite many successful interventions, some work has failed to find results. Whereas some of the studies with null results are underpowered (e.g., Donohoe, Topping, & Hannah, 2012; 33 students total), other work may lack sufficient strength to shift mindsets—that is, these studies may not include key ingredients for successful implementation (e.g., a letter stapled to an exam, Bostwick, 2015). The majority of these interventions focus on academic achievement and thus it is hard to make direct comparisons in terms of the lack of total effect on academic attitudes in the current work. One might expect stronger effects on psychological processes than on academic performance, making it especially surprising that we failed to see such an effect.

In addition to not being as highly powered as some of the more recent large-scale interventions (e.g., Paunesku et al., 2015; Yeager et al., 2016a), we elaborate on two potential explanations for the lack of total effects on learning attitudes and final grades. First, is the sample we targeted. We worked with adolescent girls who had already transitioned to high school and thus were not facing an identifiable ego-threat—"any event or communication having unfavorable implications about the self" (Baumeister, Heatherton, & Tice, 1993, p. 143). A recent meta-analysis demonstrated that the links between mindsets and self-regulation were strongest in the presence of an ego-threat (Burnette et al., 2013). That is, mindsets matter most in predicting psychological processes when challenges or transitions arise. Thus, it might be that

the intervention would be more successful as students transition to high school.

Second, the approach to shifting mindsets may not have been strong enough to also shift academic attitudes and grades. For example, a revised growth mindset intervention which included quotes from celebrities, tailored information relevant to high-school students, the use of bullet points rather than paragraphs and more (see Yeager et al., 2016b for full details), outperformed more standard growth mindset interventions that focus on the malleable message combined with a saying is believing exercise. Although we included more information about why mindsets matter, and tips from role-models, we developed the intervention prior to the publication detailing important components that can enhance mindset interventions (Yeager et al., 2016a). Additionally, because we targeted multiple mindsets (i.e., intelligence, person, self-regulation), we had limited content related to mindsets of intelligence. Thus, added material may be necessary to enhance the potency of the mindset intervention. An important line of future inquiry will be to articulate when and for whom growth mindset interventions are most effective and to gain a better understanding of which components of mindset interventions are critical.

Despite the lack of total effect, we see a shift in mindsets that lasted up to four months using a stringent test controlling for pre-existing mindsets. There is a long line of work supporting the importance of these growth mindsets for a number of outcomes related to academic success including setting goals focused on learning, using mastery-oriented strategies to reach these goals and remaining optimistic about the potential for success despite setbacks (see Burnette et al., 2013 for a review). And, in the current work growth mindsets predicted learning efficacy and motivation at immediate post-test and at follow-up—all of these outcomes correlated with higher final grades, indicating the potential of fostering a stronger belief in the malleable nature of intelligence.

Applications

Taking diverse theoretical and methodological approaches, scholars have illuminated the critical role of growth mindsets in helping students reach their academic potential (Martin, 2015; Dweck, 2015). This is the first mindset intervention, to our knowledge, to focus on promoting a growth mindset and positive academic outcomes in adolescent girls from rural, impoverished communities. Students from such backgrounds face many structural inequities stemming from economic disparities. These disadvantages can lead to poor academic outcomes in part through their impact on psychological mindsets (Claro et al., 2016). Our results suggest that endeavors to promote growth mindsets may help buffer students from the disadvantages they face. Importantly, these efforts should be made hand in hand with, not as a replacement for, those focused on dismantling systemic inequalities.

Furthermore, a better understanding of how growth mindsets affect academic development requires us to examine not only students' mindsets but also beliefs at the environmental or contextual level. Individual-level interventions would likely be bolstered by cultures that advocate student growth including teachers who themselves believe that their students have growth potential. In addition, the online, low-cost methods incorporated here allow for integration with other existing working models. For example, a recent systematic review of meta-analyses in higher education suggests that there are instructional changes that might help bolster the impact of a growth mindset such as relating information to students, presenting information clearly, and generally creating a meaningful learning environment (Schneider & Preckel, 2017). Furthermore, the systematic review suggests that the strongest student predictors of academic achievement are effortful regulation, self-efficacy, and commitment to learning—all

variables with robust links to growth mindsets, highlighting the potential value of growth mindset interventions.

Limitations and Future Directions

Although this study has notable strengths, including the randomized trial design and use of a scalable online platform, there are limitations that future work should address. First, any multifaceted intervention like this one leaves ambiguity about which component(s) drove the effect. For example, is a role model delivering a growth mindset-related tip critical for shifting mindsets? Alternatively, what role did the breadth of focus on mindsets play? We sought to leverage growth mindsets to enhance academic attitudes and thus did not design the intervention to test the question of what is required to reliably shift mindsets. Second, although we sought to limit demand characteristics, it is still possible that students in the intervention condition intuited that we wanted to enhance their academic attitudes. Expectations are a potential concern in most interventions where it is difficult to design a comparable condition that entails equivalent frequency of contact, similar delivery mechanism, and credible content without overlapping information (Wechsler et al., 2011). Third, educational interventions are prone to contamination because the "active" ingredients, in this case, a growth mindset message, can be difficult to confine to just students in the intervention condition. Thus, students could have spoken to each other about the information they received. Such contamination is difficult to discern and can reduce effect size estimates, introduce bias, and decrease power (Keogh-Brown, et al., 2007).

Fourth, despite statistical evidence of significant indirect effects, it is important to remember that, "this does not mean that the hypothetical mediator is causally effective" (Fiedler Schott, & Meiser, 2011, *p*. 1235). Although we identified a shift in mindsets as an important potential intervening variable to enhance learning attitudes and improve grades, we cannot

conclude that this is the ultimate or most important mediator. Future work should continue to elaborate on how mindset interventions work. Recent work by Miller and colleagues (Miller, Dannals, & Zlatev, 2017), noted the importance of focusing on and assessing not only psychological processes (i.e., attitude change) but also behavioral changes using long-lag interventions. For example, in growth mindset intervention work, a shift towards stronger growth mindsets may lead to more interest and efficacy regarding learning which then fosters more effective learning strategies such as time spent studying and/or seeking help from others (Yeager et al., 2016b). Future work seeking to identify such processes can address two limitations in the current work—namely, the lack of causal evidence for the mediation model and the focus on attitudes, rather than behaviors.

The potential limitations of the current work open a number of avenues for future inquiry. Additional research is required to determine which elements are necessary and which are sufficient for shifting mindsets and what approaches have the strongest and most enduring effects. For example, focusing exclusively on intelligence mindsets, using boosters, using specific strategies and examples relevant to adolescents and enhancing the interactive nature of the webpage could all lead to stronger effects. On a related note, future work should seek to establish a standard of care—that is, which ingredients are key to fostering not only stronger growth mindsets but also positive academic outcomes? Furthermore, intervention work should start to focus on not only the psychological processes driving effects of mindset interventions but also the behavioral changes.

Conclusions

In this work, we developed a growth mindset intervention to promote positive academic outcomes in students living in impoverished, rural areas. This intervention led to stronger growth

mindsets immediately and four months later. In turn, these mindsets predicted more positive academic attitudes including learning motivation and learning efficacy and correlated with higher final grades as well. Growth mindset interventions offer a promising approach, combined with other effective techniques, to counteracting the disadvantages faced by students living in high-poverty, rural areas, helping students achieve their academic potential.

Table 1
Project Growing Minds Module Descriptions

Module	Content	Goal	Example Information
Module 1: General Introduction to Mindsets	Part I: Definitions of mindsets and examples	Teach about what mindsets are	Define each type of mindset—both fixed and growth
	Part II: Standard message about changeable nature of attribute	Intelligence can change	Intelligence can change as your brain grows!
	Part III: Student Tip	Reiterate strategies associated with growth mindsets	I take plenty of time to get my work done, often longer than my peers (continues with a message related to effort not equating to ability).
	Part IV: Activity	Get students to think about their own mindsets	What is your own mindset? Do you think that some people are just talented in school whereas others are not?
Module 2: Intelligence Mindsets	Part I: Definitions of mindsets and examples	Teach about when mindsets matter	After they face a challenge, students with a growth mindset look at the challenge as a chance to grow, an opportunity to learn.
	Part II: Standard message about changeable nature of attribute	Intelligence can change	With effort, you can train your brain to get smarter.
	Part III: Student Tip	Reiterate strategies associated with growth mindsets	Next time you are stuck on a concept, try using a new strategy and ask for help.
	Part IV: Activity	Get students to think about their own mindsets	Describe in your own words why a growth mindset can help you in school.
Module 3: Self-Control Mindsets	Part I: Definitions of self-control and changeable message	Teach students that self-control, like intelligence, can change and grow	The great news is that self-control can be increased.
	Part II: Marshmallow Video	Use video from a study to teach about self-control	We have more potential for regulating how our lives play out than has been typically recognized.
	Part II: Student Tip	Changing self-control using growth mindset-oriented strategies	We can change our situations to make it easier to show self-control.
	Part IV: Activity	Get students to think about their own mindsets related to self-control	What is the main obstacle that might prevent you from accomplishing what you want?

Module	**Content**	**Goal**	**Example Quotes**
Module 4: Person Mindsets	Part I: Definitions of person theories	Teach about what person mindsets are	Beyond intelligence, grit, and self-control, people have the potential to change their personal characteristics. That is, people can change their personalities, thoughts, and feelings.
	Part II: Building social confidence	Social skills and social confidence can change	Everyone can work on developing stronger social skills to develop meaningful friendships and have more fulfilling relationships.
	Part III: Student Tip	Explain strategies associated with growth mindsets and social skills	Look at social situations as challenges, even if you're anxious, make an effort to meet new people.
	Part IV: Activity	Get students to think about their own mindsets related to social skills	What is an important wish, related to friendships or relationships, that you want to accomplish in the next 6 months?

Table 2
Means, Standard Deviations, and Correlations between Variables.

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Condition	--	--	--													
2. Pretest mindsets	4.50	1.39	.11	--												
3. Posttest mindsets	4.69	1.51	.26**	.58**	--											
4. Follow-up mindsets	4.70	1.56	.14*	.42**	.57**	--										
5. Pretest motivation	5.77	0.95	-.08	.19**	.19**	.10	--									
6. Posttest motivation	5.85	0.97	-.07	.16*	.23**	.09	.75**	--								
7. Follow-up motivation	5.55	1.15	-.03	.18**	.22**	.20**	.62**	.65**	--							
8. Pretest efficacy	5.24	1.32	-.01	.16**	.20**	.10	.62**	.55**	.48**	--						
9. Posttest efficacy	5.50	1.27	.02	.23**	.30**	.15*	.50**	.74**	.52**	.68**	--					
10. Follow-up efficacy	5.29	1.44	.01	.24**	.20**	.17*	.56**	.60**	.80**	.59**	.58**	--				
11. Pretest belonging	4.29	1.29	-.04	-.01	.01	-.13	.42**	.40**	.40**	.41**	.38**	.40**	--			
12. Posttest belonging	4.58	1.31	-.06	.04	.05	-.06	.33**	.45**	.39**	.36**	.45**	.44**	.82**	--		
13. Follow-up belonging	4.70	1.56	.08	.10	.02	-.04	.35**	.40**	.50**	.36**	.35**	.54**	.66**	.73**	--	
14. 10^{th} grade final average	81.04	9.12	.04	.29**	.31**	.36**	.30**	.34**	.40**	.29**	.38**	.43**	.14	.24**	.30**	--

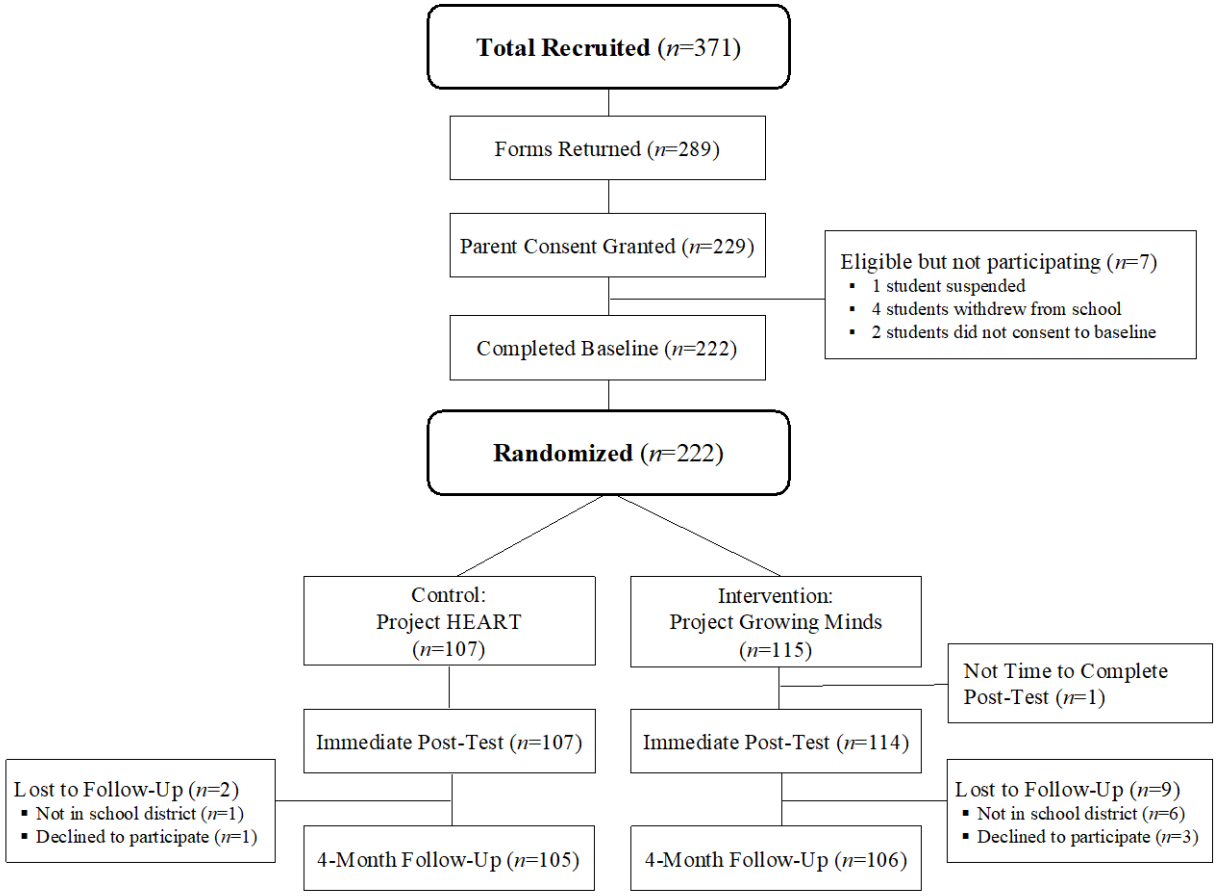

Figure 1. Study recruitment flow chart

Note: From immediate post-test to follow-up in the growth mindset condition, we added back in the one student who did not have time to complete post-test. Thus, we have 115-9, which equals 106 at follow-up.

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