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

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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

24 Growth mindset interventions, which focus on cultivating students' belief that their
25 general intellectual ability can improve, can foster academic achievement (Aronson, Fried, &
26 Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007). In the current work, we developed and
27 tested if a growth mindset intervention could be leveraged to enhance academic outcomes in a
28 sample of students in a low-income, rural area of the Southeastern U.S. These students face high
29 inequality in educational outcomes compared to youth from more affluent areas (Byun, Irvin, &
30 Meece, 2015). There are several contributors to these attainment gaps, including environmental
31 factors (Khattari, Riley, & Kane, 1997), parental expectations (Smith, Beaulieu, & Seraphine,
32 1995), and broader cultural influences (Chenoweth & Galliher, 2004). These barriers likely
33 undermine motivation to learn (Eccles, 2005). Additionally, students are deterred from
34 continuing their education beyond high school when they doubt their ability to handle learning
35 challenges and question their sense of belonging in school. We suggest a growth mindset
36 intervention can offset the belief that to be successful one must have an innate ability, thereby
37 sparking motivation, efficacy, and sense of belonging.

38 **Mindset Theory**

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

46 Considering the robust link between growth mindsets and effective self-regulatory
47 processes and goal achievement (Burnette, O'Boyle, VanEpps, Pollack, & Finkel, 2013; Dweck,
48 2008), several researchers investigated if growth mindset interventions could bolster academic
49 performance (Aronson, Fried, & Good, 2002; Blackwell, Trzesniewski, & Dweck, 2007;
50 Paunesku et al., 2015). For example, for students facing negative stereotype-based expectations
51 of underperformance, such as female students in math, a growth mindset intervention improved
52 standardized test scores (Good, Aronson, & Inzlicht, 2003).

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

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

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

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

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

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

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

104 **Methods**

105 **Procedures**

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

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

115 online interventions using headphones in a private room with minimal instruction or interaction
116 from the research assistant. Participants were compensated with \$10 for returning parental
117 consent forms, regardless of whether consent was granted. Additionally, participants received
118 \$10 for the baseline assessment, \$30 for the intervention and immediate posttest assessment, and
119 \$10 for the four-month follow-up. The University Institutional Review Board approved
120 procedures.

121 **Description of Project Growing Minds**

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

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

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

142 **Description of the Control Program**

143 HEART (Health Education and Relationship Training) was an attention-matched web-
144 based intervention developed to focus on cultivating sexual communication skills and safer
145 sexual decision-making among adolescent girls (Widman, Golin, Noar, Massey, & Prinstein,
146 2016). HEART included five interactive program modules that, like Project Growing Mindsets,
147 took approximately 45 minutes to complete. These modules were taught within a sexual health
148 paradigm that emphasized personal values, positive aspects of sexuality, and the importance of
149 competent interpersonal skills. Additional details about the development, acceptability, and
150 preliminary efficacy of HEART can be found elsewhere (BLINDED).

151 **Measures**

152 Students completed all questionnaires online, answering questions related to sexual
153 attitudes and behavior before answering questions related to implicit theories, learning
154 motivation, efficacy, and belonging. The following measures were answered on a 7-point scale
155 (1=*strongly disagree*, 7=*strongly agree*).

156 **Mindsets.** We used a 3-item intelligence mindset questionnaire that focused on three
157 fixed-worded items (e.g., “You can learn new things but you can’t really change your
158 intelligence”; Dweck, 2000). We recoded items such that higher numbers represent stronger
159 growth mindsets (baseline $\alpha=.86$, immediate posttest $\alpha=.87$, follow-up $\alpha=.92$).

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

165 **Learning Efficacy.** Participants completed three items that tapped the capacity to learn
166 in challenging situations (e.g., “I am sure I can do even the hardest work in my classes”; Fast, et
167 al., 2010). Higher scores represent greater learning efficacy (baseline $\alpha=.90$, immediate posttest
168 $\alpha=.92$, follow-up $\alpha=.94$).

169 **School Belonging.** Participants completed seven items that tapped their sense of
170 belonging at school (e.g., “I feel like I belong in school”; Cheryan, Plaut, Davies, & Steele,
171 2009; Good, Rattan, & Dweck, 2012). Higher scores represent greater belonging (baseline
172 $\alpha=.89$, immediate posttest $\alpha=.92$, follow-up $\alpha=.95$).

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

176 **Participants**

177 We recruited female participants from four rural, low-income high schools in the
178 southeastern U.S. to participate. We focused on adolescent girls because we partnered with
179 researchers testing the efficacy of HEART¹, a sex education intervention aimed at helping
180 adolescent girls communicate about safe sex. All 10th grade girls across the four schools ($n=371$)
181 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.

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

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

197 Results

198 Descriptives and pretest differences

199 Table 2 presents descriptive statistics and correlations between variables. At pretest,
 200 students in the intervention did not significantly differ from students in the control condition on
 201 any relevant assessments, including race ($\chi^2=1.13, p=.769$), previous year's final grade averages
 202 [$\beta=0.84, SE=1.08, t(177)=0.78, p=.438; M_{\text{intervention}}=83.23, SD_{\text{intervention}}=7.52, M_{\text{control}}=82.39,$
 203 $SD_{\text{control}}=7.19$], growth mindsets of intelligence [$\beta=0.30, SE=0.19, t(217)=1.64, p=.102;$
 204 $M_{\text{intervention}}=4.66, SD_{\text{intervention}}=1.37, M_{\text{control}}=4.35, SD_{\text{control}}=1.39$], learning motivation [$\beta=-0.15,$

205 $SE=0.13, t(217)=-1.22, p=.225; M_{\text{intervention}}=5.75, SD_{\text{intervention}}=1.04, M_{\text{control}}=5.90, SD_{\text{control}}=0.84$],
 206 learning efficacy [$\beta=-0.02, SE=0.18, t(216)=-0.10, p=.925; M_{\text{intervention}}=5.24, SD_{\text{intervention}}=1.39,$
 207 $M_{\text{control}}=5.25, SD_{\text{control}}=1.24$], or school belonging [$\beta=-0.14, SE=0.17, t(216)=-0.81, p=.420;$
 208 $M_{\text{intervention}}=4.18, SD_{\text{intervention}}=1.32, M_{\text{control}}=4.32, SD_{\text{control}}=1.26$]. These findings support the
 209 efficacy of randomization.

210 **Effects of the intervention at posttest**

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

217 ***Mindsets.*** To examine the effects of our intervention on students' growth mindsets at
 218 posttest, we estimated a two-level model in which growth mindsets at posttest were regressed on
 219 a dummy-coded variable (growth mindset condition=1, control condition=0) in the first level of
 220 the model, and the second level of the model controlled for the interdependence of students'
 221 data. Supporting our hypothesis, condition significantly predicted growth mindset [$\beta=.76,$
 222 $SE=0.19, t(214)=3.94, p<.001, r=.26$], with girls in the growth mindset condition reporting
 223 stronger growth mindsets ($M=5.22, SD=1.40, 12.02\%$ increase from pretest) than girls in the
 224 control ($M=4.46, SD=1.53, 2.53\%$ increase from pretest). Notably, this effect holds when
 225 controlling for pretest mindsets [$\beta=0.59, SE=.16, t(213)=3.67, p<.001, r=.24$].

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

228 dependent variable was regressed onto our dummy-coded condition variable in the first level of
 229 the model, controlling for the interdependence of students' data in the second level. Analyses
 230 revealed no significant total effect of condition on learning motivation [$\beta=-0.13$, $SE=-0.13$,
 231 $t(215)=-1.02$, $p=.309$, $r=.07$, $M_{\text{intervention}}=5.82$ (1.22% increase from pretest), $SD_{\text{intervention}}=1.07$,
 232 $M_{\text{control}}=5.95$ (0.85% increase from pretest), $SD_{\text{control}}=0.86$], learning efficacy [$\beta=0.04$, $SE=0.17$,
 233 $t(215)=0.21$, $p=.834$, $r=.01$, $M_{\text{intervention}}=5.56$ (6.11% increase from pretest), $SD_{\text{intervention}}=1.30$,
 234 $M_{\text{control}}=5.53$ (5.33% increase from pretest), $SD_{\text{control}}=1.26$], or school belonging [$\beta=-0.18$,
 235 $SE=0.17$, $t(217)=-1.02$, $p=.308$, $r=.07$, $M_{\text{intervention}}=4.59$ (9.81% increase from pretest),
 236 $SD_{\text{intervention}}=1.35$, $M_{\text{control}}=4.77$ (9.43% increase from pretest), $SD_{\text{control}}=1.27$]. All effects remain
 237 non-significant when controlling for pretest assessments [i.e., motivation: $\beta=-0.02$, $SE=0.09$,
 238 $t(214)=-0.27$, $p=.790$, $r=.02$; efficacy: $\beta=0.04$, $SE=0.13$, $t(213)=0.31$, $p=.759$, $r=.02$; belonging:
 239 $\beta=-0.06$, $SE=0.10$, $t(215)=-0.64$, $p=.526$, $r=.04$].

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

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

252 First, we tested the association between growth mindsets at posttest and learning
253 motivation at posttest. Consistent with predictions, growth mindsets significantly predicted
254 posttest learning motivation [$\beta=0.17$, $SE=0.04$, $t(213)=3.92$, $p<.001$]. We followed Tofighi and
255 MacKinnon's (2011) recommendation for computing 95% confidence intervals and submitted
256 the two components of the indirect effect, path a and path b, to the RMediation program. The
257 mediated effect was significant, 95% *CI*: [0.05, 0.23]. Once again, this effect remains when
258 controlling for pretest mindsets and pretest motivation, $\beta=0.08$, $SE=0.04$, $t(211)=2.34$, $p=.020$,
259 95% *CI*: [0.01, 0.11]. With growth mindsets in the model, the effect of condition on posttest
260 motivation (i.e., the direct effect) was significant, $\beta=-0.27$, $SE=0.13$, $t(213)=-2.09$, $p=.038$.

261 Second, we tested the association between growth mindsets at posttest and learning
262 efficacy at posttest. Again consistent with our prediction, growth mindsets significantly predicted
263 posttest learning efficacy, $\beta=0.27$, $SE=0.06$, $t(213)=4.74$, $p<.001$. Confidence intervals computed
264 using RMediation indicated that the mediated effect was significant, 95% *CI*: [0.09, 0.35]. Once
265 again, this effect remains when controlling for pretest mindsets and pretest efficacy, $\beta=0.13$,
266 $SE=0.05$, $t(210)=2.50$, $p=.013$, 95% *CI*: [0.01, 0.16]. The direct effect of condition on posttest
267 efficacy was not significant, $\beta=-0.18$, $SE=0.17$, $t(213)=-1.05$, $p=.294$.

268 Finally, we tested the association between growth mindsets at posttest and school
269 belonging at posttest. Contrary to predictions, growth mindsets at posttest were not associated
270 with school belonging at posttest, $\beta=0.04$, $SE=0.06$, $t(213)=0.61$, $p=.541$. The effect was
271 unchanged when controlling for pretest mindsets and pretest belonging, $\beta=0.04$, $SE=0.04$,
272 $t(210)=0.85$, $p=.397$.

273 **Effects of the intervention at four-month follow-up**

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

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

281 **Academic attitudes.** Consistent with the pattern of results for posttest learning
 282 motivation, learning efficacy, and school belonging, condition did not predict learning
 283 motivation at follow-up [$\beta=-0.08$, $SE=0.15$, $t(206)=-0.50$, $p=.618$, $r=.03$; $M_{\text{intervention}}=5.61$
 284 (2.43% decrease from pretest), $SD_{\text{intervention}}=1.24$, $M_{\text{control}}=5.68$ (3.73% decrease from pretest),
 285 $SD_{\text{control}}=1.05$], learning efficacy at follow-up [$\beta=0.04$, $SE=0.20$, $t(206)=0.18$, $p=.855$, $r=.01$;
 286 $M_{\text{intervention}}=5.36$ (2.29% increase from pretest), $SD_{\text{intervention}}=1.52$, $M_{\text{control}}=5.33$ (1.52% increase
 287 from pretest), $SD_{\text{control}}=1.36$], or school belonging [$\beta=0.23$, $SE=0.21$, $t(206)=1.10$, $p=.273$, $r=.08$;
 288 $M_{\text{intervention}}=4.87$ (16.51% increase from pretest), $SD_{\text{intervention}}=1.47$, $M_{\text{control}}=4.63$ (7.18% increase
 289 from pretest), $SD_{\text{control}}=1.64$].

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

296 First, growth mindsets at follow-up significantly predicted follow-up learning motivation,
297 controlling for condition, $\beta=0.14$, $SE=0.05$, $t(205)=2.78$, $p=.006$. Confidence intervals computed
298 using RMediation indicated that the mediated effect was significant, 95% *CI*: [0.01, 0.14]. With
299 follow-up growth mindsets in the model, the association between condition and follow-up
300 learning motivation (i.e., the direct effect) was not significant, $\beta=-0.14$, $SE=0.15$, $t(205)=-0.88$,
301 $p=.379$.

302 Second, growth mindsets significantly predicted follow-up learning efficacy, controlling
303 for condition, $\beta=0.15$, $SE=0.06$, $t(205)=2.42$, $p=.017$. Confidence intervals computed using
304 RMediation indicated that the mediated effect was significant, 95% *CI*: [0.004, 0.15]. The direct
305 effect of condition on follow-up learning efficacy was not significant, $\beta=-0.03$, $SE=0.20$,
306 $t(205)=-0.15$, $p=.884$.

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

309 **Grades**

310 We examined the total effect of the intervention on grades by estimating a two-level
311 model in which the average of participants' course grades was regressed onto our dummy-coded
312 condition variable in the first level of the model, controlling for the interdependence of students'
313 data in the second level. Analyses revealed no significant total effect of condition on
314 participants' final 10th grade average [$\beta=0.64$, $SE=1.35$, $t(179)=0.47$, $p=.637$, $r=.04$;
315 $M_{\text{intervention}}=81.36$, $SD_{\text{intervention}}=10.27$, $M_{\text{control}}=80.72$, $SD_{\text{control}}=7.85$].

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

319 follow-up). Intervention condition significantly predicted the averaged growth mindsets, $\beta=0.64$,
320 $SE=0.18$, $t(217)=3.61$, $p<.001$. Second, growth mindsets significantly predicted final 10th grade
321 average, controlling for condition, $\beta=2.53$, $SE=0.47$, $t(178)=5.36$, $p<.001$. Finally, we computed
322 95% confidence intervals and submitted the two components of the indirect effect to the
323 RMediation program. Confidence intervals indicated that the mediated effect was significant,
324 95% *CI*: [0.66, 2.79]. The direct effect of condition on grades was not significant, $\beta=-0.60$,
325 $SE=1.28$, $t(178)=-0.47$, $p=.642$.

326 Discussion

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

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

342 only a change in mindsets but also improved academic outcomes. For example, Paunesku and
343 colleagues (2015), in a sample of nearly 1600 students, found that growth mindset interventions
344 can be leveraged to enhance GPAs—especially for students at risk of dropping out. And, using
345 multiple samples of underrepresented students transitioning to college, Yeager and colleagues
346 (2016a), found that growth mindset interventions, relative to the controls, improved enrollment
347 rates and grades, helping to reduce achievement gaps. However, despite many successful
348 interventions, some work has failed to find results. Whereas some of the studies with null results
349 are underpowered (e.g., Donohoe, Topping, & Hannah, 2012; 33 students total), other work may
350 lack sufficient strength to shift mindsets—that is, these studies may not include key ingredients
351 for successful implementation (e.g., a letter stapled to an exam, Bostwick, 2015). The majority of
352 these interventions focus on academic achievement and thus it is hard to make direct
353 comparisons in terms of the lack of total effect on academic attitudes in the current work. One
354 might expect stronger effects on psychological processes than on academic performance, making
355 it especially surprising that we failed to see such an effect.

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

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

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

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

388 **Applications**

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

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

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

412 **Limitations and Future Directions**

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

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

456 mindsets immediately and four months later. In turn, these mindsets predicted more positive
457 academic attitudes including learning motivation and learning efficacy and correlated with
458 higher final grades as well. Growth mindset interventions offer a promising approach, combined
459 with other effective techniques, to counteracting the disadvantages faced by students living in
460 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	<i>M</i>	<i>SD</i>	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**	--

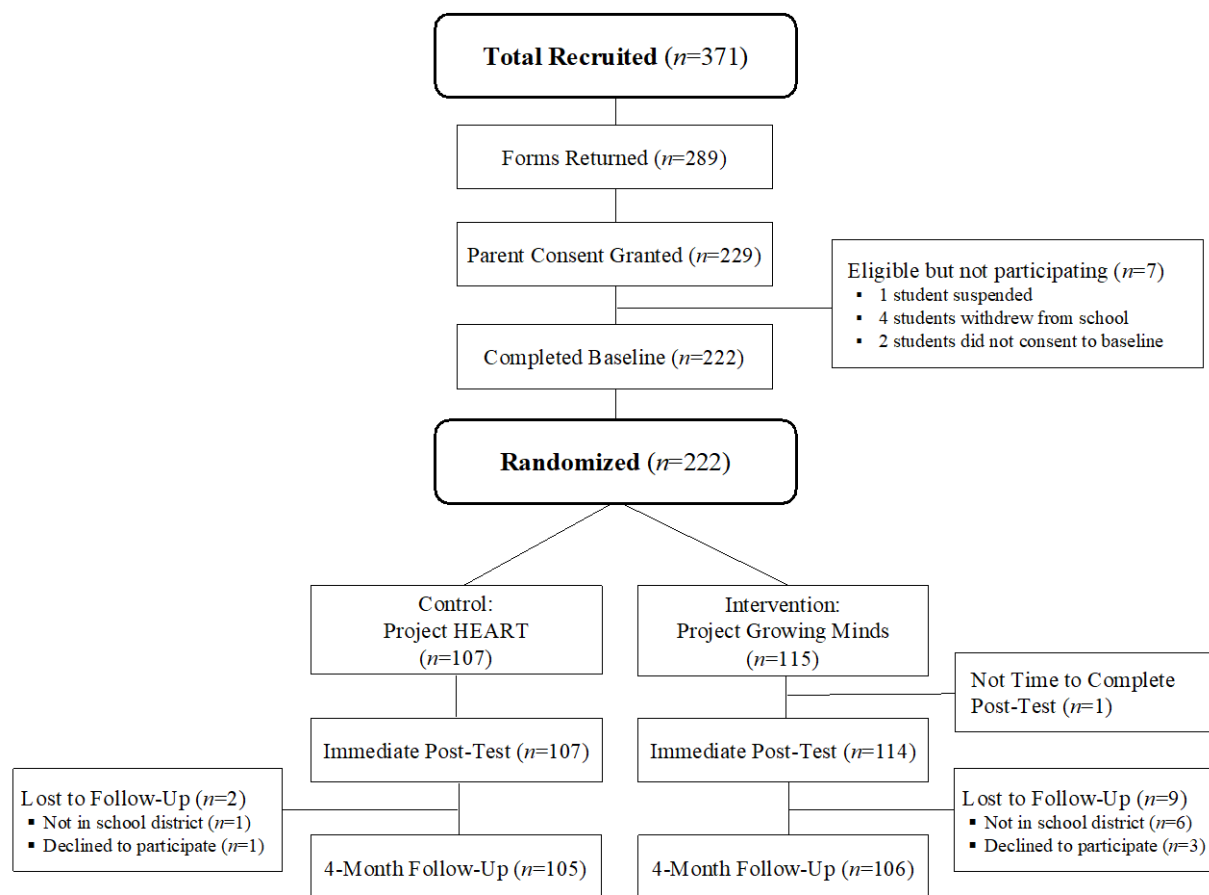


Figure 1. Study recruitment flow chart

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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