

## A growth-theory-of-interest intervention helps align science students with a new multidisciplinary curriculum

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### ABSTRACT

What happens when well-intentioned changes to curricula clash with students' pre-existing academic identity? In the present study, students entered a two-year pre-university school strongly identified with science but not arts—an identity that did not fit with their school's new multidisciplinary curriculum that mandated engagement with both academic areas. We investigated the efficacy of a growth-theory-of-interest intervention (O'Keefe et al., 2023)—which promoted the view that academic interests are developed rather than inherent and fixed—in helping students reap the benefits of the new curriculum. We conducted a randomized controlled field experiment with incoming students who overwhelmingly identified as interested in science but not arts ( $N = 151$ ). Before matriculating, students were randomly assigned to complete the growth-theory-of-interest intervention or active-control materials. Approximately 7 months later, students in the intervention condition reported a stronger arts identity (without diminishing their science identity), and stronger fit and belonging in school, relative to the active control condition. Moreover, whereas developing a stronger arts identity was associated with lower belonging in the control condition, this drop was eliminated in the intervention condition. Finally, by improving students' school belonging, the intervention indirectly predicted higher year-end GPAs. The results underscore the intervention's efficacy in promoting a mindset conducive to multidisciplinary learning and facilitating students' fit and belonging within a curriculum intended to enrich their educational experiences and future career prospects.

### 1. Introduction

History is rife with well-intended policy reformations that failed to solve underlying social problems. For example, policies to eradicate racist ideology from school syllabi in South Africa failed to reduce long-term failure rates among Black students because teachers maintained their racist beliefs (Jansen, 1999). Similarly, when healthier school lunches were introduced in the U.K., students eschewed the healthier options in favor of their less nutritious preferences (Shepherd, 2009). Likewise, a sustainable paper-sourcing initiative, conducted in collaboration with a leading non-profit organization, was largely unsuccessful because of inadequate engagement among employees who held non-eco-friendly values (Ward, 2014). These examples underscore how positive structural changes may be ineffective if they are not aligned with the people they are meant to benefit. To achieve optimal outcomes, new policies may need to be accompanied by interventions that improve the “fit” between the new policy and the attitudes, identities, or values of their intended beneficiaries.

The present research examines the efficacy of a growth-theory-of-interest intervention—which promotes the view that interests can be developed, rather than being inherent and fixed (O'Keefe et al., 2018b, 2021, 2023)—in helping students who strongly identify with science, but not arts, fit better within their new multidisciplinary curriculum that mandates engagement with both academic areas. Indeed, a multidisciplinary education can be instrumental to developing skills relevant to today's job market (e.g., critical thinking and communication), and aligns with the evolving demands of the future of work (Kumar et al., 2022). We tested whether the intervention, compared to an active control condition, can help students with strong science identities become more identified with the arts and feel a greater sense of fit and belonging at their school. Moreover, given that greater school belonging is associated with student achievement, including higher grades (e.g., Allen et al., 2018; Schachner et al., 2019), we examined whether, by increasing students' overall sense of fit and belonging in school, the intervention can predict higher year-end GPA.

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### 1.1. The importance of “fit” between students and curriculum: Implications for school belonging

Person-Environment Fit (P-E fit; Lewin, 1935) posits that adaptive human behavior emerges from the harmonious alignment between personal attributes and environmental factors. When P-E fit is high—that is, an individual's needs, interests, abilities, and values converge and align with the environment's supplies, demands, and values—it yields more favorable outcomes in education and careers (e.g., Bohndick et al., 2018; Li et al., 2013; van Vianen, 2018). Notably, P-E fit based on interests (Holland 1997), suggests that when students are in an educational environment aligned with their academic interests and identities, they will experience improved academic and motivational outcomes. For example, a study of university students revealed that greater congruence between their own interests and the interests of their social environment (e.g., of their peers) contributed positively to their performance, satisfaction, and persistence within science, technology, engineering, and mathematics (STEM) disciplines (Ertl et al., 2022). In another study (Etzel & Nagy, 2016), students who perceived a stronger fit between their academic interests and the curricula offered by their school were significantly more satisfied with their academic experience, and also reported a higher academic performance. In sum, a greater fit between a person's interests, values, or identity, and the requirements of their environment, can foster more positive outcomes within a given environment (Edwards & Cable, 2009).

The present research focused on the fit between students with strong pre-existing interests and identification with the sciences, but not the arts, yet who have matriculated into a pre-university program that, due to nationwide educational policy changes, required engagement in both academic areas and a greater emphasis on multidisciplinary learning. While the top-down policy change was intended to benefit students by fostering broader knowledge and enabling more creative thinking, it risked compromising students' sense of fit with their school. That is, in their new school, students with a strong science identity were being encouraged to explore and embrace the arts. This potentially clashed not only with their own identification with science over arts, but also with what students had, until recently, been taught to value by their educational system, upbringing, and culture—to value science over arts (e.g., Chong, 2017; Mathews et al., 2017). Without also expanding students' academic interests and identities, a new curriculum may create a poor fit between students and their school environment, potentially harming their sense of school belonging.

Indeed, a lack of fit between students' interests or identity and their educational program is associated with poor belonging, while greater fit is associated with higher belonging (e.g., Cohen & Viola, 2022; Master, Cheryan, & Meltzoff, 2016; Murphy, Steele, & Gross, 2007; Stephens et al., 2012; Suhlmann et al., 2018). For example, Master, Cheryan, & Meltzoff, 2016 explored how fit between gender-based academic identity and a stereotyped educational program (computer science) influenced high school students' sense of belonging. Across two experiments, a computer science classroom that did not reinforce common gendered stereotypes about the field increased girls' judgments that they would belong and feel interested in a computer science program compared to a classroom that highlighted those stereotypes. This effect was not observed among boys. Moreover, this reduced sense of belonging in the stereotyped classroom was attributable to the girls' perceived lack of fit with computer science stereotypes. Other research shows that fit between self-construal identity and school culture predicts belonging. In schools that promote ideals of uniqueness and independence—like “find your passion” or “do your own thing”—students who define themselves in terms of their unique characteristics rather than their relationships (i. e., higher independent self-construals) experience higher belonging (Stephens et al., 2012; Suhlmann et al., 2018). While these studies address different issues, they highlight a core phenomenon motivating the present research: that a closer fit between students' identity and their educational program can facilitate belonging, while a lack of fit can

impede it.

The importance of belonging (see Baumeister & Leary, 1995) extends beyond feeling socially connected with others. It also encompasses a sense of personal alignment with one's study materials, activities, and the broader school community (Gummadam et al., 2016). In the present work, we focus on *school belonging*, which we define as the extent to which students feel they fit in and belong and are satisfied with their life at school (for a similar approach, see Moffa et al., 2016). Notably, school belonging can strengthen students' academic self-concept and psychological well-being, as well as their academic success (Allen et al., 2018; Korpershoek et al., 2020; Lavrijsen et al., 2022). Conversely, one can experience alienation when core aspects of their identity fail to harmonize with their environment (Schmader & Sedikides, 2018). For example, a university that promotes a highly independent culture can undermine the belonging and overall academic performance (i.e., GPA) of first-generation students, who tend to have stronger interdependent self-construals (Stephens et al., 2012). Likewise, academic settings emphasizing the significance of “raw intellectual talent” for success can engender feelings of impostership among minoritized women (Muradoglu et al., 2022). The issue of belonging is pressing, as one in four students do not feel a sense of belonging at their school (OECD, 2017).

Yet, despite its importance, there are a dearth of interventions to support or promote school belonging (Allen et al., 2022). Moreover, previous work has seldom considered issues of fit that arise when educational curriculums are introduced that clash with students' pre-existing academic identities. In the present research we ask, How can we foster greater school belonging when students' multidisciplinary curriculum encourages them to adopt new academic interests and identities—in the arts—that do not fit with their pre-existing science identity? Often, efforts to improve fit and belonging between students and their school have focused on adapting the educational environment to better align with students' evolving personal needs and interests (Eccles, 2004; Eccles et al., 1997; Eccles and Midgley, 1989). By contrast, in the present research, we examined how science students can adapt to recent beneficial changes in their educational environment using an intervention to help them view academic interests as developed, not fixed. In doing so, we sought to help these students expand their academic identities while improving their sense of school belonging.

### 1.2. Enhancing fit with a growth theory of interest

The current research drew from previous work on implicit self-theories, which has shown that people hold different beliefs about the malleability of various attributes (see Dweck, 1999; Molden and Dweck, 2006). More specifically, these beliefs refer to whether an attribute is viewed as relatively fixed (referred to as a *fixed theory*) or changeable (referred to as a *growth theory*). Moreover, these beliefs are attribute-specific. For example, people can hold a fixed or growth theory about the nature and workings of intelligence (e.g., Blackwell et al., 2007; Yeager et al., 2019; also see Dweck, 2017; O'Keefe, 2013), empathy (e.g., Schumann et al., 2014), willpower (e.g., Job et al., 2010), opportunities (O'Keefe et al., 2023), and many more (see Dweck, 2017).

The present intervention builds on research examining implicit theories about interest. Research has shown that people tend to hold either a *growth theory of interest*—the view that interests can be developed—or a *fixed theory of interest*—the view that interests are inherent and relatively fixed (O'Keefe et al., 2018b, 2021). Previous work in this area has demonstrated that holding a growth theory of interest has numerous advantages over a fixed theory of interest. For example, it causes people to be more open to areas outside of their pre-existing interest identity and to maintain that interest when difficulty is encountered (O'Keefe et al., 2018b). In one experiment, college students who held an identity, such that their academic interests were rooted in either the sciences or the arts, were more open to material from the opposing

area, as evinced by their expression of more interest, enjoyment, and value when they held a growth (vs. fixed) theory of interest. These findings, among others, show that implicit theories of interest have similar effects across Singaporean and American samples, as well as student and non-student samples (see O'Keefe et al., 2018b, 2021, 2023).

More recently, O'Keefe, Horberg, Dweck, and Walton (2023) conducted a growth-theory-of-interest intervention to examine its potential to improve interest and grades in courses outside of students' pre-existing interest identity. They targeted matriculating first-year undergraduates from the school of arts and social sciences at a large university, most of whom reported that they were not a "math or science person." These students, however, were required to take two math/science courses early in their college career—courses many would have likely not chosen themselves. Before matriculating, students were randomly assigned to one of two conditions that involved completing precisely crafted reading and reflective writing activities that leveraged well-established persuasion techniques. The intervention promoted a growth theory of interest, whereas the active control condition promoted optimal study skills. Each activity took about 30 min to complete. By the end of their first year, among students who reported that they were not an "math or science person," the growth-theory intervention (vs. active control) increased interest in their mandatory math/science courses and they earned higher grades in those courses. The intervention, therefore, helped arts-identified students engage more deeply in their math/science courses and develop an appreciation for an area they might have otherwise discounted.

## 2. The present research

Extending O'Keefe et al. (2023) to novel outcomes and processes, we conducted a randomized controlled field experiment to test how a growth-theory-of-interest intervention may enable students with a strong science academic identity to develop more of an identification with the arts (without diminishing their pre-existing science identity), and to feel greater school belonging as they adopt their stronger arts identity. Finally, we examined how, by strengthening their school belonging, the intervention could improve students' GPA. Although exploratory, this mediation analysis is firmly grounded in prior research showing that increased belonging is associated with higher overall academic performance (e.g., Allen et al., 2018; Schachner et al., 2019). We take a similar approach in the present study: by boosting students' sense of belonging in their multidisciplinary curriculum as a whole, we reason that the intervention can improve the totality of their learning experiences across courses. For example, a growth theory of interest not only enhances identification and interest in new subjects but leads students to see greater connections between their Science and Arts subjects (O'Keefe et al., 2018b), potentially improving their overall academic experiences. Guided by this, we test whether school belonging mediates the effect of the intervention on overall GPA.

### 2.1. Cultural and educational context

The present research was conducted in Singapore, where students consistently rank among the best internationally in math and science (Low, 2020). The country's focus on math and science traces back to its economic rise during the twentieth century. Upon gaining independence in the mid-1960s, Singapore made a concerted effort toward modernization, development, and rapid economic growth (Maitra, 2016). As a small city-state with few natural resources, Singapore accomplished these aims by investing in the education of its people, particularly in math and science subjects that would offer the greatest economic utility for the country (Birger et al., 2008).

While math and science were essential to its post-colonial development, Singapore has more recently recognized the need for education policy reformations that promote holistic, well-rounded learners (Kwek

et al., 2023; Yang & Teng, 2016). Among other changes, the Ministry of Education introduced a compulsory "contrasting" subject into their 2-year pre-university school (called "junior college") curriculum (Ho et al., 2019). Students in the science education track (or "stream"), which is pursued by most junior college students, must complete one arts subject (while students pursuing the arts stream must complete one science subject). The reformed curriculum thus mandates that science students engage with arts subjects.

Yet this structural change may clash with prevailing cultural values, as Singaporean students and parents continue to value math and science over the arts and humanities, which are considered less practical for career paths (e.g., Chong, 2017; Mathews et al., 2017). For example, in 2021, 84% of pre-university students enrolled in the science-stream whereas only 15% enrolled in the arts stream (Ministry of Education Singapore, 2022).

We argue that this shift in educational policy alone may be insufficient to broaden students' academically if it lacks a fit with the norms, values, or perceptions of its beneficiaries. However, social-psychological tools could be used to shift students' perceptions to enhance fit. Importantly, an intervention's success largely hinges on the presence of appropriate affordances in the learning environment—contextual features that support the development of adaptive perspectives or mindsets (Walton & Yeager, 2020). In the case of junior college students in Singapore, the new multidisciplinary curriculum presents built-in opportunities for science-identified students to actively engage in arts subjects, creating fertile ground for a growth-theory-of-interest intervention.

### 2.2. Pre-registered hypotheses

The current study was designed to address multiple hypotheses. This report focuses on four pre-registered hypotheses (described in the pre-registrations of the mid-year and late-year follow-up surveys; see below for links). No other follow-ups were conducted.

First, we pre-registered two hypotheses regarding the effect of the intervention on academic interest. Specifically, we hypothesized that, compared to those who completed the control materials, those who completed the growth-theory-of-interest intervention would report greater interest in subjects *outside* of their core academic identity (called "interest identities" in the pre-registration), but would maintain equally strong interest in subjects within their core academic identity. We did not pre-register specific analyses; however, following O'Keefe et al. (2023), and given that our final student sample was overwhelmingly in the science stream (94.7%) and identified with science but not arts upon entering junior college, we tested these hypotheses in relation to those areas. That is, we examined whether, relative to the control condition, the intervention would lead students to report stronger interest in arts, humanities, and social science subjects (Hypothesis 1) without diminishing their interest in math and science subjects (Hypothesis 2). We tested these hypotheses by examining how students' identification toward generalized arts and science subjects changed as a function of condition.<sup>1</sup>

Next, we pre-registered the hypothesis that the intervention would lead to greater school belonging (i.e., overall sense of belonging and satisfaction in their junior college) (Hypothesis 3).

Finally, we pre-registered that the intervention would lead to higher achievement (i.e., grades) in subjects outside of students' core academic

<sup>1</sup> We had assessed their level of interest (and other perceptions) toward their specific courses but did not test hypotheses with respect to those courses. This was due to the wide variability in course enrollment; that is, students chose their content-based courses from a list of up to 14 options. So, many students did not take identical courses. Such variability would have introduced significant noise into course ratings, and our sample size did not permit multilevel analysis to account for it.

identity (Hypothesis 4). However, as students completed different course combinations (see Footnote <sup>1</sup>), we did not have a sufficiently large sample to account for this wide variability. Therefore, we deviated from our pre-registered plan. Based on previous research showing that increasing students' school belonging can predict stronger overall academic performance (e.g., Allen et al., 2018; Schachner et al., 2019; Williams et al., 2020), we analyzed whether the intervention indirectly led to a higher overall GPA via stronger school belonging.

### 2.3. Transparency and openness

The participants, method, materials, and hypotheses were pre-registered (Time 1: [tinyurl.com/jcToi1](https://tinyurl.com/jcToi1); Time 2 mid-year follow-up: [tinyurl.com/jcToi2](https://tinyurl.com/jcToi2); Time 3 late-year follow-up: [tinyurl.com/jcToi3](https://tinyurl.com/jcToi3)). For uploaded materials, select "Components," then "Materials," then "Files," then "Archive of OSF storage." To view the content of the Method, Participants, and Hypotheses components, select "Components," followed by the desired component, then "Wiki." Note that hypotheses about belonging were pre-registered in the mid-year and late-year follow-ups, before those constructs were assessed. We report how we determined our sample size, data exclusions, all manipulations, and all measures in the study, and we followed JARS (Kazak, 2018). Data were analyzed using SPSS, version 29, and are available at <https://tinyurl.com/JCData>. This study was approved by the institutional review board of the first author's institution at the time of the study.

### 2.4. Method

#### 2.4.1. Participants and procedure

We recruited an initial sample of 154 students (65.6 % female;  $M_{\text{age}} = 16.61$ ,  $SD = 0.59$ ) from a reputed government-aided junior college in Singapore. However, one participant who spent only 1.13 min on the Time 1 materials was removed, and two provided nonsensical, inattentive responses (specifically, straight-line entries where they selected the most extreme response (e.g., "strongly disagree") for scale items framed in opposite directions (Meade & Craig, 2012)). Omitting those students left a final sample of  $n = 151$  at Time 1.

This research focused on the first year of students' curriculum, in which all students complete a combination of four content-based subjects, plus a language course in their mother tongue (Chinese, Malay, or Tamil), and a "general paper" (i.e., writing and critical thinking) course. For their four content-based subjects, students in the science stream completed three science or math subjects of their choosing (e.g., chemistry, math, biology) plus one "contrasting" arts, humanities, or social science subject (e.g., history, literature, economics). Students in the arts stream choose three arts, humanities, or social science subjects plus one "contrasting" science or math subject.

Upon entering junior college, students were overwhelmingly science-focused. In our sample, 94.7% ( $n = 143$ ) were in the science stream (and, as reported below, held a strong pre-existing academic identity in math and science, but not in arts, humanities, and social sciences).<sup>2</sup>

The study timeline and procedure are shown in Fig. 1. Singapore is an English-speaking country and, apart from language courses, all subjects were taught in English. The study was conducted in English.

As stated in the pre-registration, all students in the incoming first-year cohort were invited to participate (approximately 850–900

<sup>2</sup> Results were nearly identical when excluding students enrolled in the arts stream ( $n=8$ ). Effects of the intervention (vs. control) on late-year school belonging, the indirect effect of the intervention on GPA via school belonging, and the interaction of condition with late-year arts identity on school belonging all remained statistically significant ( $p < .05$ ). The sole difference was that the effect of condition on late-year Arts identity became  $p = .055$  with the reduced sample. The central analyses below report results from the full sample.

students). During orientation, which took place the week before course instruction began, students received a brief announcement about the study from their orientation group leader and received an information packet containing a cover letter, information sheet and parental consent form. No mention was made of different treatment conditions in the recruitment materials. Instead, the announcement and information packet described the research in broad terms, as an initiative "to understand how students can successfully transition to [Junior College], and to assist them with this new chapter of their academic lives." They were further informed that the research would involve completing an online activity ("to help students think about their studies and academic motivations") at the beginning of the semester, plus brief follow-up surveys at the mid-year and late-year. By communicating through senior authorities at the school rather than the research team, we aimed to enhance the value of and attention to the materials, while encouraging retention.

Our final sample size comprised approximately 17% of the total cohort. While not the majority, our numbers are relatively strong in light of parents' and students' hesitation to volunteer students' time toward a non-compulsory activity that would not explicitly benefit test scores and grades. Students in this culture—and particularly junior college students preparing for university entrance exams—are under strong pressure to focus on their studies and test preparation, to the exclusion of other activities. For example, Singaporean students experience high academic anxiety (Li et al., 2008) and strong parental pressure to invest heavily in their studies (e.g., Sudo et al., 2023). To counteract these challenges and maximize participation, we emphasized that the research aimed to benefit students in school and was endorsed by their institution. This enabled us to recruit a larger final sample than might have otherwise been possible.

The week before course instruction, students who returned a signed parental consent form were emailed a link to the online Time 1 materials to complete at home. Time 1 consisted of a pre-treatment survey followed by the growth-theory-of-interest intervention or active control materials, which were randomly assigned by the survey software (Qualtrics).

The key outcomes of academic identity and belonging in junior college were assessed at two follow-up time points. The mid-year follow-up survey was conducted approximately 10 weeks after the intervention ( $n = 126$ ; 83.4% retention) and the late-year follow-up survey was conducted 28 weeks after Time 1 ( $n = 124$ ; 82.1% retention). During a designated class period, participating students received the survey link from their instructor to complete at that time or to finish at home. Students who were absent from class received the link by email from their instructor.

Students' final grades were retrieved at the end of the year ( $n = 149$ ; records were not available for two students).

### 2.5. Measures and materials

#### 2.5.1. Pre-treatment survey

The pre-treatment survey assessed participants' gender, age, and pre-existing academic identity in science and arts. Descriptive statistics of all study variables are presented in Table 1.

**Pre-existing Academic Identities.** Following past research (O'Keefe et al., 2018b, 2021, 2023), students completed two items assessing pre-existing science identity: "I am a Sciences-oriented person (for example, biology, chemistry, physics)" and "I am a Maths-oriented person (for example, algebra, calculus, computing)" (1 = *strongly disagree*, 6 = *strongly agree*). These two items were positively correlated,  $r(149) = 0.46$ ,  $p < 0.001$ , and averaged into a pre-existing science identity composite ( $M = 4.59$ ,  $SD = 0.99$ ). To assess their pre-existing arts identity, participants rated two items using the same 6-point scale: "I am an Arts/Humanities-oriented person (for example, art, languages, literature)" and "I am a Social Sciences-oriented person (for example, economics, geography, history)." These two items were

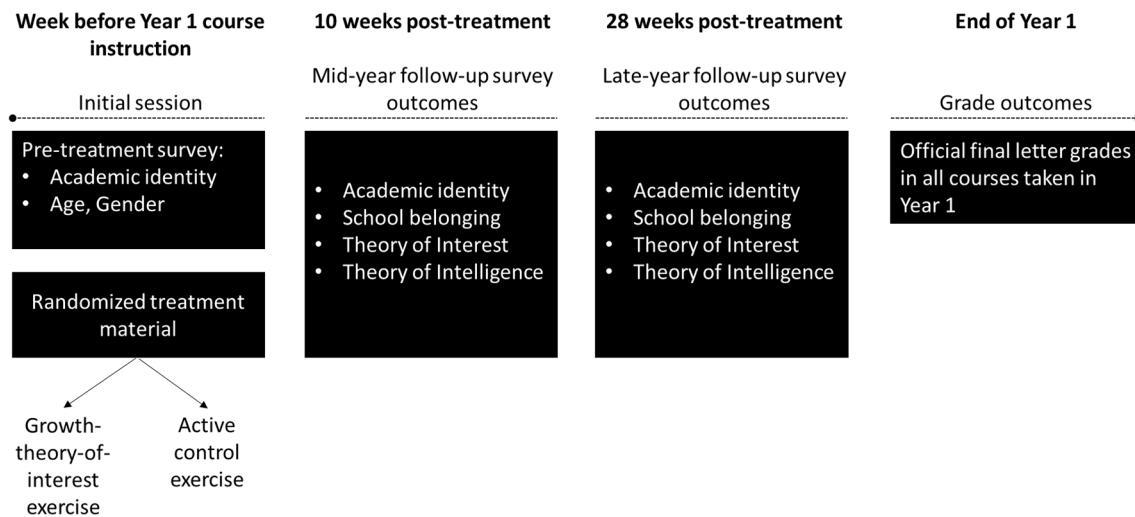


Fig. 1. Overview of the Timeline and Procedure.

positively correlated,  $r(149) = 0.32, p < 0.001$ . Again, following past research (O'Keefe et al., 2018b, 2021, 2023), we averaged them into a pre-existing arts identity composite ( $M = 3.35, SD = 1.03$ ). As expected, the science-identity composite was negatively correlated with the arts-identity composite,  $r(149) = -0.46, p < 0.001$ .

Consistent with their academic streams, students' pre-existing science identity was relatively high ( $M = 4.59, SD = 0.99$ ), and significantly higher than their pre-existing arts identity ( $M = 3.35, SD = 1.03$ ), paired  $t(150) = -8.77, p < 0.001, d = -1.24$ . Indeed, 80.8% of the students began with a high science academic identity (i.e., scored above the scale midpoint of 3.5) whereas only 31.8% began with a high arts identity (i.e., above 3.5). This supports the strong science academic identity of incoming students and, therefore, our evaluation of how the intervention could help promote students' identification with arts.

Students who completed the follow-up surveys did not vary from those who did not on any covariate or predictor (i.e., age, gender, pre-existing science identity, pre-existing arts identity;  $0.999 > ps > 0.080$ ).

### 2.5.2. Randomized growth-theory-of-interest and active control materials

Immediately after the pre-treatment survey, students were randomly assigned to complete either the growth-theory-of-interest or active control materials. These are described below and available through the Time 1 pre-registration link provided above.

The intervention and control materials were nearly identical to those used in O'Keefe et al. (2023). The core content and messages were unchanged but minor revisions were made to render the materials applicable to the students' school context (e.g., referring to the name of the junior college or to specific subjects in their curriculum).

Both conditions consisted of a series of engaging reading and reflective writing tasks that were similar in structure but varied in their content. In line with past intervention research (e.g., O'Keefe et al., 2023; Walton and Cohen, 2011), the materials were not presented as an intervention. Students were told that their participation was part of a school-wide initiative to better understand its students, and their responses would be used to assist future incoming students in their transition to junior college. As such, the materials positioned students not as targets of an intervention (nor as deficient in some way), but as experts and co-creators of materials that could be used to benefit others. Moreover, highlighting the benefits of the materials provided a compelling motivation for new students to engage in them.

The median completion time of the pre-treatment survey plus randomized materials was 24.52 min in the growth-theory-of-interest condition and 22.72 min in the control condition. The distribution was positively skewed ( $z = 23.45, p < 0.001$ ) and did not differ significantly between conditions,  $\chi^2(1) = 0.06, p = 0.804$ .

**Growth-Theory-of-Interest Intervention.** The intervention materials portrayed interests as cultivated and not fixed, and discussed how this way of thinking could help people cultivate and sustain new interests. Importantly, the materials discussed a range of different topics, and did not focus exclusively on science or arts subjects. Thus, unlike other interventions that target and promote interest in particular topics (e.g., Harackiewicz et al., 2012; Hulleman & Harackiewicz, 2009), the present materials sought to shift implicit beliefs about the nature and workings of interest.

The materials began with an accessible 1-page article that drew from actual research findings (O'Keefe et al., 2018b) to represent how interests can be developed, and are not fixed, and how this perspective can help people develop and sustain new interests, even if those new interests become difficult or tedious to pursue at times. This element of the intervention leveraged the central route to persuasion (Petty et al., 1981), as it was a message relevant and useful to students about to embark on a new and challenging chapter of their education, which required engagement with subjects outside of their core academic identity.

This was followed by a short writing task in which students described a time from their lives when they personally cultivated an interest in a new subject or activity. For example, one student wrote:

"I thought I would not be interested in Social Studies because I don't know much about current affairs. I failed my first SS test and ended up disliking it even more. After a few months, I decided to have an open mind and I ended up being interested in the subject as I gained insights and different opinions about topics of interest, even though it still wasn't my best subject."

This exercise leveraged the saying-is-believing effect, such that freely advocating for a position to a relevant audience can cause one's attitudes to become consonant with that position (Aronson, 1999). Thus, by writing about the developmental nature of interest, students should come to endorse that belief more strongly.

Next, students read four peer testimonials and a summary of survey findings. The testimonials detailed personal accounts of how students developed new academic interests in junior college, even if they initially doubted their potential for interest in those areas or occasionally found the subjects difficult or boring. The summary of findings reinforced these ideas, stating that many students initially have concerns about taking courses outside of their pre-existing interests but, over time, come to develop interest in those subjects. These elements of the intervention leveraged informational social influence (see Cialdini & Goldstein, 2004) because older peers are seen as a source of valid and useful information. Thus, reading about older students' tendency to develop new

**Table 1**  
Descriptive Statistics and Correlations.

Variables	M	SD	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. Condition	0.05	1.00	--															
2. Gender	0.33	0.47	-0.12	--														
3. Age	16.63	0.60	-0.19*	0.05	--													
4. Pre-existing Science Identity	4.59	1.00	-0.14†	0.29**	0.06	--												
5. Pre-existing Arts Identity	3.35	1.03	0.14†	-0.34**	-0.07	-0.46**	--											
6. Mid-year Theory of Interest	3.05	0.79	0.10	-0.16†	-0.14	0.08	0.08	--										
7. Late-year Theory of Interest	3.24	0.79	0.19*	-0.15†	-0.10	-0.15†	0.08	0.44**	--									
8. Mid-year Theory of Intelligence	3.57	1.14	0.13	-0.06	-0.04	0.10	0.05	0.24**	0.02	--								
9. Late-year Mindset of Intelligence	3.41	1.08	0.14	0.05	0.07	0.09	0.07	0.22*	0.51**	0.16†	--							
10. Mid-year Science Identity	4.39	1.05	-0.19*	0.25**	0.21*	0.75**	-0.39**	-0.11	-0.14	0.22*	0.07	--						
11. Late-year Science Identity	4.34	0.94	-0.06	0.36**	0.02	0.73**	-0.30**	-0.12	-0.18*	0.04	0.03	0.75**	--					
12. Mid-year Arts Identity	3.34	1.14	0.10	-0.24**	0.02	-0.42**	0.77**	0.14	0.17†	0.05	-0.10	-0.25**	-0.29**	--				
13. Late-year Arts Identity	3.45	1.09	0.19*	-0.34**	-0.06	-0.50**	0.67**	0.16	0.17†	0.04	-0.10	-0.40*	-0.37**	0.69**	--			
14. Mid-year School Belonging	4.37	0.98	0.09	-0.08	0.03	0.19*	0.10	0.00	0.00	-0.04	0.17†	0.26**	0.24*	0.06	-0.17†	--		
15. Late-year School Belonging	4.23	1.07	0.22*	-0.06	-0.00	0.14	0.09	0.18†	0.09	0.04	0.16†	0.12	0.16†	0.03	-0.11	0.62**	--	
16. Final GPA	4.44	1.08	-0.07	0.15†	0.13	0.27**	-0.29**	0.00	-0.10	-0.01	0.01	0.25**	0.43**	-0.3**	0.00	0.18*	0.18*	--

Note. M = Mean. SD = Standard Deviation. \* $p < 0.05$ , \*\* $p < 0.01$ , † $p < 0.10$ .

interest in junior college, and the benefits of doing so, would be highly persuasive.

Finally, students wrote a brief set of essays regarding (a) their concerns about taking subjects outside their pre-existing interests and why such concerns were likely to be common among junior college students, (b) how understanding that interests can be developed might help students cultivate new interests, and (c) how this understanding can help students maintain a new interest even if it becomes difficult or boring at times. The prompt was broken down into three parts to ensure students addressed each part of the essay task. Students were encouraged to write detailed responses and provide examples, as their responses may be used as guidance for future students making the transition to junior college. For example, one student wrote.

“Understanding that interests can be developed helps students to keep an open mind when they’re exposed to academic topics outside of their existing interests. It also encourages them to not give up and push through in the face of difficulties they encounter while studying. Sometimes, they just have to keep an open mind and push through in the face of adversity in order to reap the fruits of their labour.”

As with the prior essay, this task leveraged the saying-is-believing effect.

**Active Control (Study-Skills) Materials.** As in O’Keefe et al. (2023), the active control materials addressed useful and effective study skills. Moreover, like the intervention condition, it highlighted growth processes, in that it emphasized the development of effective study skills. Thus, the materials were designed to be beneficial to students, but not to change their theory of interest. The format and structure of the control materials mirrored the intervention. First, students read a 1-page article highlighting research on optimal study skills (e.g., active learning and time management). Next, they wrote a short essay describing a time in their life when they learned a new and useful study skill. Students then read four testimonials and a summary of survey findings from older students. The testimonials communicated how students learned and applied beneficial study skills during junior college (e.g., creating study guides). The survey summary communicated that incoming junior college students commonly have concerns about the increased workload, but that adopting new study skills was effective in overcoming those challenges. Finally, participants wrote a set of brief essays on (a) their concerns about the impending workload and how those concerns are common among students, (b) how to discover new study skills, and (c) how to use these newly developed study skills to manage the workload.

Essay prompts and sample student responses in treatment and control conditions are presented in Supplemental Table 1.

**2.5.3. Follow-up surveys and outcomes**

The pre-registered dependent variables we focus on in this report were students’ (a) growth theory of interest, (b) sense of fit and belonging to their junior college, (c) post-treatment arts and science academic identities, and their (d) year-end grade point average.

**Theories of Interest (and Theories of Intelligence).** To examine whether the intervention (vs. control) successfully shifted students toward a stronger growth theory over time, we assessed their theory of interest using O’Keefe et al.’s (2018b) Implicit Theories of Interest scale. This scale contains four items (“No matter how central your interests are to you, they can change substantially,” “To be honest, your core interests will remain your core interests. They won’t really change,” “You can be exposed to new things, but your core interests won’t really change,” “Even if you have very strong interests, they can change dramatically”); 1 = *strongly disagree*, 6 = *strongly agree*). The two fixed-theory-phrased items were reverse scored and averaged with the two growth-theory-phrased items to form a composite wherein higher scores reflected a stronger growth theory of interest (mid-year follow-up:  $\alpha = 0.74$ ,  $M = 3.05$ ,  $SD = 0.79$ ; late-year follow-up:  $\alpha = 0.73$ ,  $M = 3.23$ ,  $SD = 0.79$ ).

Similarly, Dweck’s (1999) 4-item Implicit Theories of Intelligence

scale was used (e.g., “You have a certain amount of intelligence, and you can't really do much to change it”; 1 = *strongly disagree*, 6 = *strongly agree*). All items, which were fixed-theory-phrased, were reverse scored before being averaged into a composite, such that higher scores indicated more of a growth theory of intelligence (mid-year follow-up:  $\alpha = 0.93$ ,  $M = 3.57$ ,  $SD = 1.14$ ; late-year follow-up:  $\alpha = 0.94$ ;  $M = 3.41$ ,  $SD = 1.08$ ). Theory-of-interest and theory-of-intelligence scores were positively correlated at the mid-year follow-up,  $r(124) = 0.24$ ,  $p = 0.006$ , but not at the late-year follow-up,  $r(122) = 0.02$ ,  $p = 0.824$ .

**Academic Identity.** The scales used to assess pre-existing academic identities in the pre-treatment survey were administered again to assess post-treatment academic identities. Once again, math and science identity items were averaged into a science-identity composite (mid-year follow-up:  $r(126) = 0.57$ ,  $p < 0.001$ ;  $\alpha = 0.72$ ,  $M = 4.39$ ,  $SD = 1.05$ ; late-year follow-up:  $r(126) = 0.53$ ,  $p < 0.001$ ;  $\alpha = 0.68$ ,  $M = 4.34$ ,  $SD = 0.94$ ). Similarly, arts/humanities and social science orientation items were averaged into an arts-identity composite (mid-year follow-up:  $r(126) = 0.47$ ,  $p < 0.001$ ;  $\alpha = 0.64$ ,  $M = 3.34$ ,  $SD = 1.14$ ; late-year follow-up:  $r(126) = 0.51$ ,  $p < 0.001$ ;  $\alpha = 0.68$ ;  $M = 3.45$ ,  $SD = 1.09$ ). As in Time 1, these two variables were negatively correlated (mid-year follow-up:  $r(126) = -0.25$ ,  $p = 0.005$ ; late-year follow-up:  $r(126) = -0.37$ ,  $p < 0.001$ ).

**School Belonging.** We assessed sense of school belonging with two items adapted from past research on belonging (O'Keefe et al., 2023; Walton and Cohen, 2007), “Overall, I feel like I fit in and belong at [Junior College]” and “Overall, I am satisfied with my life at [Junior College]” (1 = *strongly disagree*, 6 = *strongly agree*). On average, students reported relatively strong school belonging (mid-year follow-up:  $r(124) = 0.82$ ,  $p < 0.001$ ;  $\alpha = 0.90$ ;  $M = 4.37$ ,  $SD = 0.98$ ; late-year follow-up:  $r(122) = 0.86$ ,  $p < 0.001$ ;  $\alpha = 0.94$ ;  $M = 4.23$ ,  $SD = 1.07$ ).

**Grade Point Average (GPA).** To compute GPA, we obtained official final grades from the student records office at the end of the academic year. At this junior college, grades are issued according to a 7-point letter system ranging from a low of ‘U’ to a high of ‘A.’ Following past research (O'Keefe et al., 2023; Paunesku et al., 2015), we transformed letter grades to a 7-point numeric system (1 = U, 2 = S, 3 = E, 4 = D, 5 = C, 6 = B, 7 = A). GPA was computed by averaging their grades across courses.

## 2.6. Results

### 2.6.1. Analytic approach

Following past growth-theory-of-interest intervention research (O'Keefe et al., 2023; Pilot Study) and related studies of social-psychological (“wise”) interventions (Walton et al., 2015; Yeager et al., 2014), analyses were conducted primarily with multiple regression, and we examined mid-year and late-year outcomes in separate analyses. As reported below, we tended to find that effects emerged in the late-year assessments, which is consistent with past research and theorizing showing that developmental processes initiated by social-psychological interventions have compounding benefits that emerge over time (e.g., Harackiewicz and Priniski, 2018; O'Keefe et al., 2023; Walton & Cohen, 2011; Walton et al., 2015; Walton & Wilson, 2018; Yeager et al., 2016).

### 2.6.2. Success of random assignment

With respect to random assignment, we found no significant differences between the treatment and control conditions on pre-intervention measures of gender, science identity, or arts identity ( $0.152 > ps > 0.077$ ). However, age was significantly lower in the intervention condition ( $M = 16.52$ ,  $SD = 0.53$ ) than in the control condition ( $M = 16.74$ ,  $SD = 0.64$ ),  $t(149) = -2.35$ ,  $p = 0.020$ ,  $d = 0.38$ . The significance of our central results did not vary when controlling for age.

Correlations between all study variables are presented in Table 1. All statistical analyses were two-tailed.

### 2.6.3. Preliminary analyses

Pre-existing science identity and pre-existing arts identity were collected before the randomized treatments and neither significantly interacted with treatment condition to predict nearly any central outcome ( $.959 > ps > 0.070$ ). The exception was mid-year school belonging,  $b = -0.27$ ,  $t(122) = -3.08$ ,  $p = 0.003$ , 95% confidence interval (CI) [-0.442, -0.096]. In the control condition, students with a higher pre-existing science identity reported stronger mid-year school belonging,  $b = 0.53$ ,  $t(122) = 3.92$ ,  $p < 0.001$ , compared to those in the growth-theory condition,  $b = -0.01$ ,  $t(122) = -0.09$ ,  $p = 0.929$ ,  $d = 0.18$ . However, this effect did not emerge in the late-year follow-up. Generally, therefore, pre-existing academic identities did not interact with condition to determine central outcomes. Interactions with gender and age on outcomes were rare and are fully presented in the [Supplemental Material](#).

### 2.6.4. Endorsement of a growth theory of interest

For our first central analysis, we examined whether students in the growth-theory intervention condition reported a stronger growth theory of interest than those in the control condition by mid-year (10 weeks after Time 1) and late-year (28 weeks after the Time 1).

In mid-year, although in the expected direction, theory-of-interest scores in the intervention condition ( $M = 3.13$ ,  $SD = 0.77$ ) did not differ significantly from those in the control condition ( $M = 2.97$ ,  $SD = 0.82$ ),  $b = 0.81$ ,  $t(124) = 1.15$ ,  $p = 0.252$ , 95% CI [-0.058, 0.221],  $d = 0.20$ . However, as predicted, we found that by late-year, students in the intervention condition reported a stronger growth theory of interest ( $M = 3.39$ ,  $SD = 0.80$ ) compared to those in the control condition ( $M = 3.08$ ,  $SD = 0.74$ ),  $b = 0.15$ ,  $t(122) = 2.17$ ,  $p = 0.032$ , 95% CI [0.014, 0.289],  $d = 0.39$ . As stated above, that this effect did not emerge until late-year is consistent with the recursive processes thought to underlie social-psychological interventions—namely, that such interventions initiate small changes that, over time, snowball into meaningful gains (Walton & Wilson, 2018).

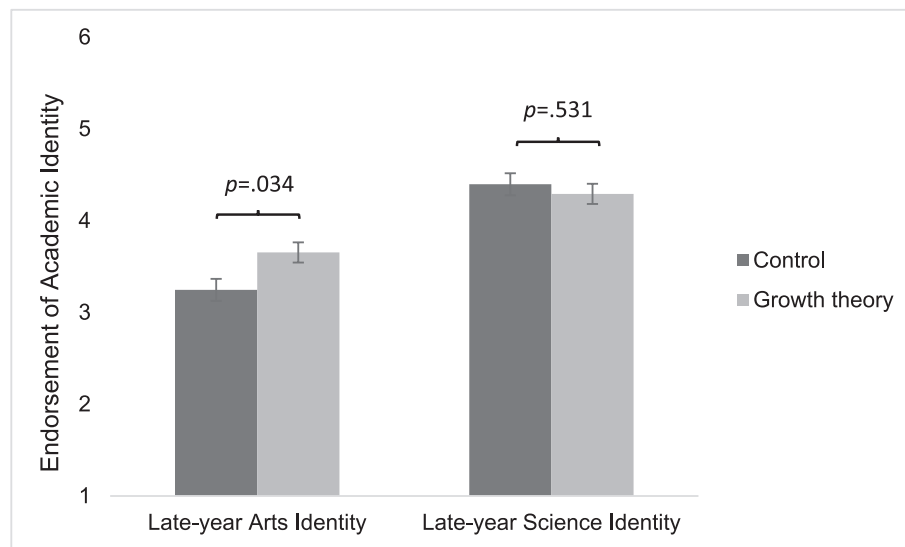
We next tested whether the treatment effect held when controlling for students' theory of intelligence. The effect remained significant,  $b = 0.15$ ,  $t(121) = 2.16$ ,  $p = 0.033$ , 95% CI [-0.012, 0.292],  $d = 0.39$ . Moreover, although theory-of-interest and theory-of-intelligence scores were correlated in mid-year, they were unrelated by the late-year (see Table 1). There were no condition differences for students' theory-of-intelligence scores in mid-year or late-year ( $ps > 0.119$ ).

In sum, by late-year, the growth-theory intervention successfully led students to adopt a stronger belief that interests can be developed, relative to the control condition. Furthermore, as in prior research (O'Keefe et al., 2023), our materials did not affect students' theory of intelligence, demonstrating the precision and durability of our intervention to change beliefs about the nature and workings of interest and not of intelligence.

### 2.6.5. Endorsement of an arts (and science) academic identity

Did the intervention lead students to more strongly identify with the arts, relative to the control condition, as pre-registered? By mid-year, although in the correct direction, this difference did not reach significance, with students in the intervention condition reporting a stronger arts identity ( $M = 3.45$ ,  $SD = 1.31$ ) than students in the control condition ( $M = 3.22$ ,  $SD = 0.94$ ),  $b = 0.12$ ,  $t(126) = 1.15$ ,  $p = 0.253$ , 95% CI [-0.084, 0.316],  $d = 0.20$ . However, as shown in Fig. 2, by late-year, this difference became significant, as predicted. Students who completed the growth-theory intervention reported a stronger arts identity ( $M = 3.65$ ,  $SD = 1.19$ ) than those in control condition ( $M = 3.25$ ,  $SD = 0.95$ ),  $b = 0.20$ ,  $t(126) = 2.14$ ,  $p = 0.034$ , 95% CI [0.015, 0.393],  $d = 0.19$ . Thus, these students' academic identities expanded to better fit their multidisciplinary curriculum.

Did this boost in arts identity come at a cost to students by diminishing their science identity relative to the control condition? We pre-registered the hypothesis that students' science identity would not differ between conditions, which our results supported. At mid-year,



**Fig. 2.** Effect of Treatment Condition on Late-year Arts Identity and Science Identity ( $n = 128$ ).  
*Note.* Bars represent standard errors.

although students in the growth-theory condition appeared to report a somewhat weaker science identity ( $M = 4.19$ ,  $SD = 1.05$ ) compared to the control condition ( $M = 4.59$ ,  $SD = 1.01$ ),  $b = -0.20$ ,  $t(126) = -2.21$ ,  $p = 0.029$ , 95% CI [-0.382, -0.021],  $d = 0.39$ , this difference became non-significant when controlling for students' age,  $b = -0.17$ ,  $t(125) = -1.81$ ,  $p = 0.073$ , 95% CI [-0.347, 0.016]. As reported earlier, age had differed significantly between conditions. Therefore, because the condition difference on science identity did not hold when controlling for age, we conclude that there was no reliable condition difference in science identity. More importantly, as shown in Fig. 2, by late-year, science identity did not differ between the intervention condition ( $M = 4.29$ ,  $SD = 0.92$ ) and the control condition ( $M = 4.39$ ,  $SD = 0.96$ ),  $b = -0.52$ ,  $t(126) = -0.63$ ,  $p = 0.531$ , 95% CI [-0.217, 0.113],  $d = 0.11$ , including in an analysis that controlled for age,  $b = -0.05$ ,  $t(125) = -0.59$ ,  $p = 0.559$ , 95% CI [-0.218, 0.119]. Taken together, these results support our hypothesis that the growth-theory intervention did not diminish students' pre-existing science identity.

#### 2.6.6. School belonging

Did the intervention lead to stronger school belonging compared to the control condition, as pre-registered? By mid-year, although in the expected direction, the difference in school belonging between students who completed the intervention ( $M = 4.45$ ,  $SD = 0.84$ ) and the control condition ( $M = 4.28$ ,  $SD = 1.11$ ) did not reach significance,  $b = 0.09$ ,  $t(124) = 0.99$ ,  $p = 0.320$ , 95% CI [-0.086, 0.261],  $d = 0.18$ . However, by late-year, this difference became significant, with stronger school belonging in the intervention condition ( $M = 4.47$ ,  $SD = 0.94$ ) than in the control condition ( $M = 3.99$ ,  $SD = 1.14$ ),  $b = 0.24$ ,  $t(122) = 2.53$ ,  $p = 0.013$ , 95% CI [0.052, 0.425],  $d = 0.45$ .<sup>3</sup> We obtained similar significant results when examining the school belonging item alone (see Footnote 3); however, we focus on the 2-item measure for greater reliability.

<sup>3</sup> Analyzing the single item, "Overall, I feel like I fit in and belong at [Junior College]" at mid-year, students who completed the growth-theory condition reported marginally significantly stronger school belonging ( $M=4.49$ ,  $SD=0.82$ ) compared to those in the control condition ( $M=4.19$ ,  $SD=1.13$ ),  $b=0.15$ ,  $t(124)=1.71$ ,  $p=.090$ , 95% CI [-0.024, 0.325],  $d=0.30$ . By late-year, this difference became significant, with greater school belonging in the growth-theory condition ( $M=4.47$ ,  $SD=0.94$ ) than in the control condition ( $M=3.97$ ,  $SD=1.17$ ),  $b=0.25$ ,  $t(122)=2.62$ ,  $p=.010$ , 95% CI [0.061, 0.439],  $d=0.47$ .

#### 2.6.7. Grade point average at the end of the year

Next, we examined students' year-end GPA. As stated earlier (see Pre-Registered Hypotheses), we deviated from our pre-registration by examining whether the growth-theory intervention indirectly predicted higher year-end GPA via greater sense of school belonging.<sup>4</sup> Because the treatment effect on school belonging emerged in late-year, we focused on mediation via late-year school belonging. The analysis was conducted with the PROCESS macro (version 4.2) for SPSS, and the indirect effect was tested with a percentile bootstrap method, using 5,000 bootstrap samples.

As shown in Fig. 3, the total effect of condition on year-end GPA was not significant, suggesting the intervention did not have an overall impact on grades (consistent with O'Keefe et al., 2023, Pilot Study). However, school belonging did predict higher GPA,  $b = 0.21$ ,  $t(120) = 2.27$ ,  $p = 0.025$ , 95% CI [0.027, 0.392], and the test of the indirect effect was significant, as the 95% bootstrapped CI did not contain 0 [0.002, 0.102]. Thus, consistent with our hypothesis, by increasing students' sense of school belonging, the intervention indirectly predicted higher grades by the end of year.

#### 2.6.8. Exploratory analysis: How strengthening arts identity from a growth-theory intervention supports higher school belonging

Did the intervention help students maintain a stronger sense of school belonging the more they developed a stronger arts identity? If so, this would further suggest that the intervention helped science-stream students adjust and fit into a school context that aimed to prioritize both science and arts. For this, we capitalized on the fact that, although the intervention led to an overall increase in arts identity by late-year, there was also variation among students (e.g., the standard deviation in arts identity in late-year was 1.19). Therefore, we conducted a moderated multiple regression predicting students' late-year school belonging from treatment condition, late-year arts identity, and their interaction, while controlling for students' pre-existing arts identity (to

<sup>4</sup> One might ask whether the intervention indirectly predicted final GPA via arts identity. An analysis similar to that shown in Fig. 3 but with late-year arts identity as the mediator showed no significant indirect effect (95% CI of the bootstrapped test of the indirect effect contained 0 [-0.089, 0.003]). However, this lack of mediation via arts identity is consistent with previous research showing that coming to value a course as personally interesting does not necessarily translate into higher grades in that course (e.g., Hulleman et al., 2008).



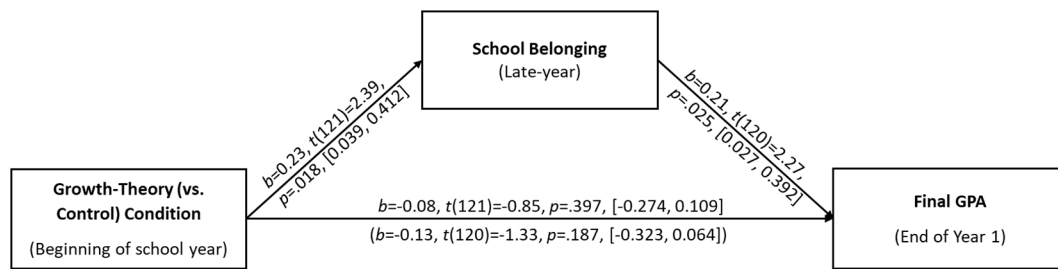


Fig. 3. School Belonging Mediates the Relation between Treatment Condition and Final GPA (n = 123). Note. Values in brackets are 95 % confidence intervals.

focus on how developing a stronger arts identity after the intervention relates to school belonging).

As shown in Table 2 and Fig. 4, there was a significant main effect of condition, such that students in the intervention condition reported overall higher school belonging than students in the control condition. Moreover, there was a significant main effect of arts identity, such that, on average, students with a stronger arts identity in late-year reported weaker school belonging. Most importantly, however, treatment condition significantly interacted with late-year arts identity to predict

Table 2 Effects of the Growth-theory Intervention (vs. Control) on School Belonging as a Function of Late-year Arts Identity.

Main Effects and Interactions	Conditional Effects	School Belonging				
		b	t	p	95 % CI	R <sup>2</sup>
Treatment condition		0.27	2.98	0.003	[0.092, 0.454]	0.152
Late-year arts identity		-0.37	-3.28	0.001	[-0.596, -0.147]	
Treatment Condition × Late-year arts identity		0.18	2.09	0.039	[0.010, 0.355]	
Pre-existing arts identity		0.30	2.50	0.014	[0.062, 0.533]	
	Effect of Treatment Condition at low (-1 SD) late-year arts identity	0.08	0.59	0.556	[-0.179, 0.331]	
	Effect of Treatment Condition at high (+1 SD) late-year arts identity	0.47	3.52	<0.001	[0.205, 0.734]	
	Effect of late-year arts identity in growth-theory condition	-0.19	-1.41	0.160	[-0.455, -0.076]	
	Effect of late-year arts identity in control condition	-0.55	-3.66	<0.001	[-0.853, -0.254]	

Note. Condition was coded as Growth-theory = 1, Control = -1. Pre-existing arts identity was centered prior to analysis. CI = confidence interval.

school belonging. In the control condition, students with a stronger (+1 SD) arts identity at late-year felt significantly lower school belonging than students with a weaker (-1 SD) arts identity at late-year,  $b = -0.55, t(119) = -3.66, p < 0.001$ . By contrast, in the intervention condition, there was no difference in school belonging between students with stronger versus weaker arts identities in late-year,  $b = -0.19, t(119) = -1.41, p = 0.160$ .

These results demonstrate that, whereas students with a stronger arts identity would otherwise be at risk of lower school belonging in this multidisciplinary learning environment—evidenced by the negative association between arts identity and school belonging in the control condition—the growth-theory intervention supported students’ sense of school belonging within their school as they developed a stronger arts identity.

### 3. General Discussion

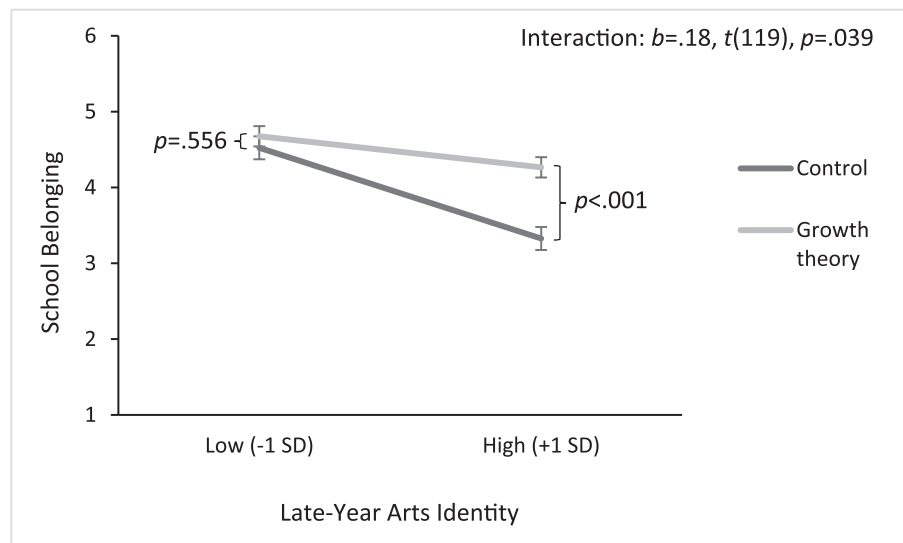
Structural educational reforms may fail if they do not align with the students they are intended to benefit. That is, their effectiveness may partly depend on the ‘fit’ between the goals of the reform and the attitudes, identities, and values of its beneficiaries. The present research showed that delivering a complementary psychological intervention can help students reap the benefits of positive changes in their school’s curriculum. As compared to an active control condition, an educational policy that instituted a multidisciplinary curriculum among predominantly science-identified students was more beneficial for those who completed an intervention that helped them understand that new interests can be developed, such that areas outside of their pre-existing interests can be relevant and meaningful.

Specifically, approximately 7 months after completing this growth-theory-of-interest intervention, students reported a stronger identification with the arts (without diminishing their science identification), relative to a study-skills condition, indicating they had more strongly embraced their multidisciplinary education by the end of their first year of junior college. Moreover, despite a broader cultural environment in Singapore that heavily prizes the sciences, the intervention helped students maintain a sense of belonging at their school as they developed a stronger arts identity. Critically, school belonging was not just important in its own right, it also supported their academic performance. By improving students’ belonging in school, the intervention indirectly predicted higher year-end GPAs.

Thus, by instilling a mindset conducive to multidisciplinary learning, the growth-theory-of-interest intervention enabled students to more seamlessly adapt to, and align with, the objectives of their new curriculum.

#### 3.1. Advancing research on implicit theories of interest and belonging

The current study contributes to several literatures within educational and social psychology. First, it advances an emerging literature on implicit theories of interest (O’Keefe et al., 2018b, 2021, 2023). This study builds on recent research demonstrating that a growth-theory-of-



**Fig. 4.** Effects of Treatment Condition on Late-year School Belonging as a Function of Late-year Arts Identity ( $n = 124$ ).  
*Note.* Bars represent standard errors. Analysis controls for pre-existing arts identity.

interest intervention can help predominantly arts-identified students develop a stronger interest in math and science (O'Keefe et al., 2023). Here, by demonstrating that the intervention helped predominantly science-identified students develop a stronger inclination toward arts fields, we answer important theoretical questions about a growth theory of interest and its generalizability across academic domains and student populations. Our results show that, in a real-world context with meaningful outcomes, adopting the belief that interests are developable, not fixed, can open students to new interests and subjects, regardless of their pre-existing interests. Relatedly, this study also extends research on other types of interventions that focused on enhancing student engagement with STEM course materials (e.g., Binning et al., 2019; Hulleman & Harackiewicz, 2009) or cultivating a sense of belonging in STEM disciplines (Walton et al., 2015). Instead, our intervention targeted an understudied phenomenon, by encouraging science-identified students to expand their repertoire of academic interests.

Moreover, this research adds knowledge and nuance to research on school belonging. While school belonging is recognized as a crucial predictor of students' life satisfaction and well-being (Schachner et al., 2019), interventions aimed at enhancing school belonging are limited (see Allen et al., 2022). Notably, there has been a dearth of exploration into the potential use of growth-theory interventions to foster school belonging (one exception is Burnette et al.'s (2018) growth-theory-of-intelligence intervention; however, their study found no effect on school belonging). As such, the present study makes an important contribution by being the first to demonstrate how a growth-theory-of-interest intervention can successfully foster school belonging. By changing the nature of students' beliefs about interests, our intervention helped students overcome the misalignment between their relatively narrow pre-existing academic identities and the aims of their school's multidisciplinary curriculum, which were to foster learning and appreciation of both science and arts subjects. The intervention also helped students take better advantage of their curriculum by expanding their academic identity, while experiencing a greater sense of fit, belonging, and satisfaction with their life in their school. In doing so, adopting a growth theory of interest helped students feel more at ease in a setting where their belonging might otherwise be at risk.

### 3.2. Limitations and future directions

Despite its noteworthy findings and implications, several limitations of the present research raise important questions for future study. For

one, given the challenges associated with recruiting large numbers of students in this unique context (as described earlier), our sample size was somewhat limited. As a result, we focused our analyses on general assessments of academic identification that could be administered to all students, rather than course-specific assessments that would have further reduced our sample sizes, as students were dispersed across many different courses. Future investigations should seek to replicate our findings, particularly with larger samples that could allow for a more nuanced analysis of specific course subjects. Replicating the mediation of the intervention on GPA via school belonging is particularly important, as this finding was exploratory.

Moreover, given that our sample was conducted in a high-achieving context and culture, conducting replications in different environments and among students with lower levels of academic preparation will help with understanding the generalizability of our results and their applicability across diverse educational landscapes (see O'Keefe et al., 2018b, 2021) for research demonstrating similar effects of a growth theory of interest with U.S. and non-student samples). Indeed, an interesting direction would be to consider how prior academic preparation or achievement might interact with a growth-theory-of-interest intervention to influence belonging, academic interest, and identity. Potentially, the largest gains from the intervention might be observed among students with low prior achievement, as has been found with other types of social-psychological interventions (Good et al., 2003; Paunesku et al. 2015).

Second, while the present research focused on helping adapt students to their new curriculum, our findings suggest how schools could help students adjust to other educational environments or changes that clash with their pre-existing attitudes or behavior. One clear application would be the administration of a growth-theory-of-interest intervention to facilitate arts-focused students' sense of belonging when new curricula is introduced that emphasizes or requires math and science education. Relatedly, fostering a growth mindset of interest could help students better appreciate mandatory units addressing subjects outside of the traditional arts and science disciplines, like units in character development, diversity education, or physical education.

Finally, while we highlighted novel outcomes of a growth-theory-of-interest intervention on academic identities and school belonging, we were unable to delve into the mechanisms underlying these effects. Additional studies and methodologies are needed to unravel these processes over time. For example, longitudinal research with frequent assessments (e.g., daily diaries) could help uncover the processes through

which a growth-theory-of-interest intervention facilitated a stronger arts identity while supporting school belonging. Although outside the scope of the present study—which sought to focus on establishing the key outcomes—we speculate on these theoretical processes below.

### 3.3. Process: How adopting a growth theory of interest works

How did a growth-theory-of-interest intervention increase students' arts identification and support a sense of belonging? We speculate that, as students matriculated to their new school and were exposed to their curriculum, the intervention *reframed* how students approached and engaged with their courses.

Initially, students may have assumed their compulsory arts subjects would be irrelevant or a waste of time rather than a fruitful and useful learning opportunity. They may even have worried that their lack of interest would negatively impact their grades. However, the intervention may have enabled students to overcome this bias by prompting them to reframe their curriculum, and consequently engage with their multidisciplinary education with increased enthusiasm and a more open mind. For example, when asked to reflect on the idea that interests can be cultivated, one student in the growth-theory condition of our study wrote: "Knowing that interests can be developed can change students' mindsets when they face subjects that they initially had disinterest in... [it] helps them to adopt a more positive and open attitude when they are learning about that particular subject." Another participant reported that "students will give academic topics outside their existing interests the benefit of doubt... especially if they are reminded that interests can be developed during their difficult times in exploring those academic topics." Thus, the growth-theory-of-interest intervention may have helped students reframe and overcome preconceived notions about a multidisciplinary education, encouraging them to begin their new curriculum by engaging deeply with all subjects, not just those aligned with their pre-existing interests. For instance, students who completed the intervention may have sought to engage more deeply and meaningfully with their arts subjects (e.g., asking questions in class, thinking deeply about the content they were learning and how it relates to their lives or to their core science interests). Doing so may have enabled students to see greater value in an arts education, while simultaneously increasing their sense of connectedness—that is, belonging—to their learning environment and school.

Over time, these processes may compound and yield further long-term benefits for interdisciplinary learning. Future prospective research could examine whether there are enduring effects of a growth-theory-of-interest intervention, such as whether students choose to pursue a more interdisciplinary educational path (e.g., in university), and whether adopting a growth theory of interest better prepares people with a traditional science background for an increasingly interdisciplinary workforce, or for a broader range of careers that include pure science as well as those that bridge science and arts disciplines (see O'Keefe et al., 2018a, 2021).

## 4. Conclusion

When schools and institutions implement new reforms or policies, they must consider how they will be received in light of students' pre-existing attitudes, identities, and values. Our research shows that these transitions can be made smoother through targeted social-psychological interventions that foster greater fit between the person and policy. Doing so can pave a path to success for those institutional endeavors and equip students to reap their benefits.

### CRediT authorship contribution statement

**Paul A. O'Keefe:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Funding acquisition, Conceptualization. **S.M. Ramya:** Writing – review

& editing, Writing – original draft, Visualization, Formal analysis, Data curation. **E.J. Horberg:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Conceptualization.

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### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.cedpsych.2025.102371>.

### Data availability

We adhere to the transparency and openness policy and have shared links to all our study methods, materials, hypotheses, and the data set.

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