A gender-specific, brochure-based intervention for improving boys' and girls' engineering stereotypes and academic self-perceptions

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ABSTRACT: The low interest in pursuing engineering among students in the US, particularly among girls and women, endangers the sustainability of this technology-based society. Although large-scale interventions are important, there is still a need for low-cost, short-term interventions that can be implemented easily and efficiently. The authors developed two brief engineering-related brochures, one for male students and the other for female students, highlighting the importance, breadth and appeal of engineering careers. Although similar, the brochures differed in their information delivery, with the boys' brochure providing only pertinent information and the girls' brochure including subtle wording changes that emphasised the students' role in the engineering community. The effects of these brochures were examined in relation to students' engineering stereotypes and academic self-perceptions. The results showed that the brochures significantly decreased negative engineering stereotypes and significantly increased engineering-related self-efficacy, utility and interest, particularly, when male and female students were exposed to gender-congruent brochures.

INTRODUCTION

Sustaining the economic and technological competitiveness of the US in the global market is contingent upon expanding the number of qualified engineers. Although some universities and organisations have developed large outreach and recruiting programmes to draw students to engineering [1-5], there is still a need for low-cost, short-term interventions that increase the likelihood that students will pursue engineering. This is particularly important for young female students, given that women represent a small minority of the engineering workforce (13% according to Science and Engineering Indicators 2013 [6]). Directing intervention efforts towards all students, but towards girls in particular, may increase the number of students who ultimately pursue engineering education and employment.

Although course selection and career choices are multi-faceted decisions that depend on many influences, perceptions of a particular field play a crucial role [7-10]. Research shows that subject-specific stereotypes affect academic self-perceptions [11-14], and that these perceptions significantly predict later performance and course enrolment [15-17]. Thus, interventions designed to counteract engineering stereotypes and improve engineering perceptions may be beneficial for increasing students' pursuit of engineering. In addition, research shows that males and females differ in their information-processing strategies, where males process information selectively and females process information comprehensively [18-21]. Interventions tailored to meet these differences may be more effective than global interventions that direct similar strategies toward all students.

Early intervention may be key to substantially affecting student's engineering perceptions, as research shows that student's perceptions may crystallise as they progress though the elementary and high school years [22]. Older students have a more differentiated view of competence in various domains [23] and, in general, self-efficacy in academic domains decreases from grades one to twelve [24]. As students more strongly associate themselves with particular subjects in school and dissociate from others (e.g. mathematics), they may be less influenced by new information about a discipline, such as engineering. This may be particularly true for girls, who by high school report feeling much less competent and interested in mathematics and science than boys [15]. Reaching students before they form rigid attitudes towards engineering is important for successfully influencing student's desire to pursue engineering.

Outreach and recruitment programmes may employ a wide range of interaction modes and media. Many programmes rely on personal interactions with engineers and engineering faculty through mentoring [25] or hand-on engineering

activities [26-30]. With the proliferation of computer-based education, outreach efforts employing computer-based modules have received increasing interest [31-35]. Computer-based interventions with animated pedagogical agents have been especially closely examined [36-39], as they have the potential to improve interactions with the students through invoking a persona effect [40-42].

Despite the wide range of interaction modes and media, conventional print materials continue to play an important role in many engineering outreach interventions. Printed recruitment material, such as brochures, flyers and postcards, can be handed to the students during the outreach activities, mailed directly to students' homes or mailed to local schools for distribution in classrooms. These print materials often complement other interaction modes and media employed in engineering outreach campaigns. However, very little is known about the effectiveness of such brochures in improving students' perceptions of engineering or likelihood to pursue an engineering degree. The overall goal of the present study was to contribute to the investigation of the effectiveness of print brochures for increasing positive engineering perceptions in elementary school students. The specific goal of the present study was to develop two brief engineering-related brochures highlighting the importance, breadth and appeal of engineering careers. One was designed specifically for males and the other for females. Because of the influence of elementary school academic self-perceptions on future course selection [9], these brochures were directed toward young students. The effects of these brochures on elementary school student's engineering perceptions were examined to determine their potential for increasing the pursuit of engineering.

Students' Engineering Perceptions

Research shows that male and female students hold preconceived notions regarding engineering as a discipline and about the characteristics of engineers as individuals [43][44]. For example, as a profession, students believe that engineering is limited to fixing or building things, that engineering is largely physical labour and that engineering is boring or *nerdy* [45-47]. These preconceived notions likely impact student's feelings of engineering self-efficacy and interest, which may result in depressed confidence in, and motivation for, engineering-related activities [48]. Other work shows that when asked to draw a picture of an engineer, young students overwhelmingly depict engineers as men [49-51]. If, as this work suggests, students believe engineering is primarily a masculine domain, subsequent engineering-related outcomes may be affected, particularly for girls. Female students who endorse traditional gender stereotypes within the engineering-related domains of mathematics and science (i.e. believe that boys and men are better at mathematics and science than girls and women) report and achieve lower grades in these fields [52][53]. Consequently, the belief that engineering is a field in which only men succeed may deleteriously affect girls and women's success in engineering.

According to expectancy-value theory [54], motivation and achievement are affected by an individual's stereotypes and academic perceptions, that is, the individual's self-perceived abilities in, interest for, and value of an academic domain [23]. Research supports this hypothesis, showing that stereotypes affect academic perceptions [11-14] and these perceptions significantly predict later performance and course enrolment [15-17]. If a student believes that she will not achieve highly in engineering, that it is not important for her to be educated in engineering and/or that there is no value in being an engineer, she will likely avoid or cease to apply herself in engineering-related activities. Thus, it is important for researchers to determine what can be done to positively influence student's engineering perceptions to increase their desire to pursue engineering-related coursework and careers.

Gender Specific Strategies for Improving Engineering Perceptions

Research shows that males and females process information in different ways [20][21]. Males often display selective processing, relying on heuristics to efficiently identify relevant information, whereas females typically process information comprehensively and integrate all available information. Interventions that are tailored to the information processing abilities of male and female students may be more effective than blanket strategies that offer similar messages to all students. Because males are more selective, providing simple, straightforward messages intended to communicate relevant information may facilitate male student's acquisition of important information. Extraneous information may hinder message reception, as during selective processing male students may unintentionally attend to irrelevant information and overlook the principal message. Alternatively, because female students process information comprehensively, additional messages may be included to further encourage the pursuit of engineering. A message that may be particularly convincing is one that appeals to girl's desire for social closeness or communality. Studies show that females, more than males, recognise the importance of social relationships, support and a feeling of belonging [55-58]. In addition, research shows that increasing feelings of communality in relation to STEM career fields improves women's interest in those careers [59][60]. Messages that appeal to this sense of communality may be more influential in improving girls' engineering self-perceptions than those that do not.

The Present Study

The goal of the present study was to develop and examine the effects of two educational brochures, one tailored specifically for boys and the other for girls, on the engineering perceptions of elementary school students (fifth graders). The brochures were developed to interest and engage students in engineering. Both brochures (i.e. the one developed for boys and the one developed for girls) emphasised the importance of engineering for creating almost everything that humans experience daily, highlighted a variety of engineering professions (e.g. aerospace, chemical, electrical) and

explained what engineers within each profession work to create. The wording of the information on the brochures was very similar for the boys and girls, with subtle wording changes emphasising communality and a sense of belonging in the brochure for girls. The authors, then, examined the effect of exposure to these brochures on boys' and girls' engineering stereotypes and perceptions (self-efficacy, interest, values). They expected to find that, overall, the brochures would reduce gender and engineering profession stereotypes and improve engineering self-efficacy, utility and interest. Furthermore, they expected to find that gender-specific brochures would have differential effects for male and female students. Specifically, they hypothesised that the boys' brochure would reduce the stereotypes and increase the self-perceptions of boys, not girls, and that the girls' brochure would reduce the stereotypes and increase the self-perceptions of girls, not boys.

DESIGN AND METHOD

To determine the relative efficacy of the two types of brochures to promote students' perceptions about engineering, the study used a two (brochure type: girls' or boys') x two (student gender: male or female) pre-test post-test design. All students were randomly assigned to review one of two types of brochures: one designed for girls or one designed for boys. The effects of these brochures on male and female students were examined via student ratings of five types of perceptions toward engineering: gender stereotypes, engineering profession stereotypes, self-efficacy, utility and interest. Students completed a pre-test survey instrument before viewing the brochures and completed an identical survey following exposure to the brochures. A total of 100 fifth grade students enrolled in a local elementary school in the Phoenix, Arizona, area participated in the study. Fifty-six percent (56%) of the students reported their ethnicity as Hispanic, 13% reported their ethnicity as Other, 11% responded that they were Native American, 10% were White, 8% were African American and 2% were Asian American. Fifty (n = 50) students were randomly assigned to the boys' brochure and 50 were randomly assigned to the girls' brochure.

Brochures

The authors developed the brochures for the study in collaboration with communications professionals from the engineering schools at the University. Brochures were designed using an iterative process. First, the Engineering Communications team provided the research team with prototype recruitment brochures that they were in the process of developing and refining. Next, the research team, comprised of psychologists, educators and engineers, reviewed the prototypes and presented the communications team with suggestive feedback concerning various issues. Feedback concerned the verbal messages, photographs used, and relative positioning and sizing of each element. For example, the research team noted that the initial photographs primarily depicted white male students. In order to appeal to females and minorities considering engineering, the authors suggested that photographs should include a greater diversity of engineering students.

After each round of feedback, the communications team responded with new versions of the brochures for another development iteration. The brochure development process involved a total of seven iterative cycles between the research team and the communications team. The final brochure was a two-page 11" x 17" glossy, coloured pamphlet, which was folded lengthwise and three times across (i.e. a total of six exterior frames and six interior frames).
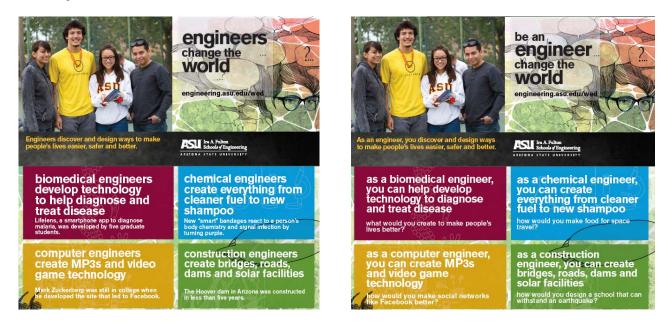

Figure 1: Excerpts from the brochure designed for boys.

Figure 2: Excerpts from the brochure designed for girls.

Two versions of the brochure were developed, one designed specifically for boys (boys' brochure) and one designed for girls (girls' brochure). Because boys are more selective in their information processing than girls, the messages presented in

the boys' brochure were stripped down to only essential information, see Figure 1. Example text included *Engineers change the world* and *Computer engineers create MP3s and video game technology*. In addition, the authors identified for the boys' brochure interesting real-life engineering designs and composed a variety of stimulating accounts of those projects/products. These snippets were constructed with the intention of promoting student interest toward engineering by giving specific examples of engineering in action. For example: *Lifelens, a smartphone app to diagnose malaria, was developed by five graduate students*. Each mini-story related to one of the ten engineering fields introduced by the brochures (each field represented a programme of study at the University): 1) aerospace engineering; 2) civil engineering; 3) materials engineering; 4) biomedical engineering; 5) computer engineering; 6) electrical engineering; 7) mechanical engineering; 8) chemical engineering; 9) construction engineering; and 10) industrial engineering.

For girls, who comprehensively process and integrate all information, and for whom communality is important, the messages in the Girls' brochure included subtle wording changes to highlight a sense of group belonging, see Figure 2. Example text included *Be an engineer…change the world* and *As a computer engineer, you can create MP3s and video game technology*. For the girls' brochure, instead of the specific engineering example snippets, the authors formulated, for each engineering field, a personalised question. The questions were designed to evoke reflection about the personal involvement in the engineering field. For example for bioengineering: *What would you create to make peoples' lives better?* Other than these differences, the images, background colouring and layouts of the brochures were identical for the two versions.

Survey Instrument

The engineering perceptions survey was adapted from Rosenberg-Kima [39]. Because our participants were much younger students, and because a large proportion of the participants (42%) were English as a Second Language (ESL) learners, we modified the wording of the items to correspond to their linguistic capacity. For example, the original survey item from [39] *I would like to have a career in an engineering related field* was changed to *I would be interested in working as an engineer*. The construct validity of the final survey was verified by early childhood education experts [61].

Identical versions of the 15-item survey were presented at pre-test and post-test; the survey was subdivided into five subscales of perceptions toward engineering, with three items in each subscale: 1) gender stereotypes; 2) negative engineering stereotypes; 3) self-efficacy; 4) interest; and 5) utility. For the three gender stereotype items, higher ratings indicated stronger rejection of gender stereotypes (e.g. *Women have the same talent for engineering as men*, Cronbach $\alpha = 0.74$). Three items assessed negative stereotypes of engineering; higher ratings indicated acceptance of stereotypes (e.g. *Engineers are unpopular people*, $\alpha = 0.75$).

For the self-efficacy, interest and utility items, higher ratings indicated higher perceptions of self-efficacy, interest and utility, respectively. The self-efficacy items measured students' confidence in their own ability to study engineering and be engineers (e.g. *I would get good grades in engineering classes*, $\alpha = 0.76$). Three items measured student interest in engineering (e.g. *I would like to learn more about engineering*, $\alpha = 0.77$). Finally, the utility subscale items asked students to report on their perceptions of the usefulness of engineering (e.g. *Studying engineering would prepare me well for many jobs*, $\alpha = 0.68$). Individual ratings from the three items for each subscale of the survey instrument were averaged to obtain a mean gender stereotype, negative engineering stereotype, self-efficacy, interest and utility rating. Each survey item was on a 5-point scale (1 - strongly disagree to 5 -strongly agree). Students responded by circling an emoticon that represented the level of agreement from 1 - face with a strong frown (strongly disagree) to 5 - face with a pronounced smile (strongly agree).

Procedure

The students participated in the study during natural classroom sessions throughout a school day in groups of up to 25 students. At the beginning of each session, students were randomly given unique experimental ID numbers and pre-surveys labelled with letters denoting brochure type. The students were, then, instructed to write their ID number on the pre-survey and to complete all survey items. Once all students had completed the pre-survey, they were collected and the appropriate brochure (corresponding to the letter on pre-surveys) was handed to each student. The students were instructed to inspect and read the brochures for seven minutes. After the seven minutes had elapsed, the students were told to put away the brochures. Then, the post-surveys were distributed to the students and they were instructed to note their experimental ID and condition letter on the post-survey and to complete all survey items. Post-surveys were collected for data analysis.

RESULTS

Overall Pre-Post Perceptions Comparisons

All significance tests for the results are one-tailed. Table 1 displays overall descriptive statistics for the pre- and post-surveys on the five subscales of engineering perceptions (gender stereotypes, negative engineering profession stereotypes, self-efficacy, utility and interest). Using the average scores across brochure type and student gender, a series of paired-samples *t*-tests were conducted to compare student ratings on each of the five subscales at pre-survey and post-

survey. The Bonferroni correction procedure [62] was used in modifying the alpha level for significance in these tests; the alpha level was set to 0.01 (0.05/5 tests). Inferential statistics for these tests are included in Table 1.

Students had significantly higher rejection of gender stereotypes, as well as significantly higher ratings of self-efficacy, utility, and interest at post-survey than at pre-survey. Results also indicated significantly lower ratings of negative engineering profession stereotypes at post-survey, compared to the pre-survey ratings.

Table 1: Pre- and post-survey means and standard deviations for five subscales of engineering perceptions survey.

	Pre-survey	Post-survey	Inferential statistics	
	M (SD)	M (SD)	t-value	d
Rejection of gender stereotypes	3.96 (0.71)	4.24 (0.77)	4.55	0.38
Negative engineering profession stereotypes	2.60 (0.74)	2.38 (0.70)	3.57	0.31
Self-efficacy	3.24 (0.87)	3.72 (0.89)	5.28	0.55
Utility	3.45 (0.80)	3.95 (0.77)	6.47	0.64
Interest	3.39 (0.95)	3.89 (0.92)	5.30	0.53

Note: All t-values are significant at $p < 0.001$

Brochure Type by Student Gender Analyses

Change scores (post-survey - pre-survey) for each subscale on the engineering perceptions survey were computed to compare engineering perception changes between brochure conditions and gender groups. Table 2 displays means and standard deviations for change scores within each survey subscale by brochure type and student gender. Analyses of variance (ANOVAs) were conducted on change scores using brochure type and student gender as between-subject factors. A series of two (brochure type: girls' or boys') x two (student gender: female or male) univariate ANOVAs were conducted for each subscale of the survey. The ANOVA on rejection of gender stereotypes indicated no significant main effect for brochure type, $F(1,96) < 1$, no significant main effect for student gender ($F < 1$) and no significant interaction between the two factors ($F < 1$).

Table 2: Post- pre-survey change scores: means and standard deviations for five subscales of engineering perceptions survey, by brochure type and student gender.

Brochure type; Student gender	Reject. of gender stereotypes M (SD)	Neg. eng. prof. stereotypes M (SD)	Self-efficacy M (SD)	Utility M (SD)	Interest M (SD)
Boys'					
Male ($n = 26$)	0.385 (0.571)	-0.462 (0.680)[1,2]	0.769 (1.192)	0.667 (0.948)[1]	0.949 (1.031)[1,2]
Female ($n = 24$)	0.222 (0.672)	-0.069 (0.709)	0.319 (0.843)	0.236 (0.825)	0.139 (1.031)
Total ($n = 50$)	0.307 (0.620)	-0.273 (0.715)	0.553 (1.053)	0.460 (0.908)	0.560 (1.099)
Girls'					
Male ($n = 26$)	0.269 (0.673)	-0.051 (0.408)	0.449 (0.805)	0.333 (0.611)	0.410 (0.762)
Female ($n = 24$)	0.236 (0.560)	-0.306 (0.605)[3]	0.361 (0.680)	0.778 (0.570)[3,4]	0.472 (0.780)
Total ($n = 50$)	0.253 (0.616)	-0.173 (0.523)	0.407 (0.742)	0.547 (0.627)	0.440 (0.763)
Total					
Male ($n = 52$)	0.327 (0.621)	-0.256 (0.593)	0.609 (1.020)	0.500 (0.807)	0.680 (0.938) [5]
Female ($n = 48$)	0.229 (0.612)	-0.188 (0.663)	0.340 (0.758)	0.507 (0.753)	0.306 (0.920)
Total ($N = 100$)	0.280 (0.615)	-0.223 (0.625)	0.480 (0.909)	0.503 (0.778)	0.500 (0.943)

[1] Boys' brochure: males > females   [2] Males: boys' brochure > girls' brochure
[3] Girls' brochure: females > males   [4] Females: girls' brochure > boys' brochure   [5] Males > females

For engineering profession stereotypes, there was not a significant main effect of brochure type ($F < 1$) or student gender ($F < 1$). However, there was a significant interaction between brochure type and student gender, $F(1,96) = 7.01$, $p < 0.01$, $\eta^2_p = 0.07$. Follow-up independent samples t-tests were conducted to examine the simple main effects. For the brochures designed for boys, the male student's negative engineering profession stereotypes decreased more than the female student's stereotypes, $t(48) = 2.00$, $p < 0.05$, $d = 0.57$. Conversely, for the brochures designed for girls, female students experienced larger decreases than the male students, $t(48) = 1.76$, $p < 0.05$, $d = 0.50$. Male students who viewed the boys' brochure had significantly larger decreases in negative engineering profession stereotypes than those who viewed the girls' brochure, $t(50) = 2.64$, $p < 0.01$, $d = 0.75$. There was not a significant difference between the two brochure types for female students, $t(46) = 1.24$, $p = 0.11$, $d = 0.36$. The ANOVA on self-efficacy indicated no significant main effect for brochure type, $F(1,96) < 1$ and no significant interaction between the two factors ($F < 1$). There was, however, a marginal effect for student gender, $F(1,96) = 2.20$, $p = 0.07$, $d = 0.16$, indicating that, overall, boys experienced a greater increase in self-efficacy from exposure to the brochures than did girls.

For utility, there was not a significant main effect of Brochure type ($F < 1$) or Student gender ($F < 1$). However, there was a significant interaction between brochure type and student gender, $F(1,96) = 8.35$, $p < 0.01$, $\eta^2_p = 0.08$. Follow-up t-tests were conducted to examine the simple main effects. For the brochure designed for boys, the male student's

engineering utility scores increased significantly more than the female student's scores, $t(48) = 1.71$, $p < 0.05$, $d = 0.48$. Conversely, for the girls' brochure, female students had a significantly larger increase in feelings of engineering utility than males, $t(48) = 2.65$, $p < 0.01$, $d = 0.76$. For male students, there was a marginally significant difference in utility change scores between the two types of brochures, $t(50) = 1.51$, $p = 0.07$, $d = 0.44$, showing that the brochure designed for boys was more effective at increasing utility scores than the brochure designed for girls. Similarly, female students had significantly larger utility change scores from the girls' brochure than the boys' brochure, $t(46) = 2.65$, $p < 0.01$, $d = 0.77$.

The ANOVA on interest indicated no significant main effect for brochure type, $F(1,96) < 1$. There was a significant main effect for student gender, $F(1,96) = 4.21$, $p < 0.05$, $\eta^2_p = 0.04$. Overall, the male student's interest in engineering increased more significantly than that of female students. There was also a significant interaction between brochure type and student gender, $F(1,96) = 5.73$, $p < 0.01$, $\eta^2_p = 0.06$. Follow-up t-tests were used to examine the simple main effects. For the brochure designed for boys', male students had significantly higher interest change scores than females, $t(48) = 2.78$, $p < 0.01$, $d = 0.79$. For the brochure designed for girls', interest change scores did not significantly differ between male and female students, $t < 1$. Male students had significantly larger interest change scores from the boys' brochure compared to the girls' brochure, $t(50) = 2.14$, $p < 0.05$, $d = 0.60$. Female students' interest change scores did not differ between the two types of brochures, $t(46) = 1.26$, $p = 0.11$, $d = 0.36$.

DISCUSSION

The overall low interest in earning degrees and pursuing careers in engineering among students in the US, particularly among girls and women, endangers the sustainability of this technology-based society [63][64]. Although it is important to develop large-scale interventions to draw more students to engineering, there is still a need for inexpensive, short-term interventions that can be widely and efficiently implemented throughout elementary, middle and high schools. The present study shows that a brochure that highlights interesting and exciting aspects of engineering can positively impact fifth grade boy's and girl's engineering stereotypes and academic perceptions.

After viewing an engineering brochure, students were significantly more likely to reject gender and engineering profession stereotypes, and reported greater self-efficacy, utility and interest in engineering. Given research showing that stereotypes and academic self-perceptions influence coursework choices and career aspirations [9][15-17], the results of the present study have implications for increasing the number of students who become engineers. Exposing students to engineering brochures may be a cost-effective method for reaching a large number of students and significantly increasing their desire to pursue engineering.

Research on gender differences in information processing also indicates that interventions tailored to the different ways that males and females process information may be particularly effective. Males generally attune to information selectively to identify relevant themes, whereas females typically consider all available information [18-21]. Thus, male students may benefit most from efforts that distil information down to the relevant details, and female students may benefit from the inclusion of additional information, particularly information that appeals to their sense of social closeness or communality [55-58]. The results of the present study support these hypotheses.

Male students were much more receptive to the brochure designed for boys, which contained only information highlighting interesting and exciting aspects of engineering. Boys who viewed the boys' brochure reported less negative engineering profession stereotypes and a significantly greater increase in the felt utility of and interest in engineering than girls who viewed the same brochure. Furthermore, the boys' brochure had a larger effect on boys' engineering profession stereotypes, utility, and interest than did the girls' brochure.

The girls' brochure contained the same information as the boys' brochure but also included wording changes that emphasised the reader's role in the engineering community by presenting a more personal message. Complementary to the findings for the boys, the brochure designed for girls more positively influenced female students. Compared to boys who also viewed the girls' brochure, girls reported less negative engineering profession stereotypes and feelings of engineering utility. In addition, the girls' brochure had a greater impact on girls' felt engineering utility than did the boys' brochure. These findings show that even subtle differences in the intervention strategies directed to boys and girls may produce different outcomes for male and female students.

Contrary to the authors' expectations there was no effect of student gender or brochure type on gender stereotypes regarding engineering. This may have been due to the lack of language in the brochures emphasising women as engineers. Messages related to women's roles in engineering, for instance, by providing examples of successful female engineers, specifically directed toward male and female students could have resulted in different effects for boys and girls depending on which brochure was viewed. However, there was an overall reduction in engineering gender stereotypes as a result of exposure to the brochure. This may have been a function of the equal number of men and women displayed in the brochures (which was consistent across the boys' and girls' brochures).

Limitations

The results of the present study should be interpreted with regard to some limitations. First, the authors did not assess any long-term intervention effects. Although a short-term intervention, such as the one in the present study, may exact

immediate change in engineering stereotypes and academic perceptions, it may not have lasting effects. However, the advantage of low-cost, short-term interventions is that they may be repeatedly administered over time as they do not require much instruction time.

The accumulated effect of these repeated administrations may have lasting effects on student's engineering stereotypes and perceptions. Future longitudinal studies could not only determine the potency of a single brochure-based intervention over time, but also examine the effects of multiple applications of an engineering brochure on student's attitudes. Second, in the present study the authors only examined the effect of the intervention on student's stereotypes and self-perceptions. Although research shows that these attitudes are related to future achievement and course enrolment [15-17], it is important for future studies to focus on examining the effect of intervention efforts on student's academic achievement and desire to pursue specific subject material. Lastly, in the present study the authors only examined intervention effects in fifth grade students. Although it is at this age that boys and girls begin to diverge in their interest and self-efficacy for engineering-related subjects (i.e. mathematics and science) [64-67], in middle and high school students begin to make decisions that shape the rest of their academic careers [68]. Thus, it is important for future studies to focus on examining the effectiveness of interventions on the engineering attitudes of students of all ages.

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