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The effect of digital storytelling on middle school students' interests in STEM fields and stereotyping

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Abstract

This study addresses the low participation rates in STEM careers due to career and intellectual stereotypes by examining the potential of digital storytelling to challenge gender stereotypes and influence middle school students' interest in STEM. Employing a quasi-experimental design, pre and post-tests, consisting of two questionnaires, were administered to measure shifts in students interest and intellectual stereotypes perceptions. The experimental group, exposed to the digital storytelling intervention, exhibited a positive shift in attitudes and interests in diverse STEM domains. In the examination of intellectual stereotypes, the experimental group displayed distinctive changes, challenging stereotypes associated with innate intelligence, girls' reading and writing abilities, leadership roles, creative thinking, and problem-solving skills. These findings underscore the need for a refined approach in narrative construction to avoid unintended consequences. Digital storytelling emerges as a promising tool for positively influencing STEM interest and perceptions of intellectual stereotypes among middle school students.

Keywords: digital storytelling, middle school, STEM education, stereotypes, attitude towards STEM, gender

INTRODUCTION

In many countries and regions, there have been many concerns about the participation rate of people in science, technology, engineering, and mathematics (STEM) careers in many countries (Marginson et al., 2013). Specifically, women who work in STEM are still, more than men, underutilized in the knowledge economy's workforce. This is because of the intellectual stereotypes surrounding STEM fields and pushing females away from STEM careers. Bian et al. (2017) believed that stereotypes about certain careers strongly affect boys' and girls' career aspirations and interests in their future. In Lebanon, the STEM fields are more dominated by males (Sarouphim & Chartouny, 2017) and high performance in science and math subjects at school is linked to a masculine label (Sarouphim, 2009, 2011). Specifically, Sarouphim and Chartouny (2017) stated that females make up only 34% of students who pick mathematics or natural sciences after finishing grade nine. In fact, this gender imbalance is visible from early levels of middle education.

In this context, efforts have been made to foster students' interest in pursuing STEM careers. Hence, from the standpoint of career development, STEM education can offer individuals experiences and information they may use to guide their career decisions. Thus, it is important to understand how students come to prefer or reject STEM careers as stereotypes about STEM careers are a significant determining factor affecting interest in those careers (Archer et al., 2013; DeWitt et al., 2012; van Tuijl & van der Molen, 2015).

Storytelling

Storytelling has a rich history as a timeless method of communication deeply ingrained in human culture (Gergen, 2022). Stories have served as essential vehicles for making sense of experience, conveying cultural values, and transmitting knowledge across generations. Within education, storytelling has proven powerful for student engagement, comprehension of intricate concepts, and creating relatable learning environments (Andrews et al., 2009). Its narrative structure taps into individuals' curiosity and emotional connections,

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Contribution to the literature

- The findings of this study add to the scarce literature on digital story-telling particularly in STEM targeting middle school students
- This study provides empirical evidence of the effectiveness of digital storytelling in a middle school setting on students' interests in the STEM fields.
- This study highlights the effectiveness of digital storytelling in reshaping intellectual stereotypes and emphasizes the need for thoughtful and precise storytelling approaches in educational settings.

making educational content more memorable and enjoyable (Lambert & Hessler, 2018). In fact, numerous studies (Lisenbee & Ford, 2017; Niemi et al., 2018) emphasized the effectiveness of teaching through storytelling on students' motivation, understanding of the content, and developing their interest in the subject matter. Consequently, educators and researchers recognize storytelling's potential to enhance learning across various domains (Clandinin & Connelly, 2000).

Technological advancements have catalyzed new dimensions in storytelling, giving rise to digital storytelling (Ohler, 2013). This approach integrates multimedia elements like images, audio, videos, narrations, and animations, engaging multiple senses simultaneously and immersing learners in a multimedia-rich environment. The visual component of digital storytelling represents a significant advancement over traditional narratives, facilitating comprehension and deeper connections with the subject matter (Dreon et al., 2011; EDUCAUSE Learning Initiative, 2007). This multisensory approach aids in understanding abstract ideas and dynamic processes, catering to diverse learning styles (Gallagher, 2019; Lambert & Hessler, 2018; Mouza et al., 2014).

Digital storytelling's flexibility and interactivity are noteworthy, allowing learners to engage with content non-linearly and at their own pace (Lambert & Hessler, 2018). Interactive features and multimedia integration foster active participation, personal agency, and increased engagement. The democratization of digital platforms enables educators and students to craft compelling narratives, empowering learners as content creators and nurturing creativity and critical thinking skills (Sadik, 2008).

Digital storytelling marks a transformative evolution of traditional narratives, harnessing multimedia's power to engage, educate, and inspire (Ohler, 2013). By leveraging visual elements, interactivity, and accessibility, it enriches the educational experience. The increased use of technologies like augmented reality and mobile devices in learning over the past decade has expanded digital storytelling's potential (Quah & Ng, 2021). While research on implementing digital storytelling in learning is limited, its effectiveness in improving comprehension, engagement, and motivation is evident (Barrett, 2006; Robin, 2006; Zak, 2014).

Studies show that digital storytelling enhances students' computational skills, computer literacy, and enthusiasm for learning (Preradovic et al., 2016; Sadik, 2008). It improves imagination and attention, with children recalling stories with as much detail as personal memories (Agosto, 2013; Kuyvenhoven, 2007). Digital storytelling aids in organizing and expressing ideas meaningfully across subjects and educational levels (Robin, 2005). It offers educational benefits, making explanations compelling, connecting content to real life, and improving engagement (Gils, 2005).

Digital storytelling promotes the 21st century skills by supporting learning diverse subjects, enhancing higher-order thinking, and fostering active learning and engagement (Niemi et al., 2018). It stimulates critical thinking, creativity, problem-solving, and collaboration (Lisenbee & Ford, 2017). While commonly used in social studies and humanities, research suggests its application in mathematics and science education as well (Robin, 2006).

Storytelling in math and science

Borasi et al. (1990) highlight that incorporating stories in school mathematics is revolutionary, enabling students to notice concepts outside curriculum and adopt a critical stance in math learning. Niemi et al. (2018) found that digital storytelling helps students acquire 21st-century skills and enhance math learning, promoting persistence, enjoyment, active learning, collaboration, and application of math knowledge in new contexts.

Toor and Mgombelo (2015) implemented storytelling in 6th and 8th grade math classrooms, finding it humanizes math and relates it to real life. Jonassen (2003) considered story math problems common in education, while Schiro (2004) used digital storytelling for problem-solving and algorithms. Wessman-Enzinger and Mooney (2014) provided ideas for teaching positive and negative integers through stories. Muir et al. (2017) emphasized using children's literature to contextualize math content, enhance engagement, and promote reasoning. Russo and Russo (2018) found picture storybooks effective in exploring math ideas and supporting flexible lesson planning. Bratitsis and Mantellou (2020) showed storytelling's effectiveness in teaching subtraction algorithms to grade 2 pupils. Piatek-Jimenez and Phelps (2016) tied math activities with the movie Frozen to teach fractals and geometry, leveraging students' enthusiasm.

Many studies highlight storytelling's impact in science education (Rowcliffe 2004; Walan 2017). Cross (2017) argued that storytelling helps students connect with abstract science content. Hugerat et al. (2011) used Archimedes' story to explain density, increasing students' appreciation of scientific imagination. Fishman (2020) emphasized storytelling's role in fostering a just and sustainable future by helping students make sense of the world and preparing equitable society citizens.

Negrete and Lartigue (2004) suggested storytelling facilitate understanding scientific knowledge and boosts interest. Stefaniak and Csikar (2018) noted that narrative presentations are more powerful than statistics. Saritepeci (2020) found digital storytelling improves learning satisfaction, knowledge acquisition, technological skills, and personality development. Consequently, storytelling in science stimulates engagement, contextualizes learning, and enhances understanding.

Students Interest in STEM Education

Several studies have explored the role of educational interventions in nurturing students' STEM interests. Chen and Tytler (2017) demonstrated that project-based learning experiences significantly increased students' motivation and interest in STEM subjects. To enhance engagement, Bybee (2013), and Osborne et al. (2003) emphasized creating relevant and meaningful connections between STEM concepts and real-world applications. This is supported by Vennix et al. (2017), who found that STEM-based outreach activities increased interest and understanding by exposing students to real-world applications. Specifically, Bybee (2013) highlighted the importance of addressing real-world challenges in STEM education, while Osborne et al. (2003) stressed contextualizing STEM content within societal issues.

Furthermore, Fadzil et al. (2019) emphasized the potential of interdisciplinary collaboration to foster positive perceptions of STEM education. Oje et al. (2021) also found that hands-on learning positively influenced students' motivation and self-efficacy toward STEM. Complementing these findings, Knezek et al. (2013) showed that experiential learning activities, like environmental power monitoring, increased interest and understanding of STEM.

Also, gender stereotypes significantly impact STEM engagement, with studies like Eccles (2015) showing their contribution to the underrepresentation of females. Dasgupta et al. (2015) found that exposure to counter-stereotypical role models increased girls' interest in STEM. Shapiro and Williams (2012) discussed "stereotype threat," which can hinder engagement, especially for underrepresented groups. Franz-Odendaal et al. (2016) examined middle school students' attitudes toward STEM, noting the influence of role models and extracurricular activities. These approaches align with the broader theme of effective curriculum design that fosters engagement and skill development necessary for success in an evolving world.

Intellectual Stereotypes

Self-estimated intelligence and early acquisition of intellectual stereotypes

Males often rate their intelligence higher than females, despite research showing no gender differences in general intelligence (Halpern et al., 2011). These self-perceptions of intelligence significantly influence motivation and educational choices. Students tend to avoid challenging subjects if they doubt their academic aptitude (Kornilova, 2009). Consequently, one's intellectual self-image plays a crucial role in the decision to pursue more demanding education in high school and college.

Building on the foundation of gender differences in self-estimated intelligence, it's evident that children acquire gender stereotypes early, which subsequently affect their interests and behaviors (Gelman et al., 2004). These early stereotypes about abilities can cause children to lose interest in activities they might otherwise enjoy (Ambady et al., 2001). Bian et al. (2017) found that girls as young as six were less likely to view their gender as "really, really smart," impacting their interest in activities requiring high intelligence. This early acquisition of stereotypes underscores the importance of addressing these biases from a young age.

Intellectual stereotype surrounding STEM disciplines and females' interest in STEM fields

Despite women making up half of the workforce in the U. S., they are underrepresented in STEM professions, with only 34% female employment in STEM sectors (Martinez & Christnacht, 2021; National Science Board, 2022). In the UK, just 26% of those graduating with a core STEM degree in 2018 were women (WISE Campaign, 2018). In Lebanon, males dominate STEM fields, with only 34% of females choosing mathematics or natural sciences after grade nine (Sarouphim & Chartouny, 2017). This underrepresentation is due to intellectual stereotypes pushing females away from STEM careers (Bian et al., 2017). Marginalization based on race and socioeconomic status exacerbates this trend (Martin et al., 2016; Wilkins-Yel et al., 2019).

Reinking and Martin (2018) indicated that the culture surrounding STEM careers contributes to the lack of women in these fields. Stereotypes about males' abilities in STEM disciplines reduce girls' motivation and interest in STEM professions (Bian et al., 2017; Master et al., 2016). Gender stereotyping is a significant factor for women's underrepresentation in STEM disciplines (Blickenstaff, 2005; Leslie et al., 2015). The masculine culture in STEM leads women to feel they do not belong, impacting their educational success and perseverance (Rainey et al., 2018). These stereotypes influence women's sense of identification with STEM when internalized (Margolis et al., 2000; Nosek et al., 2002).

Cheryan et al. (2015) researched stereotypes about STEM professionals and found that cultural assumptions discourage girls from pursuing these fields. Margolis et al. (2000) discovered that women lost confidence and interest in computer science due to not matching the traditional idea of a computer scientist. Despite the masculine view of science, women have made progress in fields like biology, chemistry, and agriculture since 2008 (National Science Board, 2022).

Tipton (2018) argued that gender stereotypes portray women as less intelligent than men. However, Voyer and Voyer (2014) found that girls outperform boys in scholastic achievement. Sociocultural factors, rather than innate intellectual abilities, explain the gender gaps in STEM (Hill et al., 2010; Steinke, 2017). Leslie et al. (2015) showed that women are underrepresented in fields that value raw, innate talent, which is stereotypically associated with men. This led women to perform worse on mathematical tasks when confronted with stereotypes, reducing their interest in the subject (Shapiro & Williams, 2012).

Reinking and Martin (2018) found evidence of gender stereotyping in STEM fields, with stereotypes about women's poor math abilities leading to their quitting the STEM pipeline (Gunderson et al., 2011). These stereotypes, communicated at a young age through teachers and parents, impact girls' math attitudes and reduce their interest in STEM subjects (Bian et al., 2017; Reinking & Martin, 2018; Roper, 2019).

Media representations

Extending the discussion on stereotypes, media plays a substantial role in perpetuating the notion that STEM fields are for asocial loners, which deters women who value work/life integration (Myers & Major, 2017). These stereotypes about males' abilities in STEM contribute to the lack of female motivation and interest in these fields (Master et al., 2016). Therefore, it's essential to challenge and change these media representations to create a more inclusive image of STEM professionals.

Therefore, a study on the use of digital storytelling in influencing girls' perceptions and interests in joining STEM fields might show promising and beneficial results.

The Present Study

The topic of exploring the impact of storytelling on students' perceptions about intellectual abilities and their interests in STEM fields is rarely addressed by research. Hence, this study was conducted, on one hand, due to the scarcity of literature about this topic, and, on the other hand, the interest in investigating the consequences of using storytelling in STEM subjects on students' interest in STEM fields.

Prior research, such as Ashby and Wittmaier (1978) and McArthur and Eisen (1976), highlighted how narratives of female success in non-traditional fields influence young girls' perceptions of gendered professions. Buckley et al. (2021) further examined how stories of accomplished female scientists challenge gender stereotypes in STEM, emphasizing the need for more research on this topic.

This study expands beyond single-gender narratives, targeting middle school students of both genders to transform conventional STEM narratives. Unlike previous studies focusing on girls aged 6 to 8 (Ashby & Wittmaier, 1978; Bian et al., 2017; Buckley et al., 2021; McArthur & Eisen, 1976; Roper, 2019), this research emphasizes the critical middle school phase, highlighted by Shapiro and Sax (2011), and Horting (2016), as a pivotal period for engaging girls in STEM.

Hence, this study explored the effect of digital storytelling in STEM on middle school students' perceptions about intellectual stereotypes and their interest in STEM fields.

The two research questions that guided the study were the following:

RQ1 What is the effect of digital storytelling on middle school students' interest in STEM fields?

RQ2 What is the effect of digital storytelling in STEM on middle school students' perceptions about intellectual stereotypes?

METHODS

This research falls under the quasi-experimental design, where established groups, classrooms in a school, were utilized. Students were divided into two groups and both groups were given pretests and posttests, but only the experimental group received the intervention. The study was conducted during the academic year 2023-2024. The intervention took place once per week for a duration of four weeks.

Sampling

The study was conducted at a private school in Lebanon with 36 students evenly distributed across two classrooms. One classroom served as the experimental group, experiencing a digital storytelling intervention, while the other served as the control group with no intervention. The 36 participants were divided equally into control (9 out of 18 females) and experimental groups (8 out of 18 females). All participants were drawn from the eighth-grade level, encompassing a population of middle to high socio-economic backgrounds. This sampling approach facilitated practical participant engagement by utilizing naturally formed classroom groups (Creswell, 2014).

Informed consent was obtained from all participants, their parents or guardians, and the school administration. Participants were informed about the voluntary nature of the study and their right to withdraw at any time without repercussions.

Digital Storytelling Intervention

The study employed a digital storytelling intervention designed to dispel intellectual stereotypes and increase interest in STEM among middle school students. The Intervention took place once per week for a duration of four weeks one different story per week. It utilized narratives that integrated STEM concepts into engaging stories, tailored to students' educational levels and prior knowledge. The stories featured diverse characters representing various genders and STEM disciplines, aiming to demonstrate inclusivity and accessibility in STEM fields. Characters were intentionally crafted to represent both genders as well as expertise in a variety of STEM subjects. The creation of people such as Nour, Jana, Maher, and Sara were motivated by the need to demonstrate that STEM is accessible to anyone, regardless of gender. Relatable names were chosen to add a personal touch and make stories more relatable to the target audience of middle school students.

Each narrative was carefully constructed to include real-world challenges, showcasing the practical application of STEM knowledge and emphasizing collaborative problem-solving. Characters exemplified teamwork, illustrating the diversity of skills needed in STEM disciplines and using their skills to overcome obstacles. The stories were crafted not only to educate but also to inspire, challenging stereotypes and empowering students to envision themselves pursuing STEM careers.

To enhance engagement and authenticity, the intervention leveraged advanced AI tools like GenCraft (GenCraft, 2023), Fotor (Everimaging, 2023), and Imagine Art (Imagine, 2023) for creating vivid visual scenes, voice-acted dialogue, and culturally diverse characters. Talker Classic mobile application (Talker, 2023) enabled selected characters to appear as if they were talking. The voice of one of the researchers was added for the narration. In addition, we incorporated probing questions that encourage middle school students to reflect on their perceptions and interests related to STEM fields. These elements were integrated using Cap Cut (ByteDance, 2023) platform creating compelling video narratives, complemented by carefully chosen background music.

This comprehensive process aimed to create a visually rich and inclusive storytelling environment, offering a fresh perspective on intellectual stereotypes and stimulating the interest of middle school students in STEM fields.

Instruments

STEM semantics survey

The STEM Semantics Survey (**Appendix A**), developed by Knezek and Christensen (2008), was used to measure students' attitudes towards Science, Technology, Engineering, and Mathematics. It includes five scales for each STEM area and STEM careers, with each scale having five semantic adjective pairs rated on a 7-point scale. The survey was adapted linguistically and culturally for Lebanese middle school students through piloting, ensuring clarity without needing changes. It was administered in paper-pencil format to both experimental and control groups before and after the digital storytelling intervention, with one of the researchers available to clarify any questions.

Intellectual stereotypes questionnaire

A custom questionnaire (**Appendix B**) was created to evaluate the impact of the digital storytelling intervention on students' perceptions of intellectual stereotypes. The items, derived from relevant literature, addressed beliefs and attitudes about gender and intellectual abilities in STEM contexts. The questionnaire was piloted with three grade eight students to ensure clarity and relevance. It featured a range of statements rated on a 5-point Likert scale from "strongly disagree" to "strongly agree," designed to be completed quickly without extensive deliberation. This questionnaire was also administered in paper-pencil format to both experimental and control groups before and after the intervention, with one of the researchers available to answer any questions.

Validity and Reliability

The STEM Semantics Survey, an already validated survey, demonstrated "respectable" to "excellent" reliability in assessing students' attitudes toward STEM disciplines (see **Table 1**). These findings indicate that the survey is a reliable instrument based on DeVellis (1991) criteria.

The Intellectual Stereotypes Questionnaire demonstrated "very good" reliability with $\alpha = .80$. The Intellectual Stereotypes Questionnaire was designed to ensure content validity by aligning items with published

Table 1. STEM semantics survey Cronbach's alpha coefficients

	Science	Math	Engineering	Technology	Career
Cronback's Alpha	0.87	0.90	0.79	0.77	0.83

literature on intellectual stereotypes and incorporating relevant research findings. A pilot study and participant feedback helped refine the questionnaire, enhancing its relevance and clarity. This rigorous development process improved its overall validity and reliability.

Data Analysis Methods/Techniques

The study used *t*-tests to analyze quantitative data. T-tests compare the meanings of two groups to determine significant differences. The two types: paired (dependent) t-tests for related groups (e.g., pre- and post-tests within the same group) and independent *t*-tests for comparing two separate groups (e.g., control vs. experimental groups) were used. Dependent t- test were used to compare the pre and post results of each of the experimental and control groups while independent t-test were used to compare the results between the experimental and control groups.

RESULTS

STEM Semantics Survey

The STEM Semantic Survey (**Appendix A**) contains 25 items divided over five scales: science, math, engineering, technology, and career. Each scale includes five adjectives describing students' attitudes toward a specific subject. Some items were negatively worded and required reverse scoring. Please refer to **Appendix C** for total data responses of pre- and post-STEM Semantics test results for the control and experimental groups.

Before the intervention, there was no significant difference in attitude scores between the control and experimental groups ($p > .15$) on all items and all five scales (science, math, engineering, technology, and career). Moreover, Cohen's d values suggest negligible effect sizes, reinforcing the lack of practical significance in the observed differences between the control and experimental groups before the intervention. The full results are presented in **Appendix D**.

After the intervention, paired samples *t*-tests were used to compare pre- and post- STEM semantics test scores within both control and experimental groups to see if there was any change in students' attitudes (see **Table 2**). In addition, independent t-tests were performed to compare the results between the control and experimental groups after the intervention. These results are presented in **Table 2**.

After the intervention, the experimental group exhibited positive shifts in attitude in all items within all 5 scales (science, math, engineering, technology, and career). This was not the case for the control group where students' attitudes in 19 out of 25 items exhibited negative shifts, 5 out of 25 items remained the same and only 2 items shifted positively.

When desegregated by scales, the results were also revealing. For Science, as seen in **Table 2**, the mean scores for the experimental group increased significantly for all attributes except "unexciting-exciting" (p = .187). In contrast, the control group shows significant decrease (p = .008) only in the "ordinary fascinating" category instead of an increase. Moreover, Cohen's d values reveal medium to large effect sizes for the significant changes observed in the experimental group, indicating the practical significance of these shifts in science attitudes following the intervention.

Table 2. Pre and post comparison STEM semantics survey

		Control					Experimental				
		Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value	Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value
Science Attitude Scores	ordinary fascinating	5.28	4.72	-0.56	-0.34	.008**	5.22	6.17	0.95	0.69	.007**
	unappealing-appealing	4.33	4.28	-0.05	-0.03	.772	4.39	5.72	1.33	0.95	<.001***
	unexciting-exciting	4.50	4.50	0.00	0.00	1.000	5.22	5.56	0.34	0.25	.187
	means nothing-means a lot	5.06	4.78	-0.28	-0.15	.205	4.83	5.50	0.67	0.40	.029*
	boring-interesting	4.33	4.44	0.11	0.05	.631	4.72	5.89	1.17	0.67	.003**
Math Attitude Scores	ordinary fascinating	5.17	4.72	-0.45	-0.27	.042**	5.28	5.56	0.28	0.19	.263
	unappealing-appealing	4.28	4.11	-0.17	-0.10	.381	4.72	5.44	0.72	0.48	.008**
	unexciting-exciting	4.39	4.22	-0.17	-0.09	.381	4.39	4.89	0.50	0.31	.070
	means nothing-means a lot	5.11	5.17	0.06	0.04	.790	5.22	5.78	0.56	0.39	.066
	boring-interesting	3.83	3.61	-0.22	-0.13	.215	4.28	5.56	1.28	0.81	.001**
Engineering Attitude Scores	ordinary fascinating	5.44	5.28	-0.16	-0.11	.331	5.61	5.89	0.28	0.22	.236
	unappealing-appealing	5.83	5.50	-0.33	-0.26	.083	5.83	6.11	0.28	0.26	.236
	unexciting-exciting	5.22	5.11	-0.11	-0.07	.542	5.22	5.89	0.67	0.48	.035*
	means nothing-means a lot	5.11	4.83	-0.28	-0.15	.135	5.11	5.61	0.50	0.30	.070
	boring-interesting	5.28	5.11	-0.17	-0.09	.331	5.61	6.06	0.45	0.35	.088
Technology Attitude Scores	ordinary fascinating	5.11	5.11	0.00	0.00	1.000	5.28	5.94	0.66	0.47	.029*
	unappealing-appealing	6.00	5.83	-0.17	-0.12	.331	5.83	6.33	0.50	0.41	.083
	unexciting-exciting	5.78	5.11	-0.67	-0.46	.004**	5.72	6.22	0.50	0.41	.070
	means nothing-means a lot	5.22	5.22	0.00	0.00	1.000	5.11	5.89	0.78	0.55	.022*
	boring-interesting	5.17	5.17	0.00	0.00	1.000	5.44	5.94	0.50	0.39	.058

Table 2 (Continued). Pre and post comparison STEM semantics survey

		Control					Experimental				
		Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value	Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value
Career Attitude Scores	ordinary fascinating	4.89	4.78	-0.11	-0.07	.542	5.00	5.61	0.61	0.42	.023*
	unappealing-appealing	4.89	4.83	-0.06	-0.04	.790	5.00	5.72	0.72	0.53	.019*
	unexciting-exciting	5.11	5.06	-0.05	-0.04	.772	5.17	5.72	0.55	0.45	.037*
	means nothing-means a lot	5.50	5.17	-0.33	-0.20	.111	5.56	6.11	0.55	0.41	.056
	boring-interesting	5.33	5.17	-0.16	-0.10	.381	5.56	6.00	0.44	0.32	.072

* p < .05. **p < .01. ***p < .001

Interpreting the Math attitude paired t-test results, the experimental group displayed positive shifts in math attitude scores across all measured categories, however the difference was only statistically significant for "boring-interesting" (*p* = .001) and "unappealing-appealing" (*p* = .008) categories. Moreover, while the p-value may not be significant for some attributes, Cohen's d values indicate a degree of practical significance, particularly in the "unexciting-exciting" (*d* = 0.31) and "means nothing-means a lot" (*d* = 0.39) categories, underscoring the importance of these shifts in math attitudes following the intervention. In contrast, the control group showed a decrease in scores in all attributes except the "means nothing -means a lot" category. These changes were statistically significant (*p* = .042) only in the "ordinary fascinating" category, but with a decrease in mean scores instead of an increase.

The analysis of engineering attitude scores indicated a positive influence of the intervention on the experimental group's perception of engineering specifically in the "unexciting-exciting" category, the experimental group experienced a statistically significant increase in mean scores (*p* = .035). Additionally, a notable increase in mean scores was observed in the remaining categories, although non-statistically significant (p-value ranging between .070 and .236). However, Cohen's d values suggest practical significance despite the lack of statistical significance for some attributes in the experimental group, particularly in the "means nothing-means a lot" (d = 0.30) and "boring-interesting" categories (d = 0.35), indicating a meaningful positive change in perception. Conversely, the control group exhibited slight decreases in mean scores across categories, suggesting a lack of substantial change in attitudes towards engineering.

The examination of Technology attitude scores revealed distinct patterns in the control and experimental groups. Notably, the experimental group demonstrated a positive influence in the "means nothing-means a lot" and the "ordinary-fascinating" categories, with a statistically significant increase in mean scores (*p* = .022 and *p* = .029), suggesting an enhanced perception of technology. Notably, there was no change in the mean score of these categories for the control group. The remaining categories also displayed a noteworthy increase in mean scores for the experimental group, though not statistically significant. *Cohen's d* values indicate practical significance for the experimental group in the "unappealing-appealing" (*d* = 0.41), "boring-interesting" (*d* = 0.39), and "unexciting-exciting" (*d* = 0.41) categories, suggesting meaningful positive changes in perception despite the lack of statistical significance. In contrast, the control group showed significant change (*p* = .004) only in the "unexciting-exciting" category, but with a decrease in mean scores instead of an increase.

For Career in STEM attitude paired *t*-tests, the data analysis indicated that the experimental group displayed positive shifts in career attitude scores across all measured categories. The mean scores for the experimental group increased for all attributes with significant difference in "exciting-unexciting" (*p* = .037), "ordinary-fascinating" (*p* = .023), and "unappealing-appealing" (*p* = .019) categories. In contrast, the control group showed slight decreases, of no significance, in mean scores. These findings suggest a consistent and impactful positive effect of the experimental intervention on career attitudes within the experimental group, distinguishing it from the control group.

The attitude mean scores of the experimental and control groups were also compared after the intervention the results are displayed in **Appendix E**. In all attributes and within all 5 scales the experimental group had a more positive attitude than the control group. However, this difference was only statistically significant for "unappealing-appealing" and "boring-interesting" in math and science and for "ordinary-fascinating," in science and for "unexciting-exciting," in technology.

Overall, the findings indicate that the intervention significantly influenced participants' perceptions, especially in terms of fascination, appeal, and interest in STEM fields, highlighting both statistical and practical significance.

Intellectual Stereotypes Questionnaire

The intellectual stereotypes questionnaire was also administered to students before and after the intervention. As part of the analysis process, all questionnaire items were reverse coded except the last three items (14, 15, 16) to ensure that higher scores

Table 3. Intellectual stereotypes questionnaire paired samples t-test analysis results

	Control					Experimental				
	Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value	Pre	Post	Mean difference (post-pre)	*Cohen's d*	*P*-value
1. Boys are better at sports than girls (R)	2.61	2.72	0.11	0.07	.331	2.61	2.83	0.22	0.15	.104
2. Boys are naturally better at math than girls (R)	3.61	3.61	0.00	0.00	1.000	3.50	3.67	0.17	0.11	.483
3. Girls are naturally better at reading and writing than boys (R)	2.39	2.39	0.00	0.00	1.000	2.33	2.78	0.45	0.34	.007**
4. Some people are just born smarter than others (R)	3.06	3.17	0.11	0.07	.430	2.78	3.17	0.39	0.26	.015*
5. Girls are better at taking care of others than boys (R)	2.22	2.11	-0.11	-0.09	.495	2.22	2.11	-0.11	-0.08	.495
6. Some subjects in school are easier for boys than for girls (R)	2.44	2.50	0.06	0.04	.668	2.44	2.11	-0.33	-0.26	.111
7. Some subjects in school are easier for girls than for boys (R)	2.28	2.28	0.00	0.00	1.000	2.67	2.61	-0.06	-0.04	.772
8. It's more acceptable for boys to show leadership than for girls (R)	2.83	3.17	0.34	0.25	.083	2.89	4.39	1.50	1.35	<.001***
9. Girls are better at helping others with their problems than boys (R)	2.61	2.56	-0.05	-0.04	.749	2.72	2.83	0.11	0.08	.542
10. Boys are better at fixing things like computers and machines (R)	2.78	2.89	0.11	0.09	.542	3.00	1.61	-1.39	-1.10	<.001***
11. Girls are better at understanding people's feelings (R)	2.28	2.39	0.11	0.09	.607	2.50	2.56	0.06	0.04	.717
12. People often expect boys to be tough and strong, and girls to be sensitive and caring (R)	2.22	2.28	0.06	0.05	.717	2.39	1.83	-0.56	-0.43	.028*
13. People think boys are better at making decisions, while girls are better at making friends (R)	3.39	3.56	0.17	0.12	.269	3.61	2.72	-0.89	-0.64	.003**
14. Boys and girls are equally capable of being good leaders.	3.67	3.78	0.11	0.07	.607	3.44	3.72	0.28	0.18	.205
15. Boys and girls can enjoy and be good at the same activities, like sports and arts.	3.94	4.00	0.06	0.05	.717	3.94	3.44	-0.50	-0.38	.008**
16. Boys and girls can both be great problem solvers and creative thinkers.	1.83	1.78	-0.05	-0.05	.717	1.83	2.50	0.67	0.53	.001**

Note. (R) indicates a reversed item
*p < .05. **p < .01. ***p < .001

represent increased disagreement or deviation from gender stereotypes. Please refer to **Appendix F** for total data responses of pre- and post- Intellectual Stereotypes Questionnaire results for the control and experimental groups.

Before the intervention, there was no statistically significant difference in the intellectual stereotypes' questionnaire on any item between the control and experimental groups (see **Appendix G**). Cohen's d values indicated negligible effect sizes, highlighting the lack of practical significance in the observed differences. In fact, both groups have identical mean scores for several statements.

After the intervention, Intellectual Stereotypes Questionnaire means within both control and experimental groups were compared using paired samples *t*-tests. The results are presented in **Table 3**.

The results of the intellectual stereotypes questionnaire were divided into 4 themes: Intellectual Abilities Perceptions, Physical Abilities Perceptions, Empathy and Caregiving Perceptions, Leadership Perceptions.

Intellectual abilities perceptions

The intellectual abilities included items 2, 3, 4, 6, 7 and 16. For the control group, the difference between the means in all six items remained similar before and after the intervention. The means of 3 out of 6 items remained unchanged before and after the intervention. As for the experimental group, all the means increased after the intervention indicating less agreement with gender stereotypes. The increase in means was statistically significant for "Girls are naturally better at reading and writing than boys", "Some people are just born smarter than others", and "Boys and girls can both be great problem solvers and creative thinkers” (p = .007, .015, and .001 respectively). This suggests a substantial change in the students’ perceptions of stereotypes in these three categories meaning students tended to agree less with these statements.

Physical abilities perceptions

The physical abilities were based on two questions:

1) “Boys are better at sports than girls” and
2) “Boys and girls can enjoy and be good at the same activities, like sports and arts” (items 1 and 15).

Before the intervention, the control and experimental groups had equal meaning on both questions. After the intervention, both groups’ means increased (less agreement) for “Boys are better at sports than girl”, however the difference was not statistically significant for any of the groups. As for “Boys and girls can enjoy and be good at the same activities, like sports and arts” while there was a slight increase in the mean of the control group (not statistically significant), the experimental group exhibits a significant decrease in mean scores (p = .008) indicating an unexpected and adverse effect of the intervention in reinforcing the stereotype that boys are better than girls in sports.

Empathy and caregiving perceptions

Items 5, 9, 10, 11, and 12 were included in this group. For “Girls are better at taking care of others than boys,” the control and experiment groups had the same means before the intervention and even though there was a slight decrease (p = .495) in the means still both groups had the same means after the intervention. For “Girls are better at helping others with their problems than boys,” and “Girls are better at understanding people’s feelings” there was no significant change in the control or experimental groups.

Conversely, for “People often expect boys to be tough and strong, and girls to be sensitive and caring,” and for the “Boys are better at fixing things like computers and machines,” the control group exhibits no significant change, whereas the experimental group demonstrates a statistically significant decrease in mean score after the intervention (p = .028). This suggests an adverse effect of the intervention in reinforcing stereotypes that boys are expected to be tough and are better at fixing things.

Leadership perceptions

Three items were included in this group (items 8, 13, and 14). For “It’s more acceptable for boys to show leadership than for girls”, the control group showed no significant change while the experimental group exhibits a significant increase in mean (p < .010) indicating a positive effect of the intervention in challenging stereotypes in this category. However, for “Boys and girls are equally capable of being good leaders,” both groups show no significant change.

Notably, for “People think boys are better at making decisions, while girls are better at making friends,” the experimental group exhibits a statistically significant decrease in mean scores after the intervention ($p \leq .003$), suggesting an unexpected and adverse effect of the intervention in reinforcing the stereotype that boys are better than girls in making decisions.

Note that for statements where no statistical significance is noticed, Cohen’s d values indicate no practical significance as well.

The data in **Appendix H** displays the comparisons between the control and experimental groups after the intervention. Before the interventions there were no statistically significant differences between the control and experimental groups on any item. After the intervention, only 2 items exhibited statistically significant differences in the means on the control and experimental groups. For “It’s more acceptable for boys to show leadership than for girls,” the mean difference (M_E – M_C) is positive with p = .003, indicating a substantial positive effect of the intervention in challenging traditional leadership stereotypes. Conversely, for “Boys are better at fixing things like computers and machines” the mean difference (M_E – M_C) is negative with p < .001, suggesting an unexpected and adverse effect of the intervention in reinforcing stereotypes related to technical skills.

DISCUSSION

Effect of Digital Storytelling on Interest in STEM Fields

When examining the results of the STEM Semantics Test after the intervention, the experimental group consistently exhibited higher mean scores across all STEM-related attitude categories compared to the control group. On the contrary the control group had lower means after the intervention in 19 out of 25 items.

Notably, the experimental group found science and math more fascinating and more appealing than the control group. Additionally, noteworthy differences were observed in technology where the experimental group was more excited about technology than the control group.

In addition, within the control group, statistically significant p-values were solely associated with a decrease in mean scores from pre to post. In contrast, the experimental group exhibited a substantial and statistically significant increase in STEM semantics test scores across various categories. Specifically, science attitude scores indicate how the experimental group considered science more fascinating, appealing, interesting, and meaningful. For math attitude scores, the experimental group displayed positive shifts in terms of interest and appellation of math. In addition, the experimental group became more excited about engineering. When it comes to technology, attitude scores show how technology meant more to the experimental group and became more fascinating. Finally, In Career attitude scores, the experimental group displayed positive shifts in terms of excitement, fascination, and appellation of a career in STEM. Thus, the results underscore the distinct and positive impact of the digital storytelling intervention on middle school students' attitudes and interests across various STEM domains. Interestingly, some of the highest means changes in the experimental group after the intervention where in math and science become more appealing and more interesting (less boring).

The results of this study are consistent with the literature, which highlights the benefits of using storytelling in STEM education, especially for science and math classes, as the experimental group's higher mean scores after the intervention, across various STEM domains indicate that digital storytelling helps students contextualize and engage with STEM subjects and improve students' attitudes towards STEM subjects.

Borasi et al. (1990) claims that using stories in math classes is revolutionary because it empowers students to see concepts outside of the curriculum and take an active role in their math education. The current study, which focuses on digital storytelling, supports the idea that storytelling can positively influence students' attitudes toward STEM fields by showing a consistent improvement in mean scores across all STEM-related attitude categories in the experimental group. Toor and Mgombelo (2015) considered how storytelling in mathematics might humanize a subject by connecting it to real-life experiences. This viewpoint is supported by the study's findings, which show the potential of digital storytelling to increase mathematics' relatability and engagement.

The findings also align with Muir et al. (2017) and Russo and Russo (2018), who emphasized the use of children's literature and picture storybooks to promote mathematical reasoning and effective teaching.

Piatek-Jimenez and Phelps (2016) used the movie *Frozen* to teach fractal and geometry concepts. Although they did not delve into the benefits of the activities, the present study's findings, with higher mean scores in technology attitude categories and significant improvements in STEM semantics test scores, suggest that interweaving storytelling with mathematics instruction, as done in the experimental group, positively affects students' attitude and engagement.

In summary, the current study's results align with a body of literature emphasizing the positive impact of digital storytelling on students' attitudes and interests in STEM fields. The findings support the idea that storytelling, whether in mathematics or science, enhances student engagement, contextualizes learning, and promotes a positive perception of STEM subjects. The study contributes to existing literature by providing empirical evidence of the effectiveness of digital storytelling in a middle school setting.

Effect of Digital Storytelling on Intellectual Stereotypes Perceptions

Before the intervention, both the control and experimental groups displayed similar mean scores for statements related to intellectual stereotypes. This aligns with existing literature that highlights the prevalence of certain stereotypes, such as gender differences in perceived intelligence (Bian et al., 2017) and early acquisition of gender stereotypes in children (Gelman et al., 2004).

After the intervention, there were no significant changes in intellectual stereotype scores of the control group. Nevertheless, in the experimental group, the results revealed three distinct patterns: challenging certain stereotypes, reinforcing others, and demonstrating no change in some.

Challenging Certain Stereotypes

The positive shift observed in the experimental group's perceptions of girls' reading and writing abilities aligns with previous research suggesting that exposure to diverse narratives, especially those featuring successful female role models, can challenge traditional stereotypes (Agosto, 2013; Buckley et al., 2021).

The significant increase in mean scores after the intervention for statements related to problem-solving and creative thinking supports the notion that storytelling interventions can positively influence how children perceive gender roles in intellectual domains (Buckley et al., 2021). This aligns with literature emphasizing the importance of early interventions to counteract the development of gender-based intellectual stereotypes (Cimpian et al., 2012; Wigfield & Eccles, 2000).

The increase in disagreement about the idea that some people are just born smarter than others suggests that the intervention might influence the perception of innate intelligence. This finding resonates with Dweck's (2006) work on mindset, emphasizing the malleability of intelligence and the potential for growth. The digital storytelling approach seems to contribute to fostering a mindset that values effort and learning over fixed notions of innate abilities.

The increased acceptability of girls showing leadership aligns with the broader goal of promoting gender equality in STEM leadership positions (Reinking & Martin, 2018) and echoes the positive outcomes seen in interventions that expose individuals to counter-stereotypical role models (Dasgupta et al., 2015). This positive change reinforces the idea that storytelling interventions can contribute to reshaping societal expectations and challenging stereotypes related to gender roles in leadership.

Reinforcing Intellectual Stereotypes

The unexpected adverse effect on perceptions related to decision-making, shared enjoyment in activities like sports, toughness, sensitivity, and fixing things, such as computers and machines, suggests a need for a more refined approach in creating narratives. This outcome may reflect the complexity of challenging stereotypes, indicating that certain aspects were unintentionally reinforced by the intervention. Notably, in story 1, the male character plays a pivotal role in assisting the female character to identify and fix a glitch in her robot. Similarly, in story 2, the male character initiates the adventure, stating, "Let's use our STEM skills to get to the bottom of this!" Additionally, in story 3, the male character, takes the lead in deciding their first destination, saying, "let's set the coordinates for ancient Egypt first."

These specific instances highlight the need for a comprehensive understanding of how narrative dynamics can contribute to reinforcing existing intellectual stereotypes and the narrative's influence on various aspects of stereotypes, even in seemingly unrelated domains (Myers & Major, 2017). While some changes are observed in certain stereotypes, others may be reinforced, emphasizing the need for refined interventions (Freedman et al., 2018).

In examining the positive and negative changes in intellectual stereotypes it is evident that the storytelling intervention had varying effects on different aspects of gender-related perceptions. While the positive changes align with the intended goals of challenging stereotypes, the unexpected negative changes underscore the importance of fine-tuning narrative content to avoid unintended consequences. Consideration should be given to the content, duration, and the way stereotypes were addressed, reflecting on the distinctive nature of stereotype change (Agosto, 2013).

CONCLUSION

The implications of this study are far-reaching, emphasizing the potential of digital storytelling as a powerful educational tool to positively influence middle school students' attitudes toward STEM fields and challenge stereotypical beliefs. The findings suggest that digital storytelling interventions can foster a sustained and heightened interest in STEM subjects, contributing to a more positive perception among students. Moreover, the study underscores the distinctive impact of digital storytelling on intellectual stereotypes, with observed changes in specific beliefs related to gender roles. While the results reveal promising shifts in perceptions, the adverse effects in certain aspects highlight the need for careful consideration of intervention content and delivery methods. These insights carry implications for educators, curriculum designers, and policymakers, urging a thoughtful integration of digital storytelling strategies to enhance STEM education by not only sparking curiosity and interest but also promoting a more inclusive and equitable learning environment. However, this study only examined the short-term effect of using digital storytelling; longitudinal studies that examine the effect of digital storytelling at the student's behavioral level (choice of courses, choice of university major, career choice) might offer better sights.

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APPENDIX A

STEM Semantics Survey

Instructions: Choose one circle between each adjective pair to indicate how you feel about the object.

To me, SCIENCE is:

1.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, MATH is:

1.	boring	①	②	③	④	⑤	⑥	⑦	interesting
2.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
3.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot

To me, ENGINEERING is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
3.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	boring	①	②	③	④	⑤	⑥	⑦	interesting

To me, TECHNOLOGY is:

1.	appealing	①	②	③	④	⑤	⑥	⑦	unappealing
2.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
3.	boring	①	②	③	④	⑤	⑥	⑦	interesting
4.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
5.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary

To me, a CAREER in science, technology, engineering, or mathematics (is):

1.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot
2.	boring	①	②	③	④	⑤	⑥	⑦	interesting
3.	exciting	①	②	③	④	⑤	⑥	⑦	unexciting
4.	fascinating	①	②	③	④	⑤	⑥	⑦	ordinary
5.	means nothing	①	②	③	④	⑤	⑥	⑦	means a lot

STEM v. 1.1 by G. Knezek & R. Christensen 4/2008

APPENDIX B

Intellectual Stereotypes Questionnaire

Instructions: Choose one circle ranging from "1. Strongly Disagree" to "5. Strongly Agree" to show how much you agree or disagree with the following statements.

1. Boys are better at sports than girls.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

2. Boys are naturally better at math than girls.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

3. Girls are naturally better at reading and writing than boys.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

4. Some people are just born smarter than others.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

5. Girls are better at taking care of others than boys.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

6. Some subjects in school are easier for boys than for girls.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

7. Some subjects in school are easier for girls than for boys.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

8. It's more acceptable for boys to show leadership than for girls.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

9. Girls are better at helping others with their problems than boys.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

10. Boys are better at fixing things like computers and machines.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

11. Girls are better at understanding people's feelings.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

12. People often expect boys to be tough and strong, and girls to be sensitive and caring.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

13. People think boys are better at making decisions, while girls are better at making friends.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

14. Boys and girls are equally capable of being good leaders.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

15. Boys and girls can enjoy and be good at the same activities, like sports and arts.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

16. Boys and girls can both be great problem solvers and creative thinkers.

Strongly Disagree	①	②	③	④	⑤	Strongly Agree

APPENDIX C

Semantics Survey Responses before the Intervention

Control Group STEM Semantics Survey Responses before the Intervention

Science									
1	fascinating	4 (22.22%)	5 (27.78%)	5 (27.78%)	1 (5.56%)	2 (11.11%)	1 (5.56%)	0 (.00%)	ordinary
2	appealing	0 (.00%)	4 (22.22%)	5 (27.78%)	5 (27.78%)	2 (11.11%)	1 (5.56%)	1 (5.56%)	unappealing
3	exciting	2 (11.11%)	6 (33.33%)	4 (22.22%)	3 (16.67%)	1 (5.56%)	0 (.00%)	2 (11.11%)	unexciting
4	means nothing	1 (5.56%)	0 (.00%)	3 (16.67%)	4 (22.22%)	1 (5.56%)	3 (16.67%)	6 (33.33%)	means a lot
5	boring	4 (22.22%)	0 (.00%)	3 (16.67%)	1 (5.56%)	2 (11.11%)	5 (27.78%)	3 (16.67%)	interesting

Math									
1	boring	3 (16.67%)	0 (.00%)	4 (22.22%)	6 (33.33%)	2 (11.11%)	1 (5.56%)	2 (11.11%)	interesting
2	appealing	2 (11.11%)	2 (11.11%)	4 (22.22%)	5 (27.78%)	2 (11.11%)	2 (11.11%)	1 (5.56%)	unappealing
3	fascinating	5 (27.78%)	4 (22.22%)	1 (5.56%)	7 (38.89%)	0 (.00%)	0 (.00%)	1 (5.56%)	ordinary
4	exciting	3 (16.67%)	1 (5.56%)	5 (27.78%)	5 (27.78%)	1 (5.56%)	1 (5.56%)	2 (11.11%)	unexciting
5	means nothing	1 (5.56%)	0 (.00%)	1 (5.56%)	5 (27.78%)	4 (22.22%)	1 (5.56%)	6 (33.33%)	means a lot

Engineering									
1	appealing	6 (33.33%)	6 (33.33%)	4 (22.22%)	1 (5.56%)	1 (5.56%)	0 (.00%)	0 (.00%)	unappealing
2	fascinating	6 (33.33%)	2 (11.11%)	6 (33.33%)	3 (16.67%)	0 (.00%)	1 (5.56%)	0 (.00%)	ordinary
3	means nothing	1 (5.56%)	2 (11.11%)	0 (.00%)	2 (11.11%)	5 (27.78%)	2 (11.11%)	6 (33.33%)	means a lot
4	exciting	5 (27.78%)	2 (11.11%)	6 (33.33%)	4 (22.22%)	0 (.00%)	0 (.00%)	1 (5.56%)	unexciting
5	boring	1 (5.56%)	0 (.00%)	2 (11.11%)	3 (16.67%)	3 (16.67%)	2 (11.11%)	7 (38.89%)	interesting

Technology									
1	appealing	9 (5.00%)	4 (22.22%)	3 (16.67%)	1 (5.56%)	0 (.00%)	1 (5.56%)	0 (.00%)	unappealing
2	means nothing	0 (.00%)	0 (.00%)	1 (5.56%)	8 (44.44%)	1 (5.56%)	2 (11.11%)	6 (33.33%)	means a lot
3	boring	0 (.00%)	1 (5.56%)	0 (.00%)	6 (33.33%)	3 (16.67%)	4 (22.22%)	4 (22.22%)	interesting
4	exciting	8 (44.44%)	4 (22.22%)	1 (5.56%)	4 (22.22%)	1 (5.56%)	0 (.00%)	0 (.00%)	unexciting
5	fascinating	5 (27.78%)	3 (16.67%)	3 (16.67%)	5 (27.78%)	1 (5.56%)	0 (.00%)	1 (5.56%)	ordinary

Career									
1	means nothing	0 (.00%)	1 (5.56%)	0 (.00%)	4 (22.22%)	4 (22.22%)	2 (11.11%)	7 (38.89%)	means a lot
2	boring	0 (.00%)	1 (5.56%)	2 (11.11%)	3 (16.67%)	2 (11.11%)	4 (22.22%)	6 (33.33%)	interesting
3	exciting	3 (16.67%)	2 (11.11%)	8 (44.44%)	4 (22.22%)	1 (5.56%)	0 (.00%)	0 (.00%)	unexciting
4	fascinating	2 (11.11%)	5 (27.78%)	5 (27.78%)	3 (16.67%)	2 (11.11%)	0 (.00%)	1 (5.56%)	ordinary
5	appealing	3 (16.67%)	3 (16.67%)	4 (22.22%)	7 (38.89%)	0 (.00%)	0 (.00%)	1 (5.56%)	unappealing

Experimental Group STEM Semantics Survey Responses before the Intervention

Science

1	fascinating	5 (27.78%)	4 (22.22%)	4 (22.22%)	1 (5.56%)	3 (16.67%)	1 (5.56%)	0 (.00%)	ordinary
2	appealing	0 (.00%)	5 (27.78%)	5 (27.78%)	4 (22.22%)	1 (5.56%)	2 (11.11%)	1 (5.56%)	unappealing
3	exciting	2 (11.11%)	7 (38.89%)	5 (27.78%)	3 (16.67%)	0 (.00%)	0 (.00%)	1 (5.56%)	unexciting
4	means nothing	1 (5.56%)	0 (.00%)	4 (22.22%)	4 (22.22%)	1 (5.56%)	3 (16.67%)	5 (27.78%)	means a lot
5	boring	3 (16.67%)	0 (.00%)	2 (11.11%)	2 (11.11%)	2 (11.11%)	5 (27.78%)	4 (22.22%)	interesting

Math

1	boring	2 (11.11%)	0 (.00%)	3 (16.67%)	6 (33.33%)	3 (16.67%)	1 (5.56%)	3 (16.67%)	interesting
2	appealing	3 (16.67%)	3 (16.67%)	4 (22.22%)	5 (27.78%)	1 (5.56%)	1 (5.56%)	1 (5.56%)	unappealing
3	fascinating	5 (27.78%)	5 (27.78%)	1 (5.56%)	5 (27.78%)	1 (5.56%)	1 (5.56%)	0 (.00%)	ordinary
4	exciting	3 (16.67%)	1 (5.56%)	5 (27.78%)	5 (27.78%)	1 (5.56%)	1 (5.56%)	2 (11.11%)	unexciting
5	means nothing	1 (5.56%)	0 (.00%)	0 (.00%)	5 (27.78%)	5 (27.78%)	1 (5.56%)	6 (33.33%)	means a lot

Engineering

1	appealing	6 (33.33%)	5 (27.78%)	5 (27.78%)	2 (11.11%)	0 (.00%)	0 (.00%)	0 (.00%)	unappealing
2	fascinating	6 (33.33%)	3 (16.67%)	7 (38.89%)	1 (5.56%)	0 (.00%)	1 (5.56%)	0 (.00%)	ordinary
3	means nothing	1 (5.56%)	2 (11.11%)	0 (.00%)	2 (11.11%)	5 (27.78%)	2 (11.11%)	6 (33.33%)	means a lot
4	exciting	5 (27.78%)	2 (11.11%)	6 (33.33%)	4 (22.22%)	0 (.00%)	0 (.00%)	1 (5.56%)	unexciting
5	boring	0 (.00%)	0 (.00%)	1 (5.56%)	22%	3 (16.67%)	3 (16.67%)	7 (38.89%)	interesting

Technology

1	appealing	8 (44.44%)	4 (22.22%)	3 (16.67%)	2 (11.11%)	0 (.00%)	1 (5.56%)	0 (.00%)	unappealing
2	means nothing	0 (.00%)	0 (.00%)	2 (11.11%)	7 (38.89%)	2 (11.11%)	1 (5.56%)	6 (33.33%)	means a lot
3	boring	0 (.00%)	1 (5.56%)	0 (.00%)	4 (22.22%)	3 (16.67%)	5 (27.78%)	5 (27.78%)	interesting
4	exciting	7 (38.89%)	5 (27.78%)	1 (5.56%)	4 (22.22%)	1 (5.56%)	0 (.00%)	0 (.00%)	unexciting
5	fascinating	5 (27.78%)	4 (22.22%)	3 (16.67%)	5 (27.78%)	0 (.00%)	0 (.00%)	1 (5.56%)	ordinary

Career

1	means nothing	0 (.00%)	1 (5.56%)	0 (.00%)	3 (16.67%)	5 (27.78%)	2 (11.11%)	7 (38.89%)	means a lot
2	boring	0 (.00%)	1 (5.56%)	1 (5.56%)	2 (11.11%)	3 (16.67%)	5 (27.78%)	6 (33.33%)	interesting
3	exciting	4 (22.22%)	2 (11.11%)	7 (38.89%)	3 (16.67%)	2 (11.11%)	0 (.00%)	0 (.00%)	unexciting
4	fascinating	3 (16.67%)	5 (27.78%)	4 (22.22%)	3 (16.67%)	2 (11.11%)	0 (.00%)	1 (5.56%)	ordinary
5	appealing	3 (16.67%)	4 (22.22%)	4 (22.22%)	6 (33.33%)	0 (.00%)	0 (.00%)	1 (5.56%)	unappealing

APPENDIX D

Pre -test STEM Semantics Survey

		Control		Experimental		Mean difference	*Cohen's d*	*P*-value
		Mean	SD	Mean	SD	(M_E-M_C)		
Science Attitude Scores	ordinary-fascinating	5.28	1.49	5.22	1.63	-0.06	-0.04	.916
	unappealing-appealing	4.33	1.41	4.39	1.54	0.06	0.04	.911
	unexciting-exciting	4.50	1.58	5.22	1.40	0.72	0.48	.156
	means nothing-means a lot	5.06	1.86	4.83	1.86	-0.23	-0.12	.722
	boring-interesting	4.33	2.25	4.72	2.14	0.39	0.18	.598
Math Attitude Scores	ordinary-fascinating	5.17	1.65	5.28	1.56	0.11	0.07	.837
	unappealing-appealing	4.28	1.67	4.72	1.67	0.44	0.26	.431
	unexciting-exciting	4.39	1.82	4.39	1.82	0.00	0.00	1.000
	means nothing-means a lot	5.11	1.71	5.22	1.63	0.11	0.07	.843
	boring-interesting	3.83	1.79	4.28	1.78	0.45	0.25	.460
Engineering Attitude Scores	ordinary-fascinating	5.44	1.42	5.61	1.33	0.17	0.12	.719
	unappealing-appealing	5.83	1.15	5.83	1.04	0.00	0.00	1.000
	unexciting-exciting	5.22	1.56	5.22	1.56	0.00	0.00	1.000
	means nothing-means a lot	5.11	1.91	5.11	1.91	0.00	0.00	1.000
	boring-interesting	5.28	1.81	5.61	1.38	0.33	0.21	.538
Technology Attitude Scores	ordinary-fascinating	5.11	1.68	5.28	1.60	0.17	0.10	.762
	unappealing-appealing	6.00	1.37	5.83	1.42	-0.17	-0.12	.723
	unexciting-exciting	5.78	1.40	5.72	1.36	-0.06	-0.04	.905
	means nothing-means a lot	5.22	1.48	5.11	1.53	-0.11	-0.07	.826
	boring-interesting	5.17	1.42	5.44	1.42	0.27	0.19	.562
Career Attitude Scores	ordinary-fascinating	4.89	1.53	5.00	1.61	0.11	0.07	.833
	unappealing-appealing	4.89	1.49	5.00	1.50	0.11	0.07	.825
	unexciting-exciting	5.11	1.13	5.17	1.29	0.06	0.05	.892
	means nothing-means a lot	5.50	1.50	5.56	1.46	0.06	0.04	.911
	boring-interesting	5.33	1.64	5.56	1.50	0.23	0.15	.675

$^*p < .05$. $^{**}p < .01$. $^{***}p < .001$

APPENDIX E

Pre -test STEM Semantics Survey

		Control		Experimental		Mean difference	*Cohen's d*	*P*-value
		Mean	SD	Mean	SD	(M_E-M_C)		
Science Attitude Scores	ordinary-fascinating	4.72	1.81	6.17	1.04	1.45	0.98	.007**
	unappealing-appealing	4.28	1.74	5.72	1.23	1.44	0.96	.007**
	unexciting-exciting	4.5	2.01	5.56	1.34	1.06	0.62	.073
	means nothing-means a lot	4.78	1.93	5.5	1.47	0.72	0.42	.215
	boring-interesting	4.44	2.12	5.89	1.23	1.45	0.84	.019*
Math Attitude Scores	ordinary-fascinating	4.72	1.71	5.56	1.42	0.84	0.53	.121
	unappealing-appealing	4.11	1.60	5.44	1.34	1.33	0.90	.011*
	unexciting-exciting	4.22	1.77	4.89	1.41	0.67	0.42	.220
	means nothing-means a lot	5.17	1.65	5.78	1.22	0.61	0.42	.216
	boring-interesting	3.61	1.61	5.56	1.34	1.95	1.32	<.001***
Engineering Attitude Scores	ordinary-fascinating	5.28	1.41	5.89	1.23	0.61	0.46	.175
	unappealing-appealing	5.50	1.38	6.11	1.08	0.61	0.49	.149
	unexciting-exciting	5.11	1.53	5.89	1.18	0.78	0.57	.098
	means nothing-means a lot	4.83	1.92	5.61	1.42	0.78	0.46	.176
	boring-interesting	5.11	1.78	6.06	1.16	0.95	0.63	.069
Technology Attitude Scores	ordinary-fascinating	5.11	1.75	5.94	1.16	0.83	0.56	.102
	unappealing-appealing	5.83	1.42	6.33	0.97	0.50	0.41	.228
	unexciting-exciting	5.11	1.53	6.22	1.06	1.11	0.84	.017*
	means nothing-means a lot	5.22	1.48	5.89	1.28	0.67	0.48	.157
	boring-interesting	5.17	1.42	5.94	1.16	0.77	0.59	.082
Career Attitude Scores	ordinary-fascinating	4.78	1.52	5.61	1.29	0.83	0.59	.085
	unappealing-appealing	4.83	1.54	5.72	1.18	0.89	0.65	.061
	unexciting-exciting	5.06	1.16	5.72	1.13	0.66	0.58	.090
	means nothing-means a lot	5.17	1.79	6.11	1.18	0.94	0.62	.072
	boring-interesting	5.17	1.50	6.00	1.28	0.83	0.60	.083

*$p < .05$. **$p < .01$. ***$p < .001$

APPENDIX F

Intellectual Stereotypes Questionnaire Responses

Pre- Control/Experimental Groups Intellectual Stereotypes Questionnaire Responses:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Boys are better at sports than girls.	Control	3 (16.67%)	3 (16.67%)	3 (16.67%)	2 (11.11%)	7 (38.89%)
	Experimental	2 (11.11%)	4 (22.22%)	3 (16.67%)	3 (16.67%)	6 (33.33%)
2. Boys are naturally better at math than girls.	Control	7 (38.89%)	4 (22.22%)	3 (16.67%)	1 (5.56%)	3 (16.67%)
	Experimental	7 (38.89%)	4 (22.22%)	2 (11.11%)	1 (5.56%)	4 (22.22%)
3. Girls are naturally better at reading and writing than boys.	Control	1 (5.56%)	3 (16.67%)	5 (27.78%)	2 (11.11%)	7 (38.89%)
	Experimental	1 (5.56%)	2 (11.11%)	6 (33.33%)	2 (11.11%)	7 (38.89%)
4. Some people are just born smarter than others.	Control	5 (27.78%)	2 (11.11%)	4 (22.22%)	3 (16.67%)	4 (22.22%)
	Experimental	4 (22.22%)	1 (5.56%)	5 (27.78%)	3 (16.67%)	5 (27.78%)
5. Girls are better at taking care of others than boys.	Control	0 (.00%)	4 (22.22%)	3 (16.67%)	4 (22.22%)	7 (38.89%)
	Experimental	1 (5.56%)	3 (16.67%)	2 (11.11%)	5 (27.78%)	7 (38.89%)
6. Some subjects in school are easier for boys than for girls.	Control	3 (16.67%)	0 (.00%)	5 (27.78%)	4 (22.22%)	6 (33.33%)
	Experimental	3 (16.67%)	0 (.00%)	5 (27.78%)	4 (22.22%)	6 (33.33%)
7. Some subjects in school are easier for girls than for boys.	Control	2 (11.11%)	1 (5.56%)	3 (16.67%)	6 (33.33%)	6 (33.33%)
	Experimental	4 (22.22%)	1 (5.56%)	3 (16.67%)	5 (27.78%)	5 (27.78%)
8. It's more acceptable for boys to show leadership than for girls.	Control	3 (16.67%)	2 (11.11%)	6 (33.33%)	3 (16.67%)	4 (22.22%)
	Experimental	3 (16.67%)	2 (11.11%)	7 (38.89%)	2 (11.11%)	4 (22.22%)
9. Girls are better at helping others with their problems than boys.	Control	2 (11.11%)	2 (11.11%)	6 (33.33%)	3 (16.67%)	5 (27.78%)
	Experimental	3 (16.67%)	2 (11.11%)	5 (27.78%)	3 (16.67%)	5 (27.78%)
10. Boys are better at fixing things like computers and machines.	Control	3 (16.67%)	1 (5.56%)	7 (38.89%)	3 (16.67%)	4 (22.22%)
	Experimental	5 (27.78%)	1 (5.56%)	5 (27.78%)	3 (16.67%)	4 (22.22%)
11. Girls are better at understanding people's feelings.	Control	2 (11.11%)	2 (11.11%)	2 (11.11%)	5 (27.78%)	7 (38.89%)
	Experimental	3 (16.67%)	2 (11.11%)	2 (11.11%)	5 (27.78%)	6 (33.33%)
12. People often expect boys to be tough and strong, and girls to be sensitive and caring.	Control	2 (11.11%)	1 (5.56%)	3 (16.67%)	5 (27.78%)	7 (38.89%)
	Experimental	3 (16.67%)	1 (5.56%)	3 (16.67%)	4 (22.22%)	7 (38.89%)
13. People think boys are better at making decisions, while girls are better at making friends.	Control	6 (33.33%)	1 (5.56%)	7 (38.89%)	2 (11.11%)	2 (11.11%)
	Experimental	8 (44.44%)	1 (5.56%)	5 (27.78%)	2 (11.11%)	2 (11.11%)
14. Boys and girls are equally capable of being good leaders.	Control	4 (22.22%)	0 (.00%)	2 (11.11%)	4 (22.22%)	8 (44.44%)
	Experimental	5 (27.78%)	0 (.00%)	2 (11.11%)	4 (22.22%)	7 (38.89%)
15. Boys and girls can enjoy and be good at the same activities, like sports and arts.	Control	1 (5.56%)	1 (5.56%)	5 (27.78%)	2 (11.11%)	9 (50.00%)
	Experimental	1 (5.56%)	1 (5.56%)	5 (27.78%)	2 (11.11%)	9 (50.00%)
16. Boys and girls can both be great problem solvers and creative thinkers.	Control	10 (55.56%)	2 (11.11%)	5 (27.78%)	1 (5.56%)	0 (.00%)
	Experimental	10 (55.56%)	2 (11.11%)	5 (27.78%)	1 (5.56%)	0 (.00%)

Post- Control/Experimental Groups Intellectual Stereotypes Questionnaire Responses:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Boys are better at sports than girls.	Control	3 (16.67%)	3 (16.67%)	4 (22.22%)	2 (11.11%)	6 (33.33%)
	Experimental	3 (16.67%)	3 (16.67%)	5 (27.78%)	2 (11.11%)	5 (27.78%)
2. Boys are naturally better at math than girls.	Control	8 (44.44%)	2 (11.11%)	4 (22.22%)	1 (5.56%)	3 (16.67%)
	Experimental	6 (33.33%)	5 (27.78%)	2 (11.11%)	1 (5.56%)	4 (22.22%)
3. Girls are naturally better at reading and writing than boys.	Control	2 (11.11%)	1 (5.56%)	6 (33.33%)	2 (11.11%)	7 (38.89%)
	Experimental	2 (11.11%)	3 (16.67%)	7 (38.89%)	1 (5.56%)	5 (27.78%)
4. Some people are just born smarter than others.	Control	6 (33.33%)	1 (5.56%)	5 (27.78%)	2 (11.11%)	4 (22.22%)
	Experimental	5 (27.78%)	3 (16.67%)	5 (27.78%)	2 (11.11%)	3 (16.67%)
5. Girls are better at taking care of others than boys.	Control	0 (.00%)	3 (16.67%)	4 (22.22%)	3 (16.67%)	8 (44.44%)
	Experimental	1 (5.56%)	2 (11.11%)	4 (22.22%)	2 (11.11%)	9 (5.00%)
6. Some subjects in school are easier for boys than for girls.	Control	3 (16.67%)	0 (.00%)	6 (33.33%)	3 (16.67%)	6 (33.33%)
	Experimental	0 (.00%)	2 (11.11%)	6 (33.33%)	2 (11.11%)	8 (44.44%)
7. Some subjects in school are easier for girls than for boys.	Control	2 (11.11%)	1 (5.56%)	4 (22.22%)	4 (22.22%)	7 (38.89%)
	Experimental	2 (11.11%)	2 (11.11%)	7 (38.89%)	1 (5.56%)	6 (33.33%)
8. It's more acceptable for boys to show leadership than for girls.	Control	3 (16.67%)	2 (11.11%)	7 (38.89%)	3 (16.67%)	3 (16.67%)
	Experimental	10 (55.56%)	5 (27.78%)	3 (16.67%)	0 (.00%)	0 (.00%)
9. Girls are better at helping others with their problems than boys.	Control	0 (.00%)	2 (11.11%)	10 (55.56%)	2 (11.11%)	4 (22.22%)
	Experimental	2 (11.11%)	6 (33.33%)	2 (11.11%)	3 (16.67%)	5 (27.78%)
10. Boys are better at fixing things like computers and machines.	Control	1 (5.56%)	2 (11.11%)	11 (61.11%)	2 (11.11%)	2 (11.11%)
	Experimental	0 (.00%)	1 (5.56%)	2 (11.11%)	4 (22.22%)	11 (61.11%)
11. Girls are better at understanding people's feelings.	Control	1 (5.56%)	0 (.00%)	9 (5.00%)	3 (16.67%)	5 (27.78%)
	Experimental	1 (5.56%)	4 (22.22%)	3 (16.67%)	6 (33.33%)	4 (22.22%)
12. People often expect boys to be tough and strong, and girls to be sensitive and caring.	Control	1 (5.56%)	1 (5.56%)	5 (27.78%)	6 (33.33%)	5 (27.78%)
	Experimental	1 (5.56%)	0 (.00%)	3 (16.67%)	5 (27.78%)	9 (5.00%)
13. People think boys are better at making decisions, while girls are better at making friends.	Control	7 (38.89%)	1 (5.56%)	7 (38.89%)	1 (5.56%)	2 (11.11%)
	Experimental	2 (11.11%)	2 (11.11%)	8 (44.44%)	1 (5.56%)	5 (27.78%)
14. Boys and girls are equally capable of being good leaders.	Control	2 (11.11%)	0 (.00%)	6 (33.33%)	2 (11.11%)	8 (44.44%)
	Experimental	3 (16.67%)	0 (.00%)	3 (16.67%)	5 (27.78%)	7 (38.89%)
15. Boys and girls can enjoy and be good at the same activities, like sports and arts.	Control	1 (5.56%)	1 (5.56%)	5 (27.78%)	1 (5.56%)	10 (55.56%)
	Experimental	2 (11.11%)	1 (5.56%)	8 (44.44%)	1 (5.56%)	6 (33.33%)
16. Boys and girls can both be great problem solvers and creative thinkers.	Control	10 (55.56%)	2 (11.11%)	6 (33.33%)	0 (.00%)	0 (.00%)
	Experimental	7 (38.89%)	2 (11.11%)	4 (22.22%)	3 (16.67%)	2 (11.11%)

APPENDIX G

Pre- Intellectual Stereotypes Test Data Analysis Results

	Control		Experimental		Mean difference	*Cohen's*	*P*-value
	Mean	SD	Mean	SD	(M_E-M_C)	*d*	
1. Boys are better at sports than girls (Reversed)	2.61	1.58	2.61	1.46	0.00	0.00	1.000
2. Boys are naturally better at math than girls (Reversed)	3.61	1.50	3.50	1.62	-0.11	-0.07	.832
3. Girls are naturally better at reading and writing than boys (Reversed)	2.39	1.33	2.33	1.28	-0.06	-0.05	.899
4. Some people are just born smarter than others (Reversed)	3.06	1.55	2.78	1.52	-0.28	-0.18	.591
5. Girls are better at taking care of others than boys (Reversed)	2.22	1.22	2.22	1.31	0.00	0.00	1.000
6. Some subjects in school are easier for boys than for girls (Reversed)	2.44	1.42	2.44	1.42	0.00	0.00	1.000
7. Some subjects in school are easier for girls than for boys (Reversed)	2.28	1.32	2.67	1.53	0.39	0.27	.421
8. It's more acceptable for boys to show leadership than for girls (Reversed)	2.83	1.38	2.89	1.37	0.06	0.04	.904
9. Girls are better at helping others with their problems than boys (Reversed)	2.61	1.33	2.72	1.45	0.11	0.08	.812
10. Boys are better at fixing things like computers and machines (Reversed)	2.78	1.35	3.00	1.53	0.22	0.15	.648
11. Girls are better at understanding people's feelings (Reversed)	2.28	1.41	2.50	1.50	0.22	0.15	.650
12. People often expect boys to be tough and strong, and girls to be sensitive and caring (Reversed)	2.22	1.35	2.39	1.50	0.17	0.12	.729
13. People think boys are better at making decisions, while girls are better at making friends (Reversed)	3.39	1.38	3.61	1.46	0.22	0.15	.642
14. Boys and girls are equally capable of being good leaders.	3.67	1.61	3.44	1.69	-0.23	-0.14	.689
15. Boys and girls can enjoy and be good at the same activities, like sports and arts.	3.94	1.26	3.94	1.26	0.00	0.00	1.000
16. Boys and girls can both be great problem solvers and creative thinkers.	1.83	1.04	1.83	1.04	0.00	0.00	1.000

*$p < .05$. **$p < .01$. ***$p < .001$

APPENDIX H

Post- Intellectual Stereotypes Test Data Analysis Results

	Control		Experimental		Mean difference	*Cohen's*	*P*-value
	Mean	SD	Mean	SD	(M_E-M_C)	*d*	
1. Boys are better at sports than girls (Reversed)	2.72	1.53	2.83	1.47	0.11	0.07	.825
2. Boys are naturally better at math than girls (Reversed)	3.61	1.54	3.67	1.50	0.06	0.04	.913
3. Girls are naturally better at reading and writing than boys (Reversed)	2.39	1.38	2.78	1.35	0.39	0.29	.399
4. Some people are just born smarter than others (Reversed)	3.17	1.58	3.17	1.50	0.00	0.00	1.000
5. Girls are better at taking care of others than boys (Reversed)	2.11	1.18	2.11	1.32	0.00	0.00	1.000
6. Some subjects in school are easier for boys than for girls (Reversed)	2.50	1.42	2.11	1.13	-0.39	-0.30	.371
7. Some subjects in school are easier for girls than for boys (Reversed)	2.28	1.36	2.61	1.38	0.33	0.24	.471
8. It's more acceptable for boys to show leadership than for girls (Reversed)	3.17	1.38	4.39	0.78	1.22	1.09	.003**
9. Girls are better at helping others with their problems than boys (Reversed)	2.56	0.98	2.83	1.47	0.27	0.22	.509
10. Boys are better at fixing things like computers and machines (Reversed)	2.89	0.96	1.61	0.92	-1.28	-1.36	<.001***
11. Girls are better at understanding people's feelings (Reversed)	2.39	1.09	2.56	1.25	0.17	0.14	.672
12. People often expect boys to be tough and strong, and girls to be sensitive and caring (Reversed)	2.28	1.13	1.83	1.10	-0.45	-0.40	.239
13. People think boys are better at making decisions, while girls are better at making friends (Reversed)	3.56	1.38	2.72	1.32	-0.84	-0.62	.073
14. Boys and girls are equally capable of being good leaders.	3.78	1.35	3.72	1.45	-0.06	-0.04	.906
15. Boys and girls can enjoy and be good at the same activities, like sports and arts.	4.00	1.28	3.44	1.34	-0.56	-0.43	.212
16. Boys and girls can both be great problem solvers and creative thinkers.	1.78	0.94	2.50	1.47	0.72	0.58	.089

* $p < .05$. ** $p < .01$. *** $p < .001$