STEM for All: How goal congruity improves tech career recruitment and retention

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***Abstract*—A projected shortage in US tech workers in STEM fields can be addressed by tapping into the "missing millions" of potential workers driven away by long-standing disparities. Evidence-based research shows that many women do not see themselves in technical careers due to masculine culture, insufficient early experiences, and gender gaps in self-efficacy. Industry outreach programs address these issues, but what strategies help rather than hurt the recruitment of Gen Z women into pursuing tech careers? Evidence-based scientific management provided the methodology used to conduct this research following Rapid Evidence Assessment (REA) guidelines. The research question was defined using the SPICE framework and identified 21 relevant scholarly articles through a search of three academic and professional research databases. A critical appraisal using the mixed methods assessment tool (MMAT) of the selected studies rated 14 articles with high quality. Finally, qualitative coding was performed using the Atlas.ti data analysis software to identify common codes, categories, and themes which were synthesized into a conceptual model supported by the articles in the dataset. The three main findings viewed through the lens of goal congruity theory characterized the STEM career path as a pipeline with intake moderated by early experiences and stereotypes, a social identity fit mediated by perceptions of tech, and retention persistence moderated by self-efficacy and community support. This helps identify effective recommendations to increase the future candidate pool through better alignment and framing for people who favor communal goals, a characteristic that falls along gender lines.**

***Index Terms*—STEM outreach, tech career pipeline, recruitment, retention, gender gap, goal congruity, social identity**

I. Introduction

THE US faces a shortage of science, technology, engineering, and mathematics (STEM) workers in the increasingly critical field of information technology infrastructure. However, the US education pipeline is not on track to produce enough qualified Gen Z candidates to fill these roles in the 2030 timeframe. The NSF has identified that the US education system lags behind many other competing countries in preparing students with the educational prerequisites for careers in tech. This provides an opportunity to better prepare the future workforce by tapping into the "missing millions" driven away from the field by long-standing disparities [1]. Women form the largest group, and while much effort has been expended over the past decades to reduce the gender gap in STEM fields, certain occupations such as computer science still see the gap growing. This presents a business problem in recruiting a sufficient engineering workforce to keep critical projects and infrastructure operational.

Cheryan et al. (2017) summarize many factors that dissuade women from joining the STEM workforce, including labor market forces, availability of peer support, and outright discrimination. However, even with those obstacles removed, women still choose not to pursue careers in STEM, and through systematic review of evidence they've narrowed it down to three main factors: (1) "masculine cultures" which create a hostile environment and a prevalence of tech nerd stereotypes which strip a girl's sense of in-group belonging, (2) "insufficient early experience" with STEM starting at an early age of development of attitudes, and (3) "gender gaps in self-efficacy" [2, p. 21]. Industry outreach programs help address these three issues. Instituted correctly, outreach can be instrumental in shifting public perception of the field away from what has sometimes been referred to derogatorily as a "sausage-fest" [3], but only if enough women decide to step up to redefine tech culture in their own image. The challenge in practice is identifying what aspects of the STEM intervention programs are particularly helpful in encouraging women to commit to the pursuit of careers in technology. Thus, supporting young women in technology interest helps fill the shortage of qualified workforce in the tech field.

II. Previous Work

Prevailing literature explores several causes for the STEM gap. The initial approach investigated the social effects of bullying, sexism, harassment, and microaggressions. This impacts enrollment multiple ways with tech stigma but also against women, the latter dealing with both forms of discrimination. Starr (2018) describes how peer pressure in school acts to dissuade interest in STEM education pathways due to multiple stereotypes of people in STEM "as socially awkward, unattractive, and naturally intelligent" [4, p. 4] and "as a male domain" [4, p. 3]. Furthermore, computer usage from a young age paradoxically provides a new cyberbullying venue to *apply* this type of pressure, as described by [5]. Bullying children out of interest in STEM comes from several sources, as [6] recalls the reaction from her own mother on wanting to major in engineering was, "eww, why?" This presents a sociocultural problem without a simple solution. However, the study of these issues leads to social theories which provide some insight.

The effects of stereotypes and stigmas are explained by social identity theory (SIT) and role theory, which frame a person's utility by their association with in-group organizational fit [7, p. 730]. A body of research spearheaded by Diekman et al. (2010) proposes goal congruity as a combination of SIT and role theory through a useful integrative lens [8]. Studies have shown that women tend to prefer roles with communal goals more than agentic goals. This helps explain why many other technical fields such as medicine, law, and even business have seen the gender gap close significantly since 1960 [8, p. 1052]. However, many surveys indicate that information technology and engineering are viewed as primarily agentic pursuits. There is a misconception that engineering fields such as computer science involve much alone time, do not require use of social skills, and have fixed and rigid course curricula and career paths. While this couldn't be further from the truth due to the collaborative nature of engineering and requirement for extensive knowledge transfer among diverse specializations, engineering fields still suffer from this image problem.

Goal congruity theory still has many exceptions and doesn't form a complete explanation of the state of the gender gap across other nations and cultures. Diekman et al. (2019) still continue to explore other integrative theoretical lenses [9]. The entire nerd outcast stigma following STEM careers may be a uniquely Western construct. A branch of research noted that the gender gap is reduced or even reversed in several countries around the world. Attempts to sort this out have found correlations between what they've called WEIRD (Western, Educated, Industrial, Rich, and Democratic) nations which are considered "post-materialistic" societies and "Majority World" nations which are driven more by scarcity and are still considered materialistic and collectivist [10]. The Majority World nations were observed to have smaller gender gaps because everyone had less economic freedom to adhere to stereotypes and took technical occupations out of necessity. While this perspective is corroborated by data from other studies such as Charles et al. (2014) and Moè et al. (2021), implementing this scale of national socioeconomic change to emulate conditions in other countries is impractical for a US tech company [11], [12].

Some studies pointed out that much of the gender gap was inadvertantly caused by universities in the wake of the 1990s dot-com boom, during which they saw so many new applicants to computer science (CS) programs that the introductory level classes adapted into "weed-out" courses to reduce the student population because they thought too many students were studying CS "for the money" [13, p. 281]. This practice may have resulted in the opposite of the intended effect, filtering for people who were in CS for the money even stronger and resulting in an industry more driven by agentic greed than if they had allowed more communally-minded students into the programs. As the US adapts to reinvent the tech industry into a more inclusive, diverse workforce, it's important to acknowledge that these forces were at play in creating a hostile and fiercely competitive environment.

Finally, a relatively new theory based on role authenticity provides a promising alternative to goal congruity. Schmader & Sedikides (2018) describe a framework for an individual to maintain state authenticity as fit to environment (SAFE) [14]. This framework shows how a person identifies more readily with a familiar environment, often constructed by the majority demographic, and fails to connect when experiencing an unfamiliar, incongruous fit. While constructed similarly to goal congruity, the SAFE framework provides additional explanatory power for other gaps such as socioeconomic differences. However, this novel theory has only been around to influence research for a few years, half as long as goal congruity. For the purposes of this REA, the SAFE framework is relegated to future study.

A. Theoretical Lens

Scientific evidence-based management provides a powerful tool to analyze the world. Formal theory "provides the base for knowledge and understanding of important relationships in various disciplines" [15, p. 1] and is the result of a deliberate process of investigation, validated and improved using scientific methods based on data collection and analysis. Bhattacherjee (2012) elaborates that good theory has the following properties:

• Logical consistency between constructs, propositions, boundary conditions, and assumptions

• Explanatory power to measure how well it explains and predicts reality

• Falsifiability to allow the theory to be tested and potentially refuted by evidence

• Parsimony in that the theory simplifies understanding by using the fewest variables, exceptions, and edge cases [16, p. 28]

The theoretical lens used by this research will therefore attempt to focus on the relatively narrow task of merging the social identity theories of goal congruity. Figure 1 depicts the initial conceptual framework developed after reviewing the literature for relevant foundations. Central to the framework is the young participant's self-image as a person capable of entering a career involving STEM. This is affected by various environmental experiences surrounding the participants following a social identity theory framework.

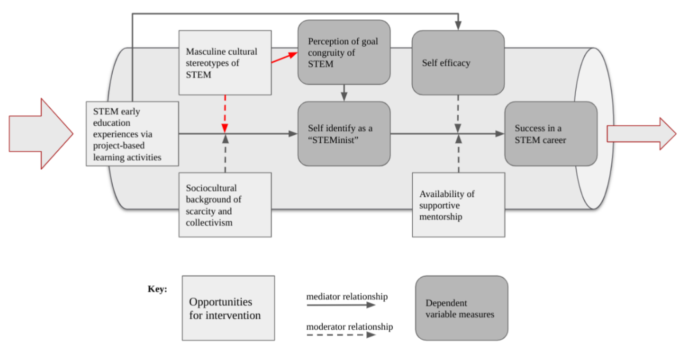

Fig. 1. STEM career pipeline initial conceptual framework

The SPICE framework as described by [17] provides context to the research question, particularly by enabling "splitting the population component into both setting and perspective" (p. 363). This allows for more reflective self-study which includes the effectiveness of the facilitators of a STEM activity program as much as the participants themselves. The evaluation would be from program participants reflecting on the effectiveness of the delivery of project-based learning activities. As a social science, Bhattacherjee (2012) accepts that this positions the "researcher as instrument," where the mere knowledge of the theoretical constructs being studied can affect the outcome [16, p. 106]. The role of an outreach facilitator is a performative process, in which the understanding of how the participants perceive a topic is important to absorbing the information itself.

TABLE I
SPICE FRAMEWORK COMPONENTS

Component	Description
Setting	STEM educational project-based learning program
Perspective	Gen Z youth entering the 2030 workforce under the encouragement of adult STEM industry volunteers and facilitators
Intervention	early age project-based learning activity
Comparison	participant gender
Evaluation	intention to self-identify into a STEM career path

The SPICE framework shown in Table I provides useful context for the research question driving this study: "What strategies does goal congruity theory provide to tech industry outreach programs to recruit and retain Gen Z women into the STEM career pipeline, thus ameliorating the crisis due to lack of qualified professionals in the STEM field?"

III. Methodology

Due to the potential impact of this research on interpersonal relationships and team performance, the principles of evidence-based management were used to investigate this problem. According to Barends *et al.*, "Evidence-based practice is about making decisions through the conscientious, explicit and judicious use of the best available evidence from multiple sources" [18, p. 4]. Due to time constraints, a full systematic review was not practical. Instead, a scaled-down methodology called Rapid Evidence Assessment (REA) was used to determine the best available scientific knowledge from the highest reliability evidence, often in the form of peer-reviewed journal articles and systematic reviews. In keeping with the practice of scientific method, research was conducted via a transparent, repeatable process.

Barends *et al.* (2014) define an REA in 12 major steps reflected in the table of contents: (1) background, (2) research question, (3) inclusion/exclusion criteria, (4) search strategy, (5) study selection, (6) data extraction, (7) critical appraisal, (8) results with findings and CERQual evaluation of each finding, (9) synthesis of a conceptual model, (10) limitations, (11) conclusion, and (12) implications for practice [18, p. 5]. Each step of the way, relevant articles were filtered and evaluated for applicability through the SPICE framework to contextualize the REA question. Emphasis was placed on extracting article findings, particularly from systematic reviews as "the likelihood of bias is considerably smaller" [19, p. 38]. The major findings from 14 articles identified by the search were synthesized into a conceptual framework for application to management practice during the subsequent organizational restructuring, and those recommendations were subjected to peer review from other doctoral students to assess suitability. This careful attention to bias and critical assessment of each step of the process ensures validity of the results.

A. Search Strategy and Inclusion/Exclusion Criteria

The search begins with a selection of databases of scholarly research to query, and the search terms to explore. A broad selection of search terms related to the research question was initially used across a variety of databases to cast a wide net for a variety of articles across different fields. After a range of highly relevant articles was identified, a more targeted search string was created that would reliably return these articles through the lens of the goal congruity theoretical framework via more formal queries of the databases, including several other sufficiently similar articles in the search space for further appraisal and evaluation.

The original set of search strings was derived from the SPICE criteria used to develop the research question and filter articles for relevance. This ensured the REA search was conducted in a manner that is "transparent, verifiable, and reproducible" [19, p. 12]. These provided several primary search terms as well as related theoretical models and contextual terms, providing the terms and variations documented in Appendix A. A sampling of highly relevant articles was scanned for common terminology and then the search space was then condensed to find the minimum number of terms that would return those articles from a query. The final search strings used on each database were recorded in Appendix B. The primary database used is the UMGC OneSearch based on Elsevier and includes a variety of articles from scholarly academic journals. Additionally, a selection of databases from a list not included in OneSearch were accessed as well for a more comprehensive search. Two technical industry databases were selected for the quality of search results provided: the ACM Digital Library and IEEE Computer Science Digital Library. These provided access to more technically focused engineering articles in the industry to complement the academic journals and provide a practitioner focus. The interface we had did not allow wildcards, so the search strings were modified to spell out the variations of common search terms. Finally, ABI/Proquest and SAGE Journals were also searched using these strings but returned few relevant non-duplicative articles among hundreds to thousands of additional irrelevant results from other fields even when focused with additional search terms, so they were excluded from further reporting in this REA.

B. Study Selection

Moher et al. (2009) define the PRISMA flow chart methodology [20] used to filter studies as shown in Figure 2

Date ranges were limited from 2011 through 2021. Articles from 2022 were excluded to make the search repeatable. In total 21 articles were identified for full text download for further data extraction and critical appraisal.

C. Data Extraction

The articles then go through a summary evaluation of primary findings to condense their major characteristics. These characteristics were extracted into worksheets summarizing properties including: Author(s), Publication Year, Citations,

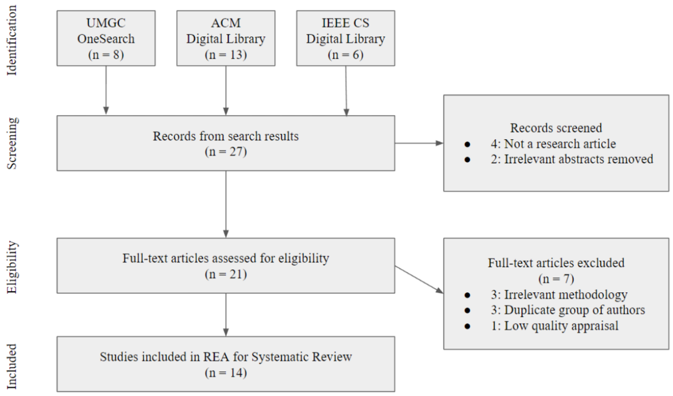

Fig. 2. PRISMA flow chart. **Note**: Adapted from "The Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement," by D. Moher, A. Liberati, J. Tetzlaff, D. G. Altmann, and The PRISMA Group, 2009, The BMJ, 6, p. 3, Copyright 2009 by The PRISMA Group.

Sector/Population, Research Design, Sample Size, Main Findings, Outcome Measures, Possible Moderators or Mediators, Effect Size with a 95% Confidence Interval, Limitations, and Level of Trustworthiness.

This helps identify their research question, sample demographics, methodology, and main elements of their conceptual framework and outputs along with relevant discussion of primary effects and limitations. This extracted information was used to categorize and critically appraise the article to determine its trustworthiness.

D. Critical Appraisal

The quality of the article was evaluated using the Mixed Methods Assessment Tool (MMAT) [21]. The MMAT consists of two screening questions followed by a set of five questions appropriate to the type of study, making the MMAT more appropriate for use in an REA that includes a blend of qualitative and quantitative research methods. For this REA, the MMAT scoring of an article is calculated from the sum of the answers to these five questions using a three-level Likert scale where a "yes" counts as two points, "can't tell" counts as one point, and a "no" counts as zero points. With a scoring range from zero to ten, articles that rate higher than six have been shown to have been conducted appropriately and were retained in the study. One study with a score of five was dropped from the dataset.

Five articles were all from the same group of authors collaborating with Diekman *et al.* (2011) [22]. While many of them scored highly on trustworthiness level [19, p. 17] due to the methodology of randomized controlled trials (RCT), many of them followed a nearly identical format and findings across undergraduate psychology student populations under study each year. Therefore, three of the articles were dropped from this REA as duplicates in order to avoid outweighing the rest of the dataset, leaving one of the oldest [22] and one of the more recent works [23] to adequately represent the evolution of thought in that group of academics in this REA.

TABLE II
CRITICAL APPRAISAL SCORING SUMMARY

#	Article	Type	Methodology	Sector	Sample sizes	Trust Level	Appraisal Score
1	Allen et al. (2021) [24]	Quantitative	RCT SEM	science undergraduate	245, 152	4	10
2	Barretto et al. (2021) [25]	Quantitative	cross sectional study	CS undergraduate	159	1	7
3	Bego & Nwokeji (2021) [26]	Qualitative	scoping review	CS	21	2	9
4	Boedeker et al. (2015) [27]	Quantitative	cross sectional study	HS students	186	1	7
5	Clarke-Midura et al. (2020) [28]	Quantitative	uncontrolled study w/ pretest	HS students	87, 43	2	8
6	Diekman et al. (2011) [22]	Quantitative	RCT	science undergraduate	318, 75, 551, 64, 241	4	10
7	Isenegger et al. (2021) [29]	Qualitative	case studies	undergraduate	18, 11	0	8
8	Lewis et al. (2019) [30]	Quantitative	cross sectional study	engineering undergraduate	5,821	1	10
9	Morrison et al. (2021) [31]	Qualitative	systematic review	STEM career women	87	4	10
10	Qiu et al. (2021) [32]	Quantitative	cross sectional study	career women	114, 136	1	8
11	Salguero et al. (2021) [33]	Quantitative	cross sectional study	CS undergraduate	1676	1	10
12	Svozil et al. (2020) [34]	Qualitative	case studies	HS	134	0	10
13	Wang & Redmiles (2019) [35]	Quantitative	RCT	SW Dev organizations	142	4	10
14	Weisgram & Diekman (2017) [23]	Quantitative	RCT	MS, HS, undergraduate	103, 80, 217, 87	4	10

TABLE III
DESCRIPTION OF REA DATA SET

Study Type	# articles	Publication Year	# articles
Quantitative RCT	4	2011	1
Quantitative cross-sectional	6	2012	
Qualitative systematic review	2	2013	
Qualitative case study	2	2014	
		2015	1
		2016	
Sector	**# articles**	2017	1
Professional	3	2018	
Undergraduate	8	2019	2
HS	4	2020	2
MS	1	2021	7
Sample Size	**# articles**	**Assessment Score**	**# articles**
< 25	2	10	8
25 - 100	4	9	1
100 - 200	7	8	3
200 - 300	2	7	2
400 - 500	0	*6*	*0*
>500	3	*5*	*1 (removed)*

E. Description of Data Set and Critical Appraisal

Tables II and III provide descriptive summaries of the data set, showing a balanced distribution of study types, sectors, sample sizes, and publication years. This REA skewed towards primarily quantitative cross-sectional studies, though the qualitative studies had equal representation of half case studies and half systematic reviews. The distribution of included sectors focuses on undergraduate university students, which represent the middle of the tech career pipeline. This likely represents some selection bias due to undergraduates being readily available for scholarly research, whereas middle and high school students require parental permission from an Institutional Review Board (IRB) to include in research. This subjects many samples to survivor bias since research indicates that students form career aspirations as early as middle school age. Study sample sizes ranged from a low end of under 25 samples for case studies to above 200 for the larger quantitative surveys. The quantitative articles in between had enough data to show correlations but often lamented that they did not have enough data to confirm confounding factors or fully establish other useful statistical indicators. The year of publication displays a spike in interest on this topic during the pandemic, which tracks with the decline of women's representation in the tech workforce over the past decade. Finally, the critical assessment scores showed most articles ranking highly, with a low-scoring outlier which was removed. This indicated that the search may be close to exhaustive in this space for high-quality articles.

F. Coding

Once the dataset was identified, the articles were coded in accordance with Saldaña's (2021) methodology for qualitative research [36]. Coding was performed using Atlas.ti, a qualitative data analysis computer software. Following the practice recommended by Barends *et al.* (2017), only the findings sections from "the collation of the results and other information of the studies included" were coded [19, p. 15]. This focuses the findings on the evidence and removes author bias introduced in the literature review and introductory sections. The findings were condensed by lumping and linking codes into categories and themes in multiple cycles. Initial first cycle codes were drawn from the SPICE terminology and coded using "exploratory coding" methods described by Saldaña (2013), which focused on using "In Vivo Coding" of terms encountered directly in the source material and "Versus Coding" of terms presented in opposition [37, p. 63].

The next coding cycle included identifying and forming emergent categories depicted by Saldaña. This combined over 600 individual in-vivo codes using Saldaña's (2013) practice of "lumping" and "splitting" using Atlas.ti's "merge codes" feature helped bring the number of unique codes to 270. Further merging of grammatical forms and synonyms further reduced the codes of interest into categories related to each other across 9 sub-themes organized into 3 major thematic findings. Relationships between themes, sub-themes, and codes were diagrammed in Atlas.ti using networks, code groups, and codes, respectively. This provides traceability back to the individual codes linked to the source documents identified in the REA.

IV. RESULTS

The major thematic findings from the REA expand on the initial conceptual framework shown in Figure 1 in three areas. The concept of "masculine cultural stereotypes of STEM" was replaced with two concepts of "attractors" and "detractors" towards the positive perception of goal congruity in STEM, of which stereotypes is a component of detractors. Similarly, the perception of STEM is split into positive and negative components to ease coding. The "sociocultural background of scarcity and collectivism" was not a major component of this dataset and was instead incorporated with the attractors that encompassed societal usefulness. Finally, the "availability of supportive mentorship" was expanded to include community and outreach intervention. A more useful definition of the dependent variable "success in a STEM career" is also introduced as "persistence in the STEM career pipeline" as that measure of outcome was more explicit in the data.

The revised conceptual model more neatly fits into a three-stage pipeline summarized as "experience", "identity", and "persistence". Each of these broadly overarching thematic stages encompasses three individual categories tied together through relationships. All nine categories and their supporting articles are summarized in Table IV and discussed in detail in the three primary findings presented below.

Due to a lapse of creativity, the final conceptual framework pipeline consists of a three-legged stool made of three-legged stools.

A. Finding 1:

Three categories of experience were identified by the articles and summarized in Table V, divided into early project-based learning (PBL) education activities, attractors, and detractors to STEM interests.

TABLE IV
REA ARTICLES SUPPORTING THEMES

	Article provides support for category														
Category	**1.**	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**	**11.**	**12.**	**13.**	**14.**	**Total**
STEM experience		X	X	X	X		X	X	X	X	X	X		X	**11**
STEM attractors	X		X	X	X	X	X	X	X	X		X		X	**11**
STEM detractors	X		X			X	X	X	X	X	X	X	X	X	**11**
STEM identity		X	X	X			X	X	X	X	X			X	**9**
pro-STEM perception	X	X	X	X	X	X	X	X	X	X	X	X		X	**13**
anti-STEM perception	X	X	X			X	X	X	X	X	X	X	X		**11**
persistence in STEM	X	X	X	X	X	X		X	X	X	X			X	**11**
self-efficacy			X		X				x	X	X		X		**6**
support network	X		X		X	X		X	X	X				X	**8**
Supportiveness	**6**	**5**	**9**	**5**	**6**	**6**	**6**	**8**	**9**	**9**	**7**	**5**	**3**	**7**	

TABLE V
SELECT CITATIONS SUPPORTING EXPERIENCE FINDING

Category	Supports
Early education experiences via PBL	"STEM PBL activities seemed to have stemmed the attrition of females in the high school in the study. Therefore, STEM PBL activities may attribute to retention of girls in high school." [27, p. 7] "the use of the PBL framework fits with participants' learning styles" [32, p. 97] "design concepts and principles to engage girls in learning programming through different media and interaction techniques" [35, p. 8]
Attractors	"benefts to women's persistence were statistically predicted by greater science communal perceptions" [24, p. 951] "opportunities for communal STEM experiences - such as volunteering, mentoring, and group projects - may be effective for improving students' perceptions of computing" [30, p. 18]
Detractors	"barriers include the lack of awareness of some site features, the intimidating community size, fear of receiving negative/unfriendly comments and lacking confidences on their qualifications." [35, p. 8] "despite a rhetoric of change, the dominant portrait of technology education remains artifact-centric and socially distant. This finding is deeply problematic in the light of prior research on the impact of an artifact-centric and socially distant structure on inclusivity and diversity of recruitment in the engineering education literature, both in terms of gender balance, as well as the broader accessibility of engineering identities for under-represented, and diverse socioeconomic groups." [34, p. 6]

TABLE VI
SELECT CITATIONS SUPPORTING IDENTITY FINDING

Category	Support
Self-identification with STEM aspirations	Introduction of PBL affected "the STEM course selections made by students… the number of females who chose to take physics courses was almost three times the number of males" [27, p. 7]
Positive perceptions of STEM	"This result is harmonious with prior study results showing that females were more interested in STEM courses and fields when they were able to see benefits to individuals and to society" [27, p. 7] "Perceptions of communal affordances … exhibit a positive relationship with sense of belonging in computing, … compared to their peers who perceive computing as having fewer communal goal affordances." [30, p. 17]
Negative perceptions of STEM	"beliefs that family caregiving is incongruent with a science career become more extreme from adolescence through young adulthood, and this perceived incongruity can have strong implications for career decisions." [23, p. 14] "students with high communal goals tend to have a lower sense of belonging in computing than their peers with low communal goals" [30, p. 17]

B. Finding 2:

Three categories of self-identity and belonging were detailed by the articles and summarized in Table VI. These are divided into positive and negative perceptions which alter the individual's sense of identity associated with a STEM career.

C. Finding 3:

Three categories concerning persistence to stay in the STEM pipeline were identified by the articles and summarized in Table VII. The final persistence to continue on to the next segment of the STEM pipeline is bolstered by an individual's self-efficacy, and that failing, caught by a supportive social safety net made of community, peers, and mentors.

D. Summary of the Findings

The findings support several practices that should be included in industry outreach programs to help rather than hurt the recruitment of women into identifying with a career in tech, thus helping to increase the number of qualified professionals in technical fields.

First, early experiences must steer clear of stereotypical detractors as well as increase appeal to women by highlighting the communal nature of group problem-solving. Also, a continuous support structure should be provided to dissuade young women from dropping out due to incongruous self-image. In both cases, the application of goal congruity is clear. Alignment of goals helps individuals identify with technology which has a useful impact serving their communities. Simultaneously, the feeling of in-group belonging to a community of like-minded technology provides the support needed to remain dedicated to the tech career educational path.

E. Conceptual Model

The REA findings provide more detail into the inner workings of the initial theoretical framework depicted in Figure 1. Through the process of meta-analytic "triangulation" described

TABLE VII
SELECT CITATIONS SUPPORTING PERSISTENCE FINDING

Category	Support
Persistence to continue in the STEM career pipeline	"present data suggest that affording communal values during a tedious science task protected women's science persistence and buffered their intrinsic motivation for science." [24, p. 959] "results consistently revealed benefits to women's persistence on a boring data transcription task, which were statistically predicted by greater science communal perceptions, which in turn led to increased intrinsic interest (and in limited cases, belonging). Importantly, this pathway was primarily true for women participants, although it is noteworthy that men were not harmed by increased communal perceptions of science, and in fact, communal perceptions still predicted increased science interest for men." [25, p. 956]
Self-efficacy	"her high expectations resulted in feelings of insecurity, exclusion, and shame as she interacted with students who had had stronger pre-engineering experiences… Her negative feelings reinforced themselves; the feelings were demotivating, she fell behind in her studies, and she considered leaving engineering." [26, p. 6] "Our findings on the increase in self-efficacy and interest among the outreach group (although the latter was not significant) indicate that the camp design has the potential to promote a positive affect among youth from low income high poverty areas" [28, p. 16] "Building Confidence and Professional Identity… a large body of research on growth mindset, but to date few studies looking specifically at its impact in computing." [31, p. 79]
Support structures	"STEM programs could implement a curriculum that not only teaches the content but also fosters relationships in the process, thereby not harming majority groups but significantly bolstering the experience of minority groups." [24, p. 957] "good advertising is not enough; the opportunities for collaboration, helping, and altruism within STEM fields need to be facilitated if retaining communally oriented individuals is an important goal." [22, p. 913] "students who participated in their learning communities had a stronger intention to persist in computing … characterized by common residence and mentoring and outreach activities … learning community students and students in the comparison group were both negatively impacted by environmental threats as their psychological and aspirational outcomes decreased over time" [31, p. 65]

by Petticrew and Roberts (2006) [38, p. 187], a more refined conceptual model was constructed in Figure 3 giving a more nuanced and readily measurable view of the phenomenon of interest.

V. Discussion

A growing body of evidence shows studies effectively using goal congruity to increase interest and persistence in STEM career progression, Notably, while several studies noted this perspective helps increase participation among women, it also increases STEM interest among "men who highly endorse communal goals … firmly [suggesting] the 'gender' problem in STEM pursuits can be at least partially considered a 'communion' problem." [22, p. 912] This has the potential to remove an unnecessary filter from the population of potential STEM candidates that is non gender specific but relies on a characteristic that aligns along gender boundaries.

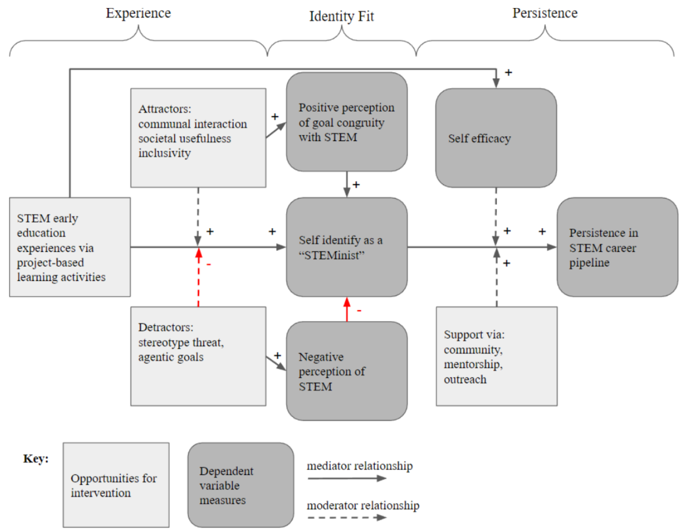

Fig. 3. Conceptual model of findings from STEM for all data set

A. Recommendations for Management and Scholarship

The evidence presented by the research papers identified by this REA demonstrated several opportunities to address different parts of the STEM career pipeline. The recommendations correspond to the independent variables identified in the conceptual framework shown in Figure 3.

1) Recommendation #1: The simplest way to counter stereotypes is by offering counter-evidence. By providing early experiences to engage with technologists, young women can form a more accurate representation of what the field looks like as distinct from how it's portrayed in news, media, and even technical school catalogs and websites. Depiction of engineering as a highly collaborative endeavor where diverse and specialized knowledge is accessed across every contributor quickly dispels the notion of scientists and engineers working in isolation.

2) Recommendation #2 : In accordance with goal congruity theory, the emphasis on STEM careers building useful infrastructure that benefits society helps align with people who strongly identify as useful team members who want to support social well-being. Illustrating and framing the social impact of many engineering products and the teams who support them is a simple way to show the necessity of STEM careers to coordinate life-saving advances in technology in fields such as emergency response, disaster recovery, biomedical engineering, and mental health applications among many others. This malleability of perception helps connect STEM to a person's own identity.

3) Recommendation #3: Finally, the self-efficacy of young women pursuing a STEM career can be bolstered using continued project-based learning activities. These can take the form of incremental challenges that gradually build skill and ability, such as hackathons, side projects, and ten-percent time to pursue independent projects at their skill level. Each success will bolster confidence and increase interest and desire in participating in future STEM opportunities. Also vital is to simultaneously include the support infrastructure of mentoring communities who are ready to intervene and provide a path forward when participants get frustrated and tempted to drop out of the pipeline. Several studies in this dataset have shown the effectiveness of peer and mentor connections in assuring participants of their worth and helping them persist when their own self-efficacy is low.

Applications of these recommendations in industry established outreach programs have been shown to help recruit and retain women in STEM career pathways, increasing the availability of qualified professionals in the candidate pool.

B. Recommendations for Future Study

An important theme from several studies that included demographic data beyond gender indicated the goal congruity techniques that work to improve recruitment of women also work for other underrepresented minorities. All of these studies called for more intersectionality studies due to insufficient sample sizes. This would help extend the generalizability of these findings beyond gender.

Future work could focus study on alternate theoretical lenses that would focus more on sociocultural factors and state authenticity. Other nations and cultures do not have the same gender imbalance present in western nations and more research could be done to attempt to reproduce some of their conditions. Additionally, the field of state authenticity has some explanatory powers that better tackle the socioeconomic gap. This field posits that group belonging is highly dependent on the fit between a person's self-image and their environment. A thoroughly unfamiliar environment serves to strongly dissuade them from identifying with the group.

The search terms for goal congruity perspective may have limited the scope of the search and excluded papers with relevant data. Broader search coverage incorporating new terminology and similar theories such as state authenticity may have turned up more insight present in the literature review.

C. Limitations

The CEBMa REA methodology made some concessions for the sake of expediency described by Barends *et al.* (2017) [19, p. 32]. This results in limitations on "the breadth and depth" of the search resulting in fewer articles than a full systematic review. Potentially insightful evidence from gray literature has also been excluded. Methodologically, the majority of this REA was conducted by a single researcher, increasing the risk of bias during critical appraisal and coding. Another limitation was the restriction to a ten-year period. Work on increasing diversity in the workforce has been underway through several tech boom and bust cycles of the 1990s and earlier, which has provided relevant data available for analysis. Finally, the REA was conducted by a sole researcher who would be classified as in the majority gender and race/ethnicity categories. This subjectivity statement acknowledges and attempts to minimize a potential source of bias with "a summary of who researchers are in relation to what and whom they are studying" [39, p. 845]. However a full systematic review should include peer reviews from other categories to incorporate a more balanced perspective into what interpretations or findings would be noteworthy or unexpected.

While the recommendations sound as simple as pointing out that STEM stereotypes are untrue, Weisgram and Diekman (2017) point out that "a strong caveat ... is that such family-friendliness cannot only occur in marketing about careers; the real-life cultures of institutions and workplaces must encompass work-life resources" [23, p. 13]. This authenticity would be necessary to build on a foundation of trust with Gen Z.

D. Conclusion

STEM careers have a long path of education and skill building due to rigid requirements and high educational and professional certification dependencies. STEM recruitment and retention practices could be more effective by using goal congruity to enable larger segments of the population to identify into joining an increasingly essential career path. All industries are in the process of being revolutionized by the introduction of technology to increase business intelligence capability and efficiency. Without a trained workforce many of the benefits could be squandered by unqualified individuals who don't have the breadth of connection to adequately solve problems for everyone.

APPENDIX A
INITIAL SEARCH TERMS AND VARIATIONS

STEM, tech / technical / technology / engineering, industry / computer / CS / programming, outreach, career / profession / professional, recruitment / retention pipeline, PBL / project based learning, gender, underrepresented minority, race / ethnicity, women, masculine / feminine, mentor / role model, agentic, goal congruity / congruence, communal, identity, belonging, attitude / perception, interest / intention / motivation, sociocultural / socioeconomic, self-efficacy, stereotype threat / stigma, nerd / geek, bully, collaboration / collaborate, help / service, affordance

APPENDIX B
DATABASES AND SEARCH STRINGS

UMGC OneSearch (Elsevier)

STEM AND TX (recruit* OR retain OR retention) AND (congruity OR congruence) AND communal

(8 results; yield: 3, retained 38%)

ACM Digital Library

STEM AND (recruit OR recruitment OR retain OR retention) AND (congruity OR congruence) AND communal

(13 results; yield: 6, retained 46%)

IEEE Computer Society Digital Library

STEM AND (recruit OR recruitment OR retain OR retention) AND (congruity OR congruence) AND communal

(6 results; yield 5; retained 83%)

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